



**BUG**

Tale of the  
Lost Technician  
Coloring and Activity Book

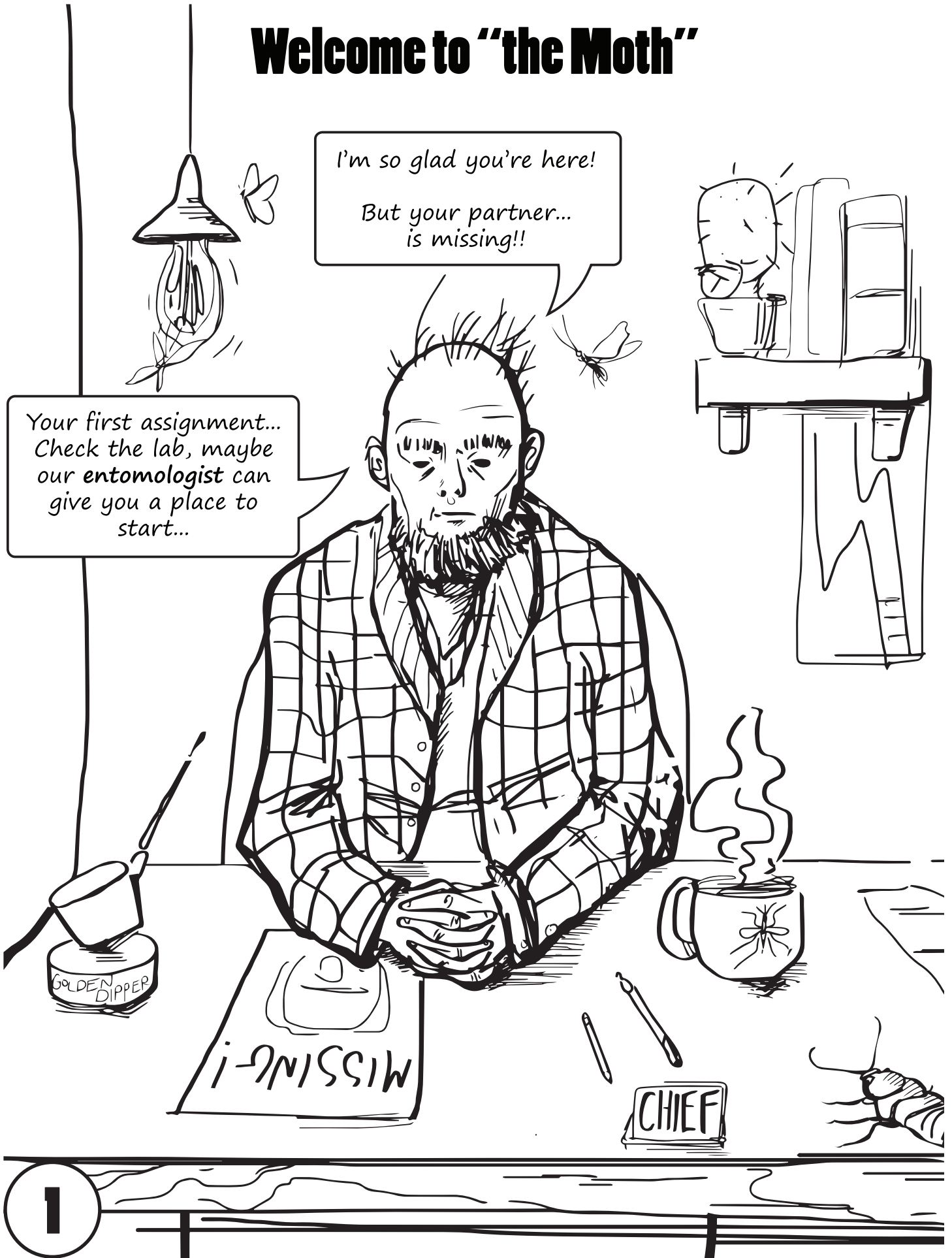
**QUEST**

# Welcome to "the Moth"

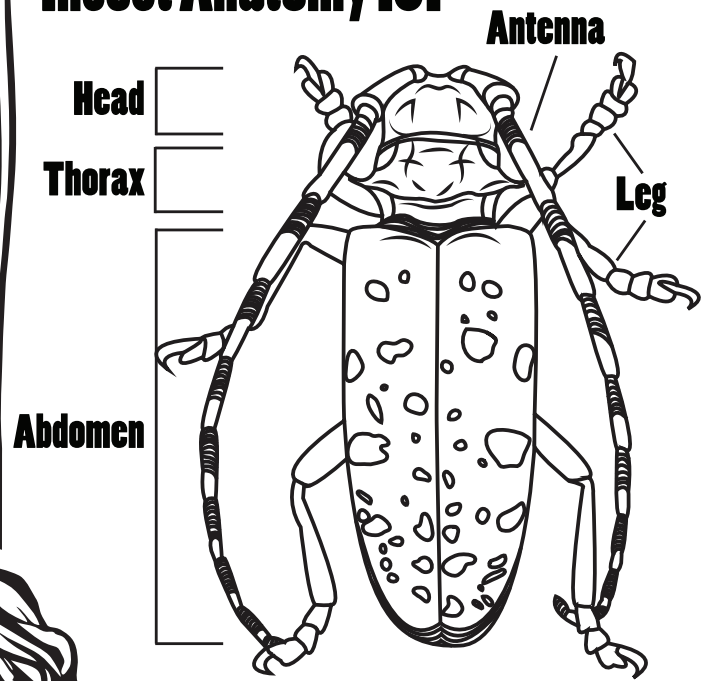
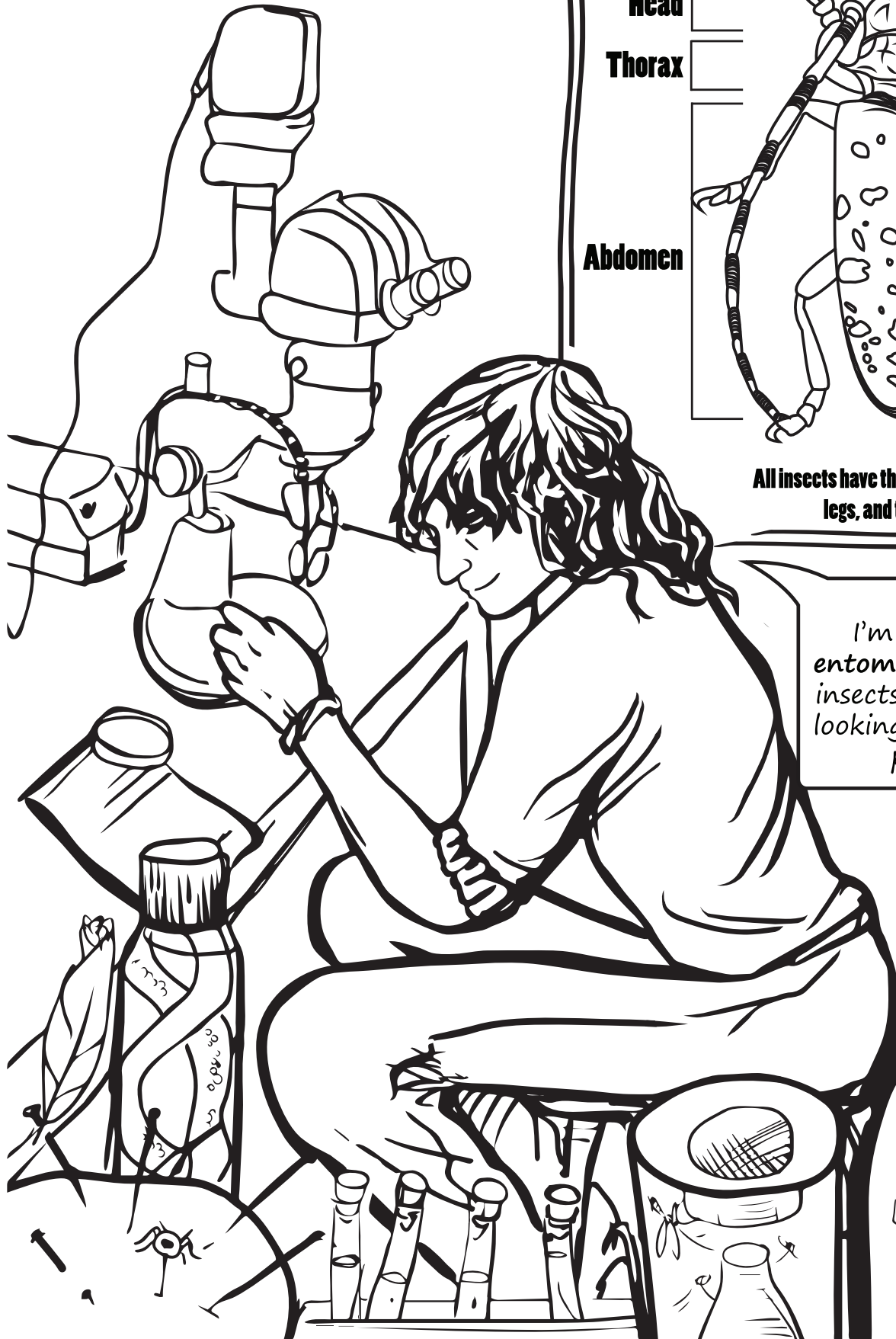
I'm so glad you're here!

But your partner...  
is missing!!

Your first assignment...  
Check the lab, maybe  
our entomologist can  
give you a place to  
start...



# Insect Anatomy 101



Head

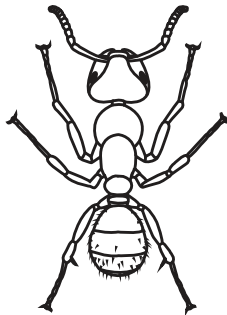
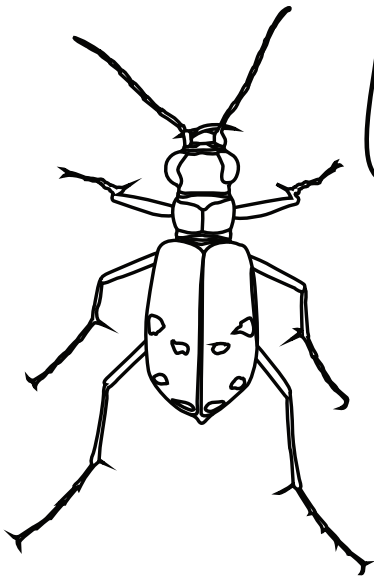
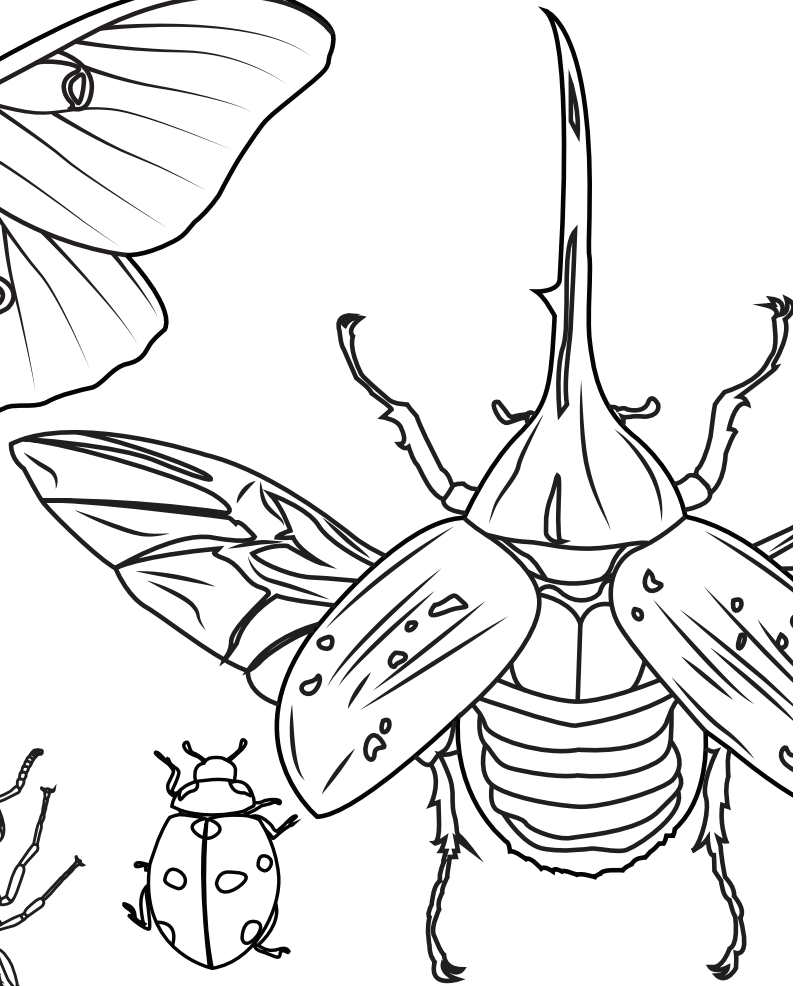
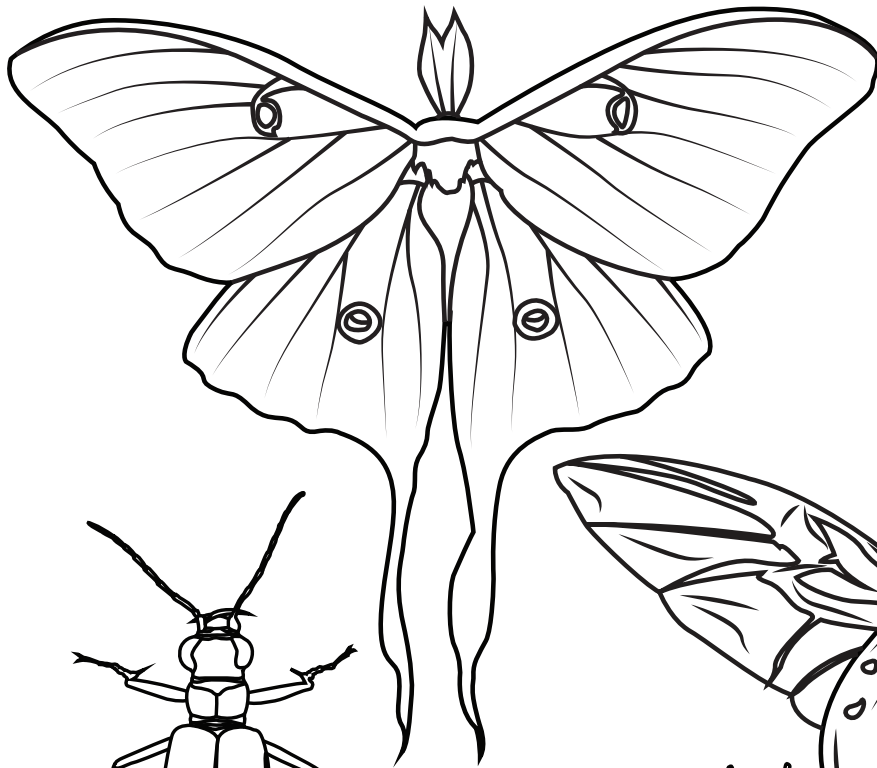
Thorax

Abdomen

All insects have three body segments, six legs, and two antennae

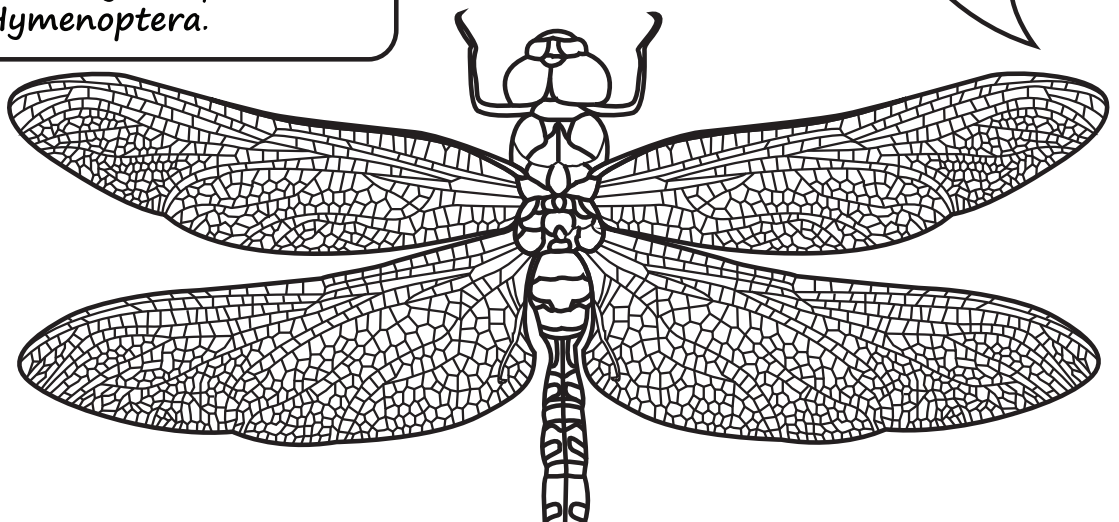
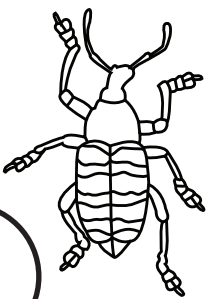
Hello...  
I'm the branch entomologist. I study insects. I hear you're looking for your new partner?





Your partner mentioned something about searching for an insect that we've been having difficulty finding... a species of *Hymenoptera*.

The Hymenoptera are a huge order of insects that includes all wasps, ants, and bees. How are you on your insect taxonomy by the way?





Taxonomy is the science of naming and classifying **organisms** (living things). All plants, animals, fungi, and microbes that have been described have a formal scientific name and are grouped according to their shared characteristics.

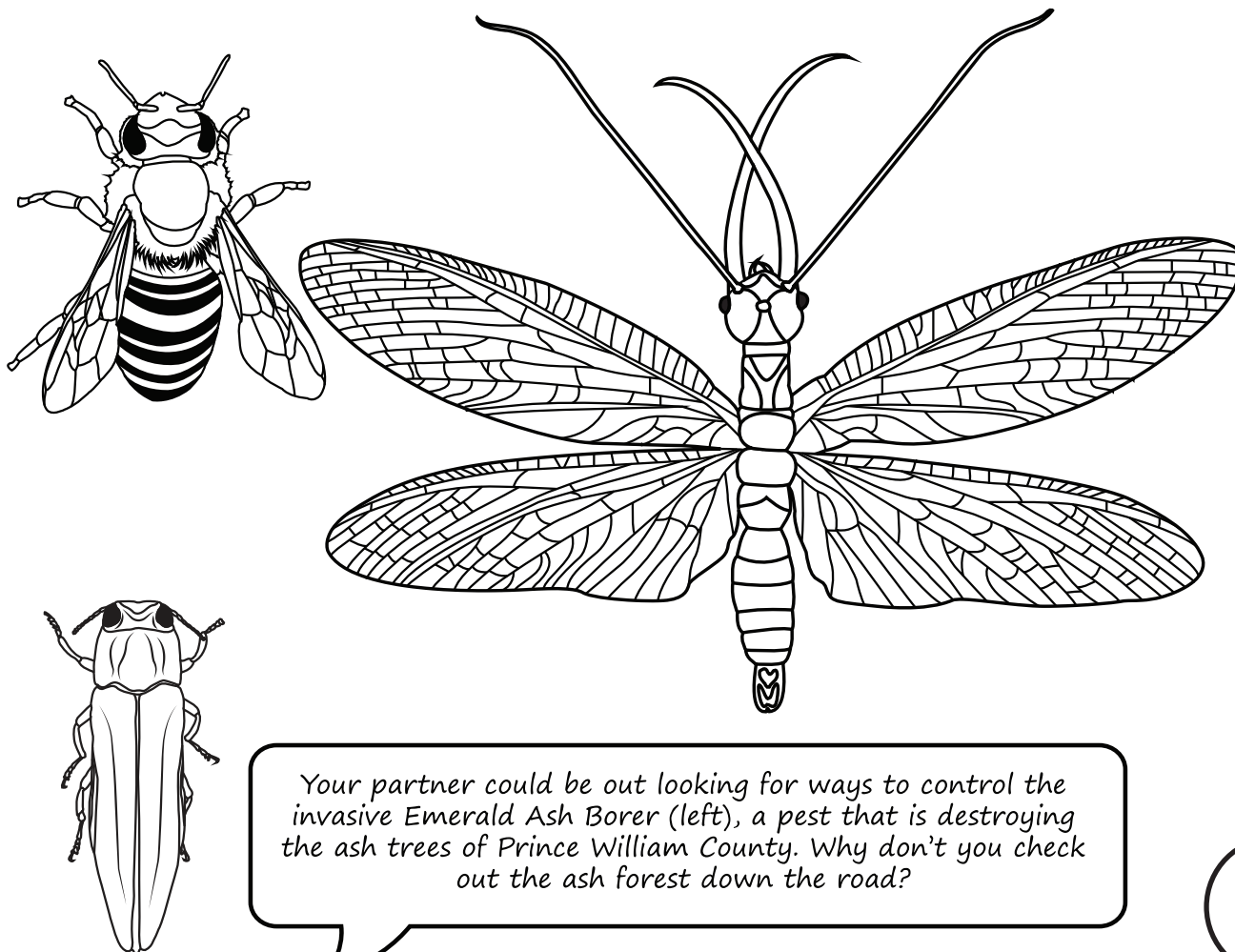
A scientific name has two words: the first is the **genus** name, the second is the **species** name. Lots of the names come from or are inspired by Latin, Greek, or Hebrew words and describe something about the organism, but some are named after people, places, and other things. Can you match these scientific names with their meaning?

Hexapoda  
 Canadensis  
 Megaloptera  
 Ferox  
 Arthropoda  
 Japonicus  
 Quadrimaculatus  
 Diptera  
 Toxicodendron  
 Luna

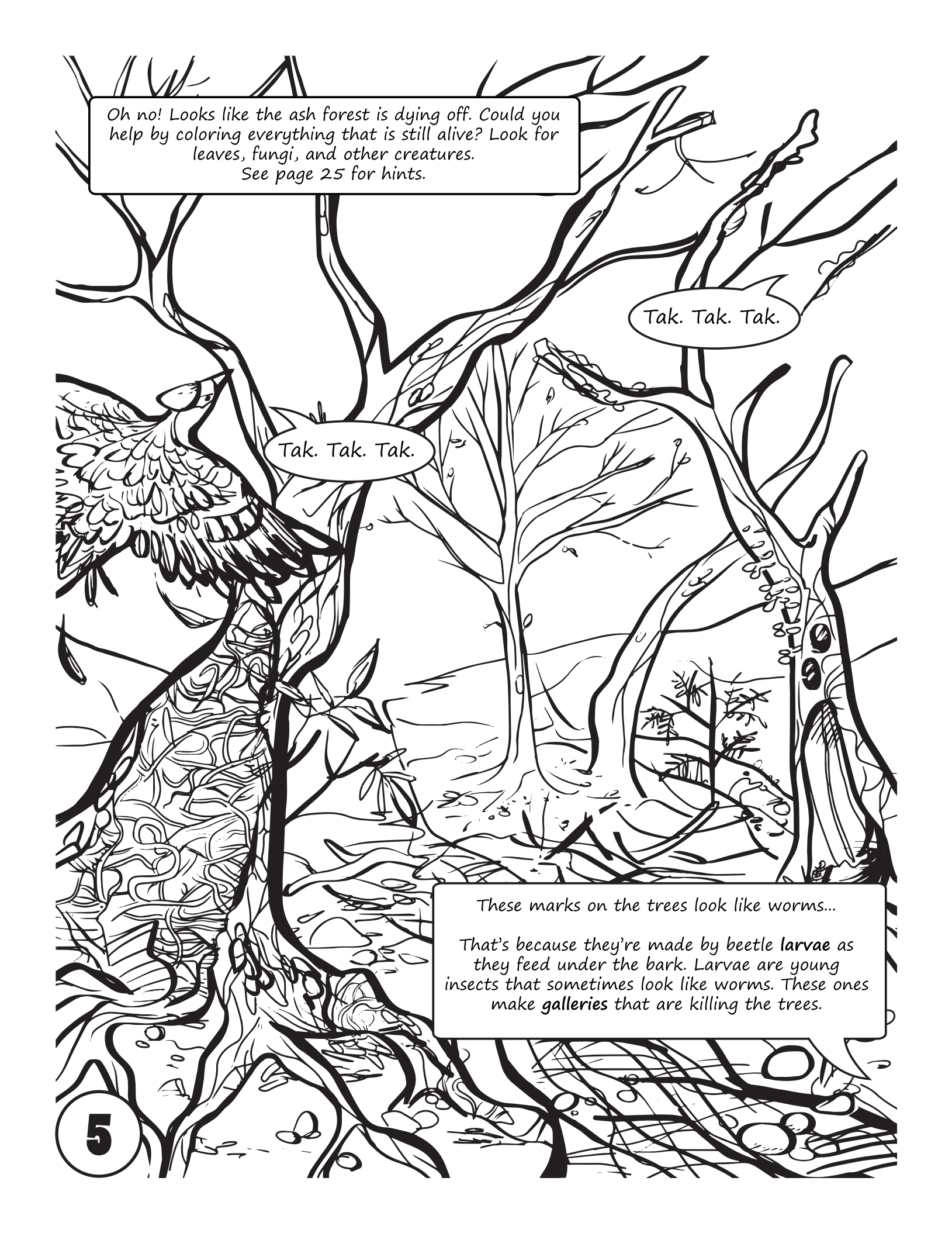
Two wings  
 Poison tree  
 Moon  
 Canadian  
 Large wings  
 Fierce  
 Six legs  
 Japanese  
 Jointed legs  
 Four spots

**Domain**  
**Kingdom**  
**Phylum**  
**Class**  
**Order**  
**Family**  
**Genus**  
**Species**

Above:  
 The  
 hierarchy  
 of life



Your partner could be out looking for ways to control the invasive Emerald Ash Borer (left), a pest that is destroying the ash trees of Prince William County. Why don't you check out the ash forest down the road?



Oh no! Looks like the ash forest is dying off. Could you help by coloring everything that is still alive? Look for leaves, fungi, and other creatures.  
See page 25 for hints.

Tak. Tak. Tak.

Tak. Tak. Tak.

These marks on the trees look like worms...

That's because they're made by beetle larvae as they feed under the bark. Larvae are young insects that sometimes look like worms. These ones make galleries that are killing the trees.

Hi!!!!

You look a little bummed...  
You were checking out the  
dying forest, weren't you? Not  
much of it left at the  
moment...

A lot of the damage was caused by Emerald Ash Borer...  
But some of my buddies here are to blame for the  
non-Ash trees. That's a gypsy moth caterpillar to my left.  
Visit [pwccgov.org/gypsymoth](http://pwccgov.org/gypsymoth) to find out how to color the  
spots on his back!



Gypsy moths are one of the many **pests** that our branch deals with. Pests are any organisms (living things) that are destructive or harmful to humans, forests, livestock, structures, or other living things. Sometimes they are simply annoying, but often they can cause serious damage.



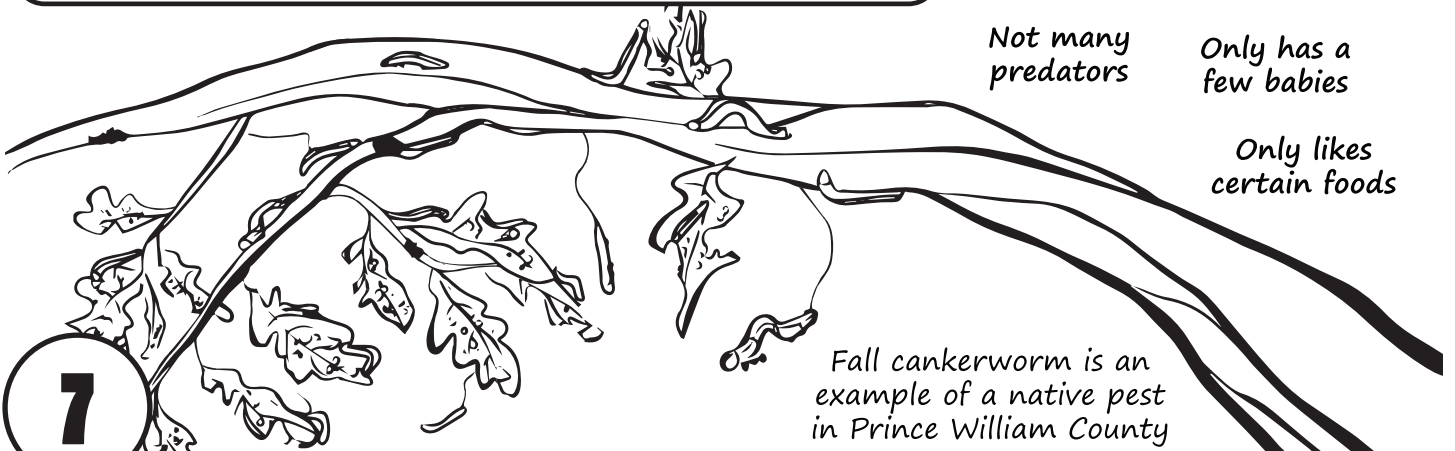
Tree of Heaven, an invasive tree, in its native habitat (left), versus its non-native habitat (right)

Native pests (pests that have been part of a local community for a long time) can be destructive (see below), but most of our worst pests in Prince William County are **invasive pests** (also called non-native or introduced), which means they were brought in from another environment and have become established where they don't belong.

In their new homes, invasive pests often do not have any predators to keep them under control and the organisms they eat, grow on, or compete with have no defense against them. They can quickly take over an environment and lead to loss of native species and **biodiversity**.

Circle the traits that you think would help an invasive pest become established:

- Calm and shy      Lots of enemies
- Grows quickly      Has lots of babies
- Not a picky eater
- Aggressive      Grows slowly
- Not many predators      Only has a few babies
- Only likes certain foods



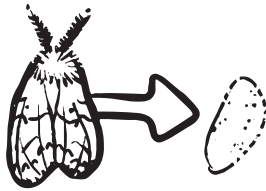
Fall cankerworm is an example of a native pest in Prince William County

Invasive pests come from all over the world and can be brought into a new environment in many ways. There are a few ways we can stop them though! It all starts with recognizing how they are transported and where they live in the different stages of their development.

This is a tricky activity, but read the descriptions of the pests below carefully and see if you can match them to the ways they might be able to travel around. Some of them may be able to use more than one mode of transportation! Answers are on page 25.

### Gypsy Moth

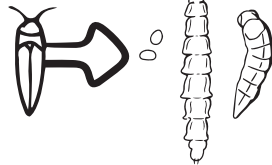
**A** Caterpillars eat oak and other tree leaves. Lays fuzzy egg masses on any protected surface near trees it likes to feed on.



Young trees from a nursery

### Emerald Ash Borer

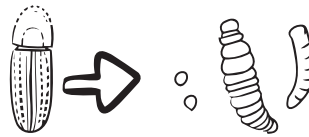
**B** Larvae chew tunnels (galleries) under ash tree bark. Lays eggs on ash tree bark.



Lawn furniture or other outdoor objects

### Walnut Twig Beetle

**C** Lays eggs on and feeds underneath walnut tree bark. Spreads a fungal infection that can stress and kill the tree.



Birds or other small animals

### Hemlock Woolly Adelgid

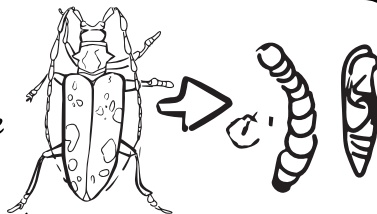
**D** Sucks sap from hemlock trees. Adults visible as white fluffy masses. Tiny nymphs can spread via wind and animals.



Untreated firewood

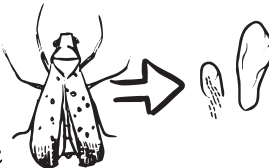
### Asian Longhorned Beetle

**E** Lays eggs under the bark of maple and other trees. Larvae tunnel under the bark to feed.



### Spotted Lanternfly

**F** Feeds on sap from a large variety of trees, fruit, and other plants. Lays egg masses on any surface close to a host.



Oh right! You were looking for your partner. I think I saw him walking through a field down the hill. Another coworker is down there too, why don't you check with her?

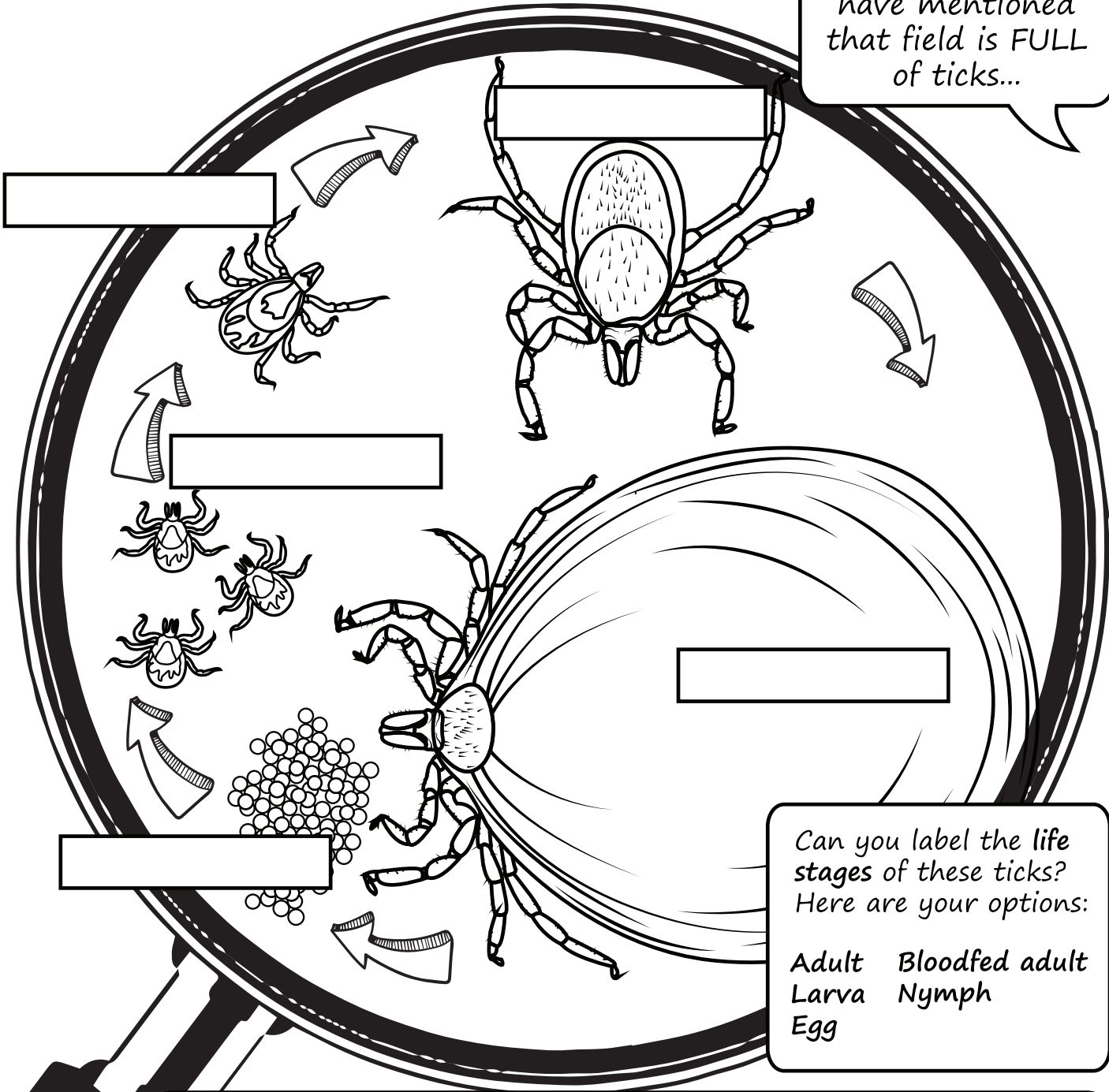


WAIT!

Don't move!!



Eww! I should have mentioned that field is FULL of ticks...



Ticks look a lot like insects at first glance, but they are arachnids and are more closely related to spiders. They are parasites and need blood from a host to develop.

Each stage in their lifecycle requires a bloodmeal. Because they feed on blood, they can transmit pathogens and make you very sick. They anchor themselves under your skin and feed for days at a time. Their bites can be really itchy and painful!

# Tick Bite Prevention Techniques

ALWAYS DO TICK CHECKS DURING AND AFTER OUTDOOR ACTIVITIES!  
After you come inside, then...

## Repellent

(I ran out, as you can see...)  
Have an adult help you when you know you'll be spending some time around ticks



## Long Sleeves, Pants, and "Fashionable" Socks

Will help to keep ticks on your clothes and off your skin so you can pick 'em off easily



## Dry

Dry your clothes on high heat for at least 15 minutes



## Shower

Wash unattached ticks off



## Save

Any ticks you find attached to you, just in case. Place them in a ziploc bag in the freezer

## Light Colors

Will help you find ticks more easily!  
Check bags and other items you have with you outdoors for ticks too!

Ticks like moist environments like high grass, brush, and leaves. Any time you're outside, use these tick bite prevention techniques!

Uh oh... this friendly neighborhood cat may be carrying ticks

Alright, so you were trying to find your partner. Yeah... no one but me and the ticks here...



Gravel, chipped wood mulch, and cut grass should be relatively tick-free!

Any vegetated areas that have high humidity can harbor ticks



Sweet shortcut... but the grass looks kind of high...

Leaves are awesome mulch. Great for trees and wildlife... including ticks...

If you follow this route you should reach one of our colleagues 'chilling out' by a pool. She may be able to help you out. Just try to avoid tick habitat if possible... a habitat is the home of an organism.



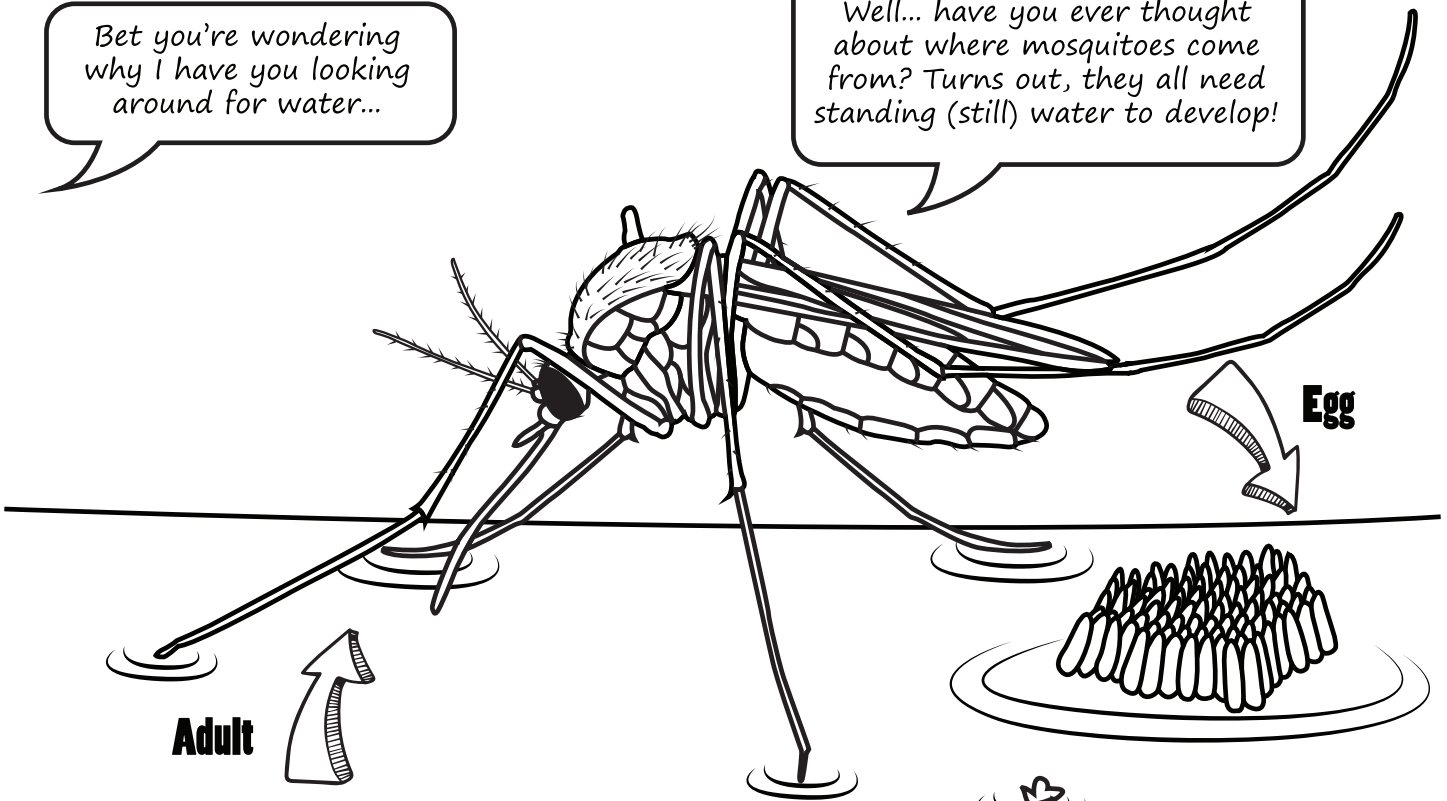


Do me a favor and help me find ANYTHING that's holding water?

Oh, not the pool you were looking for? Haha.

Bet you're wondering why I have you looking around for water...

Well... have you ever thought about where mosquitoes come from? Turns out, they all need standing (still) water to develop!

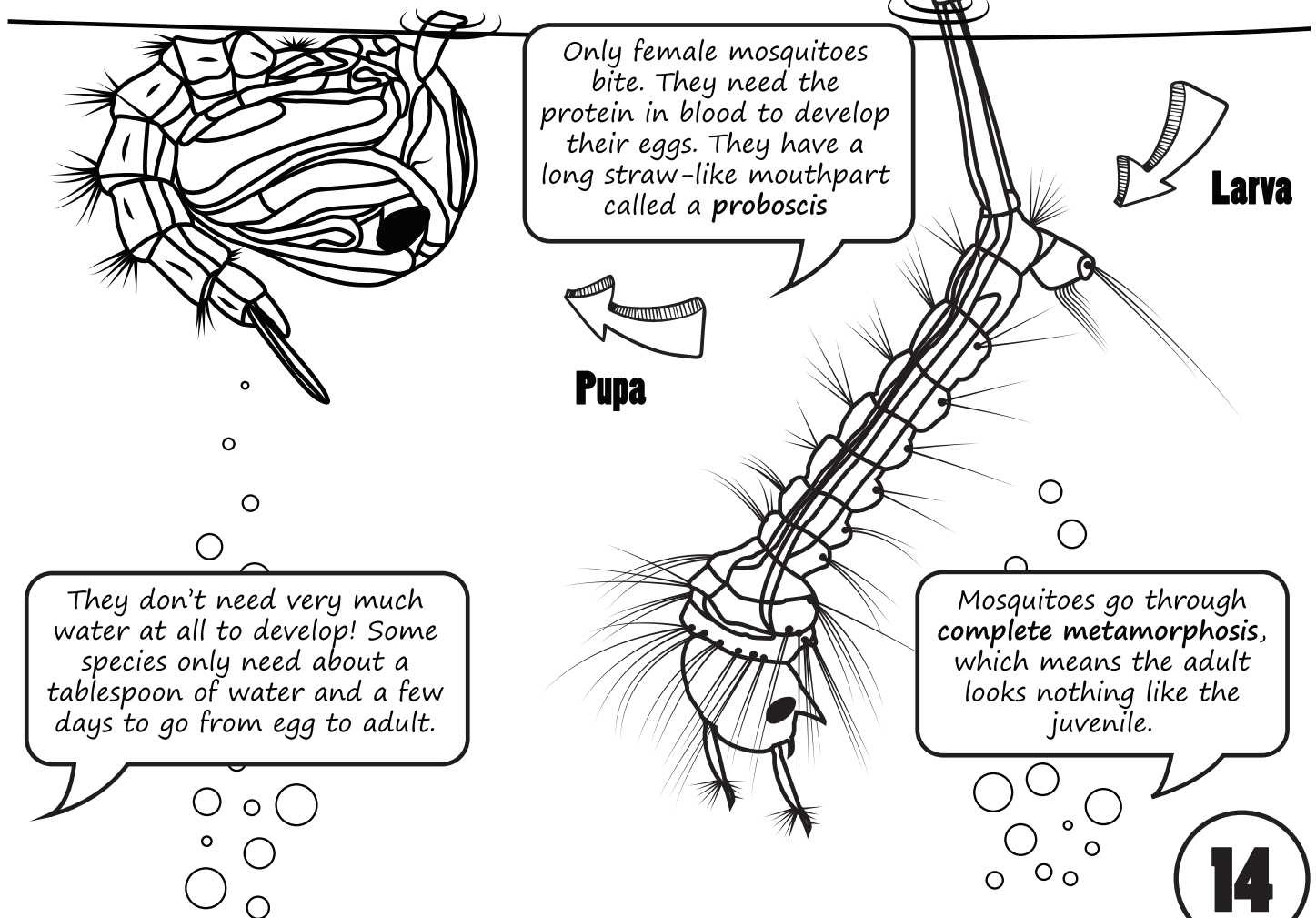


**Adult**

**Egg**

Only female mosquitoes bite. They need the protein in blood to develop their eggs. They have a long straw-like mouthpart called a proboscis

**Larva**



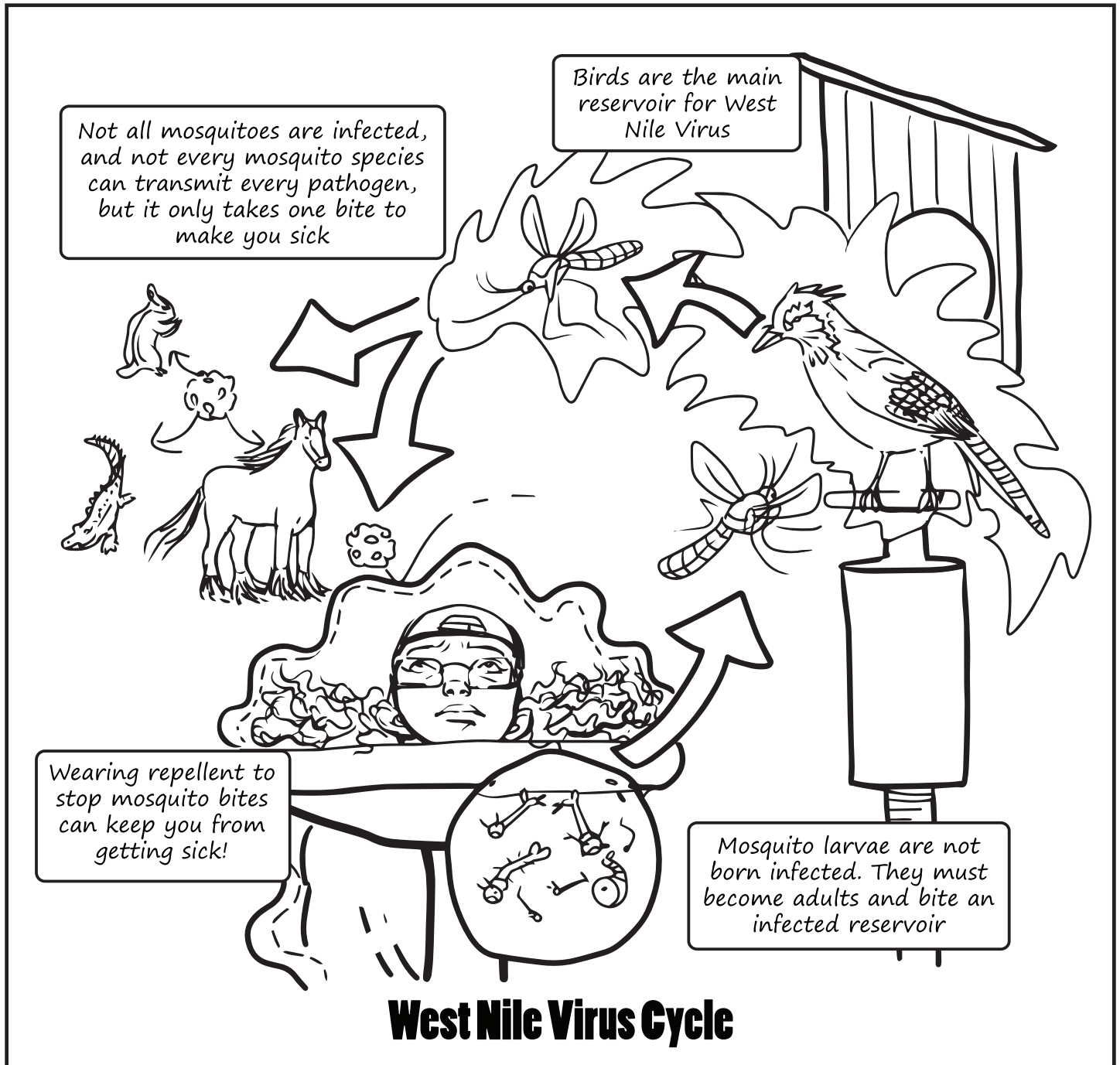
**Pupa**

They don't need very much water at all to develop! Some species only need about a tablespoon of water and a few days to go from egg to adult.

Mosquitoes go through complete metamorphosis, which means the adult looks nothing like the juvenile.

Mosquitoes are really annoying, but the main reason that we're concerned about them is because they're **vectors**.

A **vector** is an organism that is capable of transmitting **pathogens** like West Nile Virus and Zika Virus from one animal to another, which can make us very sick.



Some animals are **reservoirs**, or organisms that carry pathogens in their blood, sometimes without being harmed by them. When mosquitoes bite them, the mosquito then can pass along the pathogen to the next host that it bites.

Humans are not reservoirs for West Nile Virus, (but can get sick from it), while some bird species are reservoirs.

Yikes! So when we find a mosquito problem, what can our branch do about it?

We use something called **Integrated Pest Management (IPM)**. IPM simply means that we use multiple techniques to control mosquitoes, based on what we know about their lifecycle and biology (this applies to other pests too!). We set traps to monitor adult mosquito populations for pathogens, and our technicians inspect many different aquatic habitats for mosquito larvae. When we find a problem, we have a few options:



**Larviciding:** Controls mosquito larvae while they're still in the water, before they can emerge to bite you and transmit pathogens. This is our main method of mosquito control, because the treatment we use most often is both effective and very environmentally friendly. It does not harm many other aquatic critters.

**Adulticiding:** If we find a lot of adult mosquitoes and they have a high risk of transmitting pathogens, we will spray targeted areas with a truck mounted fogger. Because this method can also harm other insects, we don't use it unless we absolutely have to. If you see the spray truck in the evening or at night, please stay inside!

**Source Reduction:** If mosquitoes don't have water to lay their eggs in, they won't be able to complete their lifecycle! You did hunt down all the water sources from earlier right? Then you helped me out with **source reduction** by getting rid of some of those potential larval habitats!

We need your help around your home and neighborhood to control mosquitoes. Take a look around for any amount of standing water and dump it if you can. Here are some common places mosquitoes will use to lay their eggs- circle anything you find water in!

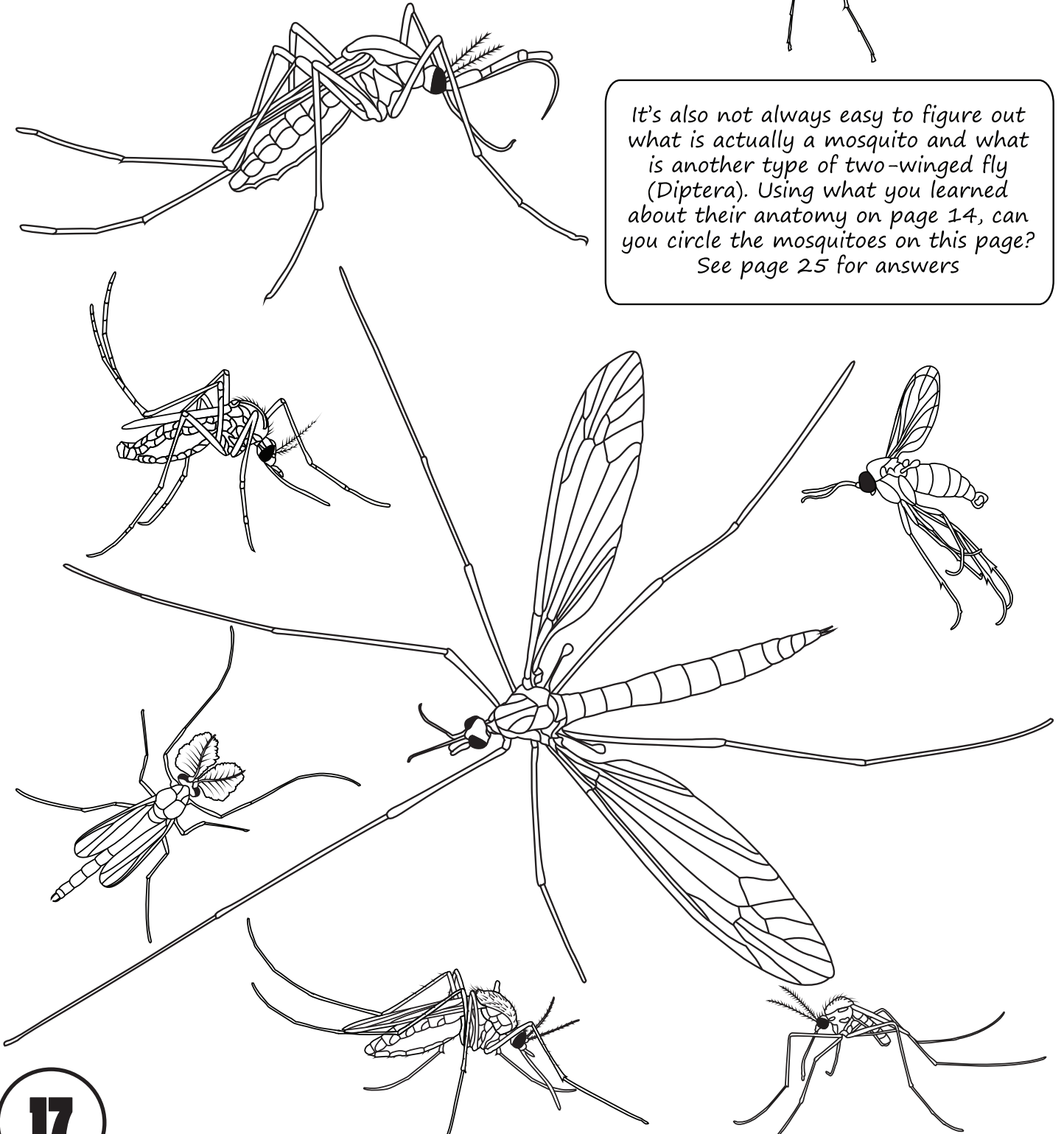
Birdbaths    Plant saucers    Pet water dishes    Buckets    French drains  
Tires    Kid's pools    Tarps    Outdoor toys    Black corrugated pipes



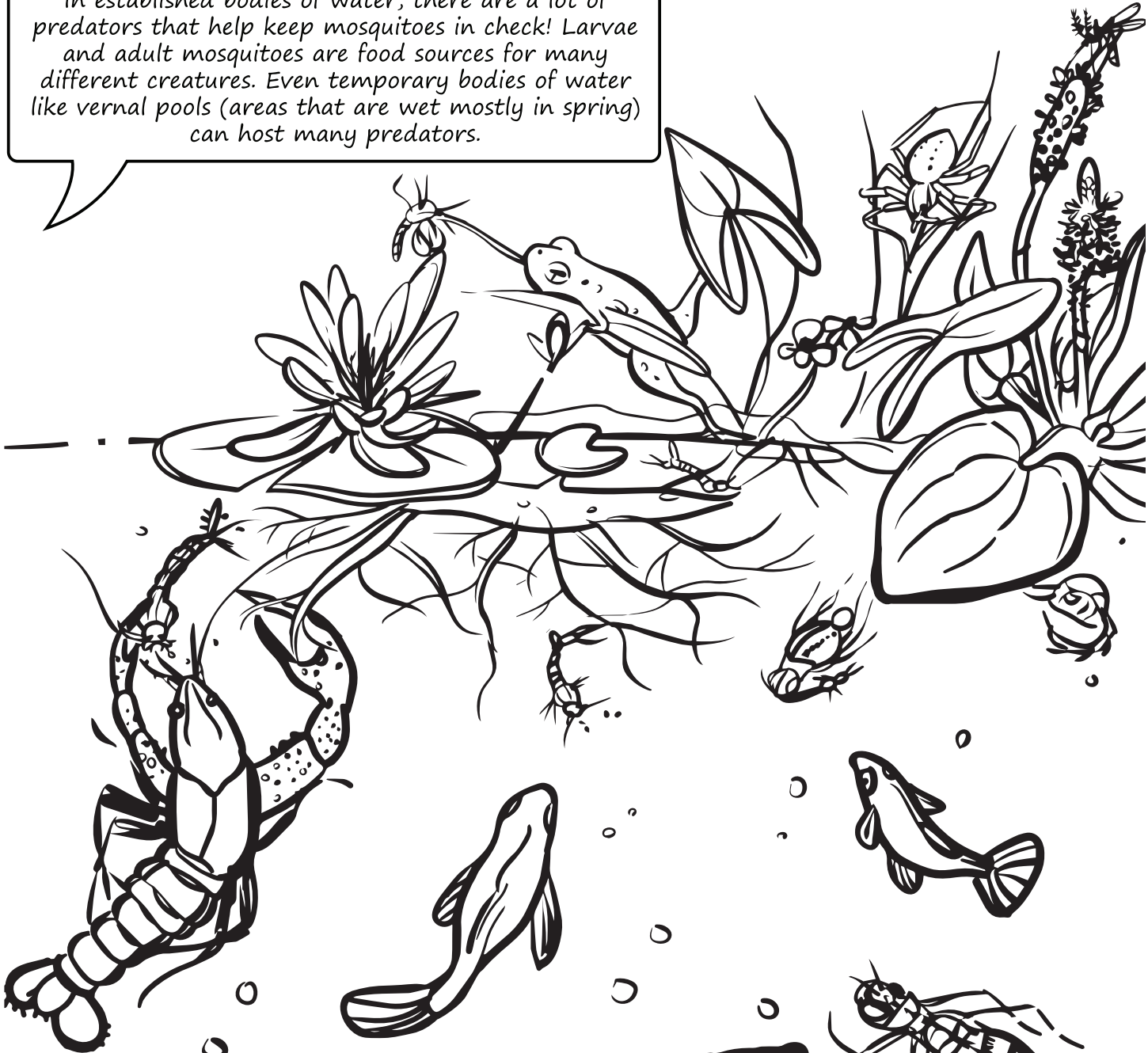
Although mosquitoes are annoying and sometimes dangerous, they don't all bite people, and many are important meals for other insects and animals. In Prince William County, we have more than thirty different species of mosquitoes! Each has its own preferred hosts and habitats.



It's also not always easy to figure out what is actually a mosquito and what is another type of two-winged fly (Diptera). Using what you learned about their anatomy on page 14, can you circle the mosquitoes on this page? See page 25 for answers



In established bodies of water, there are a lot of predators that help keep mosquitoes in check! Larvae and adult mosquitoes are food sources for many different creatures. Even temporary bodies of water like vernal pools (areas that are wet mostly in spring) can host many predators.



Sometimes I get complaints about large ponds being a magnet for mosquitoes, but usually that isn't the case. Why do you think that is?

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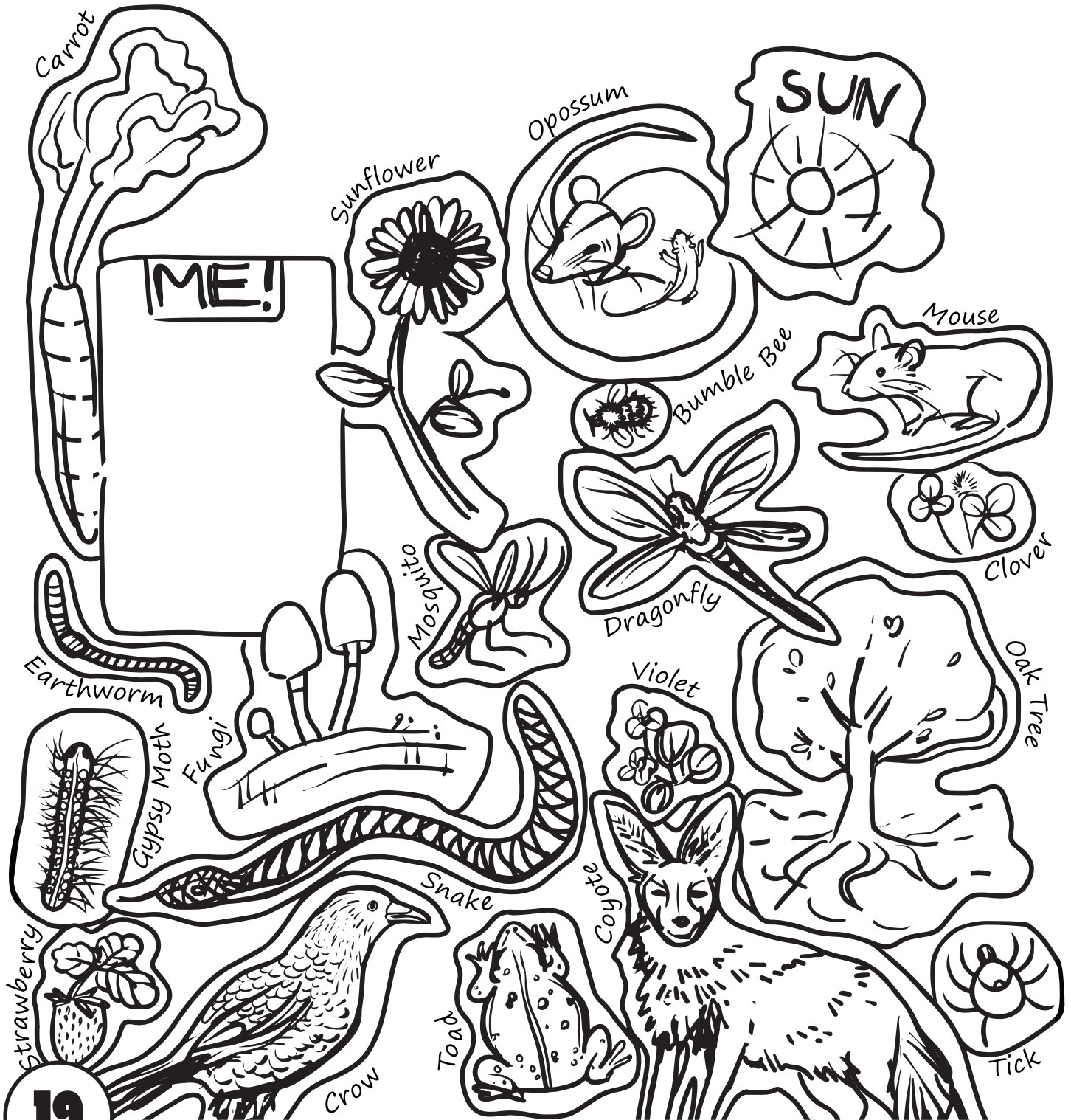
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Your partner was looking into community relationships and food webs...

Hey, there's a forest down thatta way he might have checked. Good luck!

A **food web** shows the interactions between different organisms, namely 'who eats who'. These relationships are important to consider for Integrated Pest Management. For example, if a certain plant species is eliminated from an area due to a non-native insect, the creatures that rely on it for food can find themselves with nothing to eat. Every organism is important and if even one of them is missing it can upset the balance of the community.

Explore this food web by drawing a line between each food source and the organism that consumes it. Use a green line for organisms that directly require the sun for food.



Ah HAH!

There's our lost technician!!



Do you see it?!?!?  
A solution!

You learned about *Integrated Pest Management*, correct?  
This is another component of IPM – a type of control involving organisms... can you find the term below? (Other terms are mixed in there too. Answers are on page 25)

R  
P  
A  
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V  
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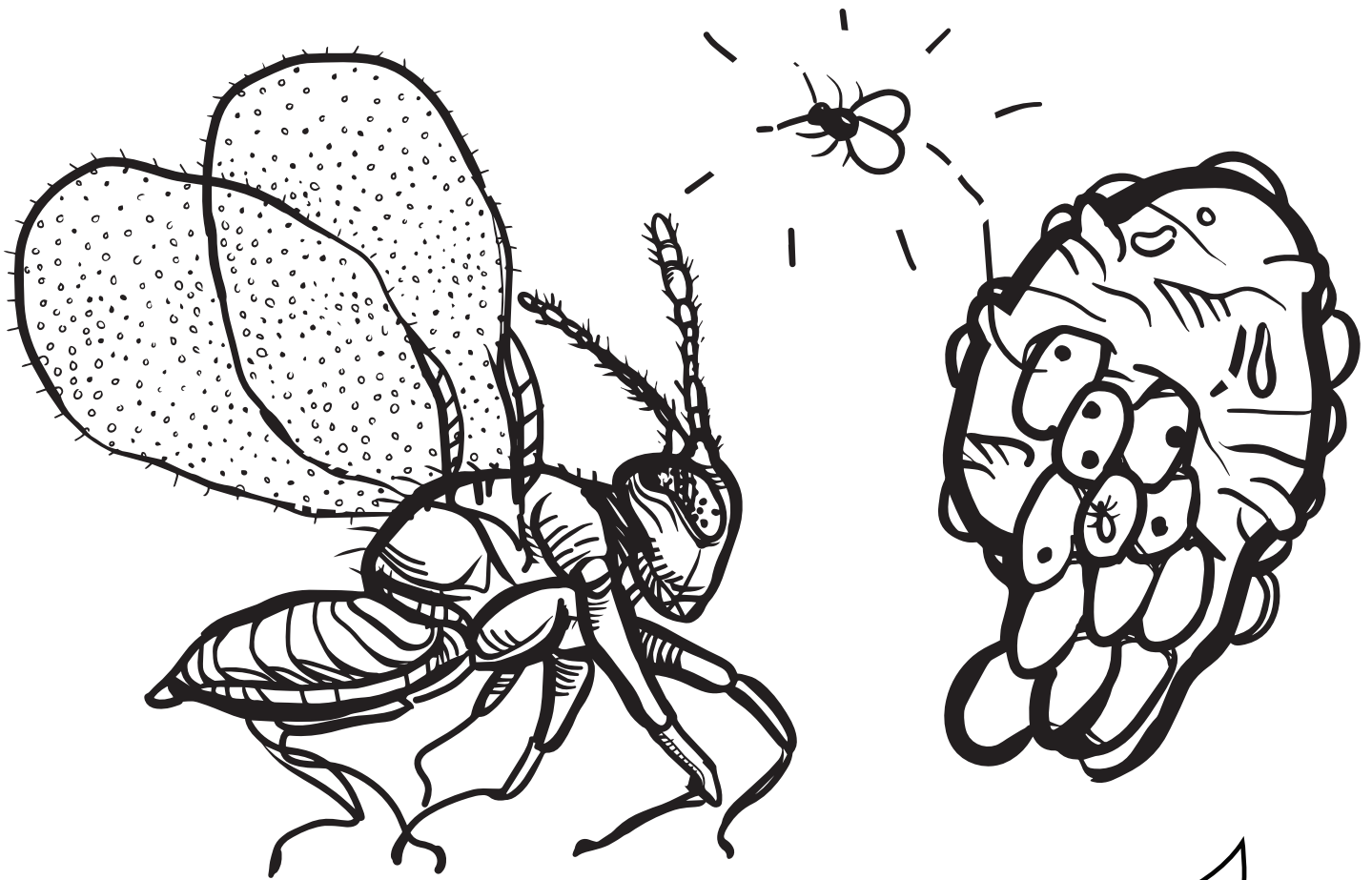
L  
N  
P  
R  
E  
D  
A  
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O  
R



**Biocontrol!**  
That's right!

Welcome new partner! My sincerest apologies! You've been looking all over for me, haven't you? I get really excited by the work we do.

I've been exploring an IPM option we have, called **biocontrol**, which is when we use one organism to help control another. This can have unintended consequences, so we have to make sure we thoroughly study all the effects it can have on the environment!

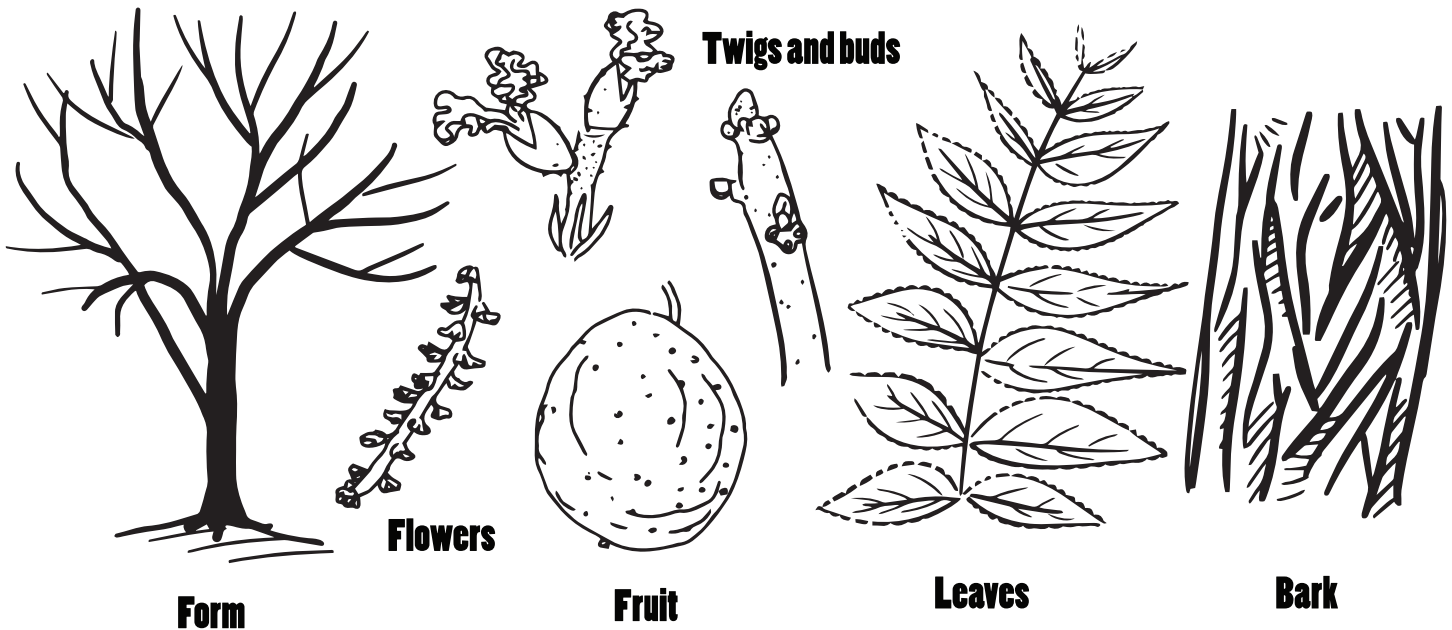


We call this tiny little guy the "OK wasp" (its scientific name is *Ooencyrtus kuvanae*). It was first released a century ago to help control the invasive Gypsy Moth (which destroyed a lot of our oak forests), and now seems to be targeting a new invasive species, the Spotted Lanternfly.

We don't have Spotted Lanternfly here yet, but it could be very destructive if it does eventually find its way to Prince William County. Hopefully the OK wasp or another biocontrol option will be a powerful ally for us if that happens!

To monitor and control pests, we have to be able to find them! And finding them starts with understanding their lifecycle, the habitat they prefer, and the host species that they live on. To find forest pests we have to be able to identify the tree species they target.

When identifying trees we look at many features:



Above: Identifying features of Black Walnut (*Juglans nigra*).

Habitat: Black Walnut is a native tree species that likes lots of sun in moist, undisturbed rich soils.

How is your tree ID by the way?

Here's a fun activity you can try at home to help you identify your local trees!

You can save leaves you find for future study by making a home made leaf press:

**Step 1:** Investigate and collect leaves from local trees near you. Leaves can vary a lot even on the same tree, so try to see if you can spot the differences!

**Step 2:** Place leaves between two sheets of office paper in the middle pages of a large book and close the book on top of them. Protect the pages with additional paper if it's a book you care about.

**Step 3:** Wait a few weeks for the leaves to dry out and flatten completely, then voila! Your leaves are ready! Use them in crafts, glue them to paper and label them, laminate them, or come up with your own projects for them.

Check out the tree ID links on pg. 26 to help you identify the trees you find!

When mosquitoes or forest pests reach certain **thresholds** and threaten human or forest health, our branch intervenes. However, prevention is the first and often the best solution for vector borne diseases and to prevent ecosystem harm. Using repellents before spending time outdoors, dumping out containers of water, and encouraging the growth of healthy trees through proper care are all prevention techniques that help reduce the need for control.

All organisms fit somewhere in our web of life within Prince William County. Organism communities are influenced by climate, soil, water, disturbances and other factors. These environmental factors and the life they support together are called an **ecosystem**. The study of ecosystems is called **ecology**. How we live and the daily choices we make influence the systems we depend on.

By understanding and appreciating the world around us, we can make better choices to preserve and protect our local and global ecosystems.



Hey! What sort of ecosystem do you live in? Observe the plants, animals, and terrain around you and draw it here!

# Congrats!!

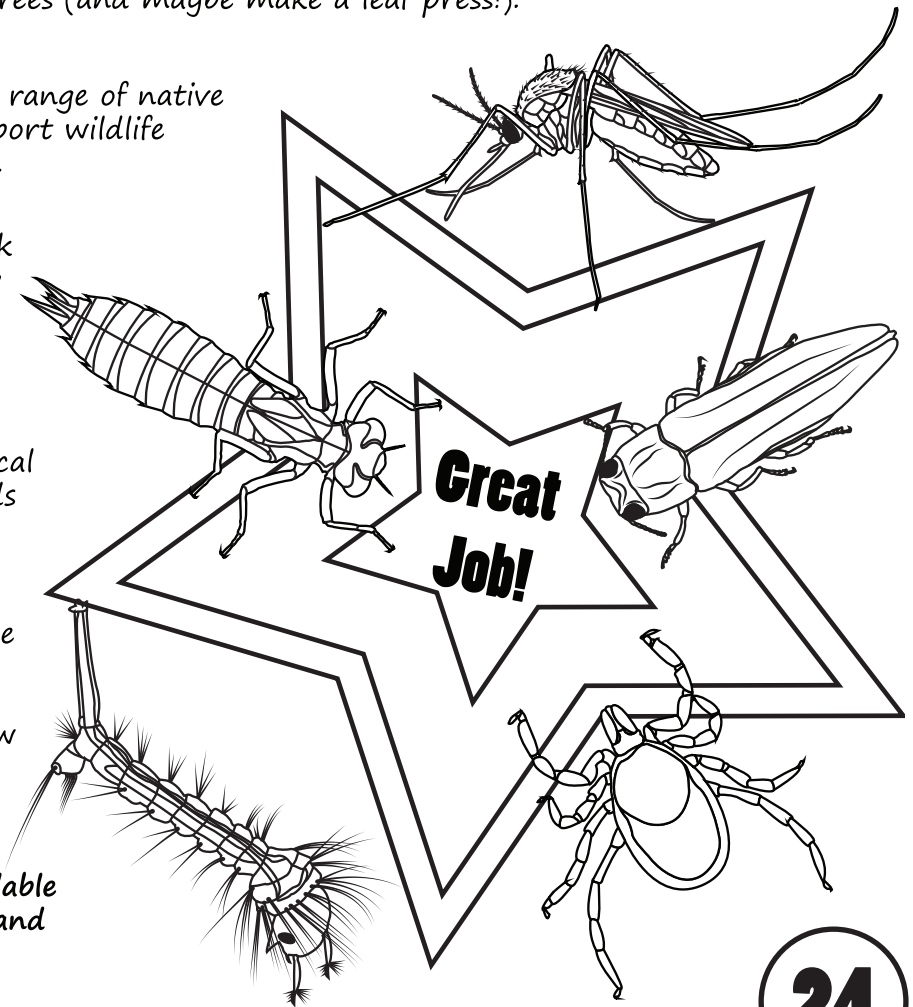
## You are now a member of "the Moth"!

Let's put your training to good use, but first your oath as a new member:

I, \_\_\_\_\_ commit to making good choices to protect myself, the people around me, and the natural world that I'm a part of.

Use the skills you've learned:  
I can: <check the boxes next to each action item>

- Use repellents with adult help when going outside to prevent ticks and mosquito bites and do tick checks after time outdoors.
- Make sure no toys or containers are left outside that may hold water and dump standing water wherever you find it.
- Learn about and identify insects and animals in our area.
- Learn about and identify trees (and maybe make a leaf press!).
- Help adults plant a diverse range of native plants in your yard to support wildlife and reduce forest pest risk.
- Have an adult help to check all materials before moving them outside the county if they may contain forest pest stowaways.
- Check out ecosystems at local parks with family or friends or with a guided tour.
- Remind adults to use source reduction and prevention before using chemicals for insect control, and to follow all labels and guidance.



And remember, our office is available for advice on mosquitoes, ticks, and tree pest related issues.



Hexapoda	Six legs
Canadensis	Canadian
Megaloptera	Large wings
Ferox	Fierce
Arthropoda	Jointed legs
Japonicus	Japanese
Quadrifasciatus	Four spots
Diptera	Two wings
Toxicodendron	Poison tree
Luna	Moon

**Page 4**

Circle the traits that you think would help a non-native pest become established:

Calm and shy    Lots of enemies

Grows quickly    Has lots of babies

Not a picky eater

Aggressive    Grows slowly

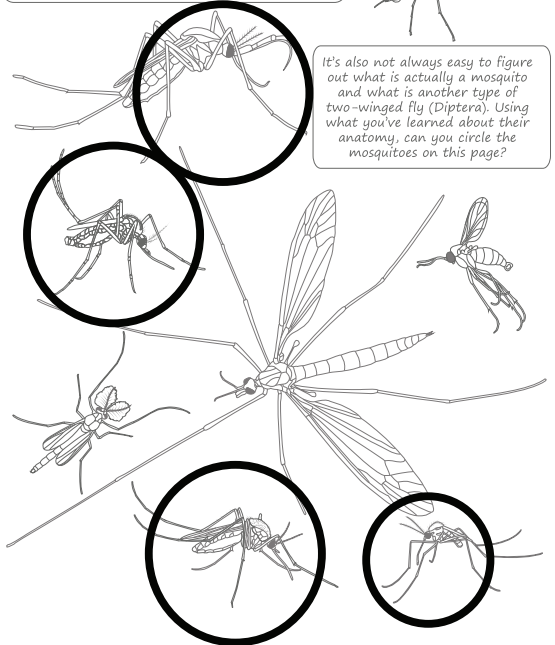
Not many predators    Only has a few babies

**Page 7**    Only likes certain foods

Although mosquitoes are annoying and sometimes dangerous, they don't all bite people and many are important meals for other insects and animals. In Prince William County we have more than thirty different species of mosquitoes! Each has its own preferred hosts and habitats.



It's also not always easy to figure out what is actually a mosquito and what is another type of two-winged fly (Diptera). Using what you've learned about their anatomy, can you circle the mosquitoes on this page?



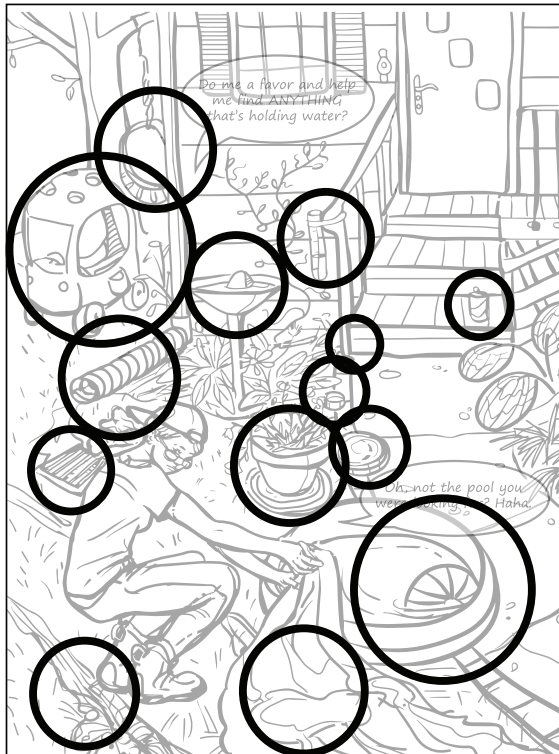
**Page 4**

R	E	P	E	L	L	E	N	T	L
P	R	E	V	E	N	T	I	O	N
A	N	T	E	N	N	A	R	Q	
M	O	S	Q	U	I	T	O		
J	I	P	G	H	N	H			
V	E	C	T	O	R	B	W		
V	K	T	C	S	P	A	N		
R	C	O	T	T	O	H	V		
T	L	P	M	X	R	T	A		
B	T	G	A	L	L	E	R	Y	

**Page 20**

It can be tough to find life, but it's there! While the tree on the right hand side is dead but fungi breaking it down are alive, birds are noticeable as they hunt for wood boring larvae, the smaller tree in the background has had most of its leaves eaten, but is alive, young Ash trees are sprouting up.

**Page 5**

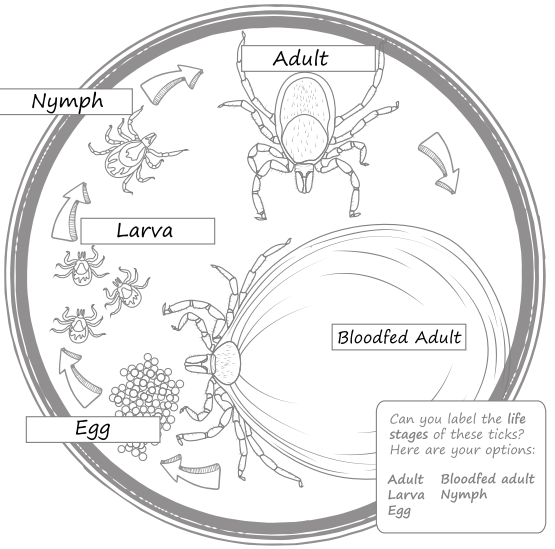


Anything that holds a tablespoon of water or more can also contain mosquito larvae.

**Page 13**

You guessed it, predators! The web of life usually keeps everything in check.

**Page 18**



Can you label the life stages of these ticks? Here are your options:  
 Adult    Bloodfed adult  
 Larva    Nymph  
 Egg

**Page 10**

Don't be discouraged, this was tough!

**Nursery Trees:** A, B, C, D, E, F (All); encourage adults to buy from good companies who are certified by the state

**Lawn Furniture:** A, F; Gypsy Moth/Spotted Lanternfly; their eggs can be laid on ANYTHING by trees they like

**Birds:** D; Hemlock Wooly Adelgid

**Firewood:** A, B, C, D, E, F (All); any wood not treated to special standards is risky, encourage adults to buy only treated or LOCAL firewood

**Page 8**

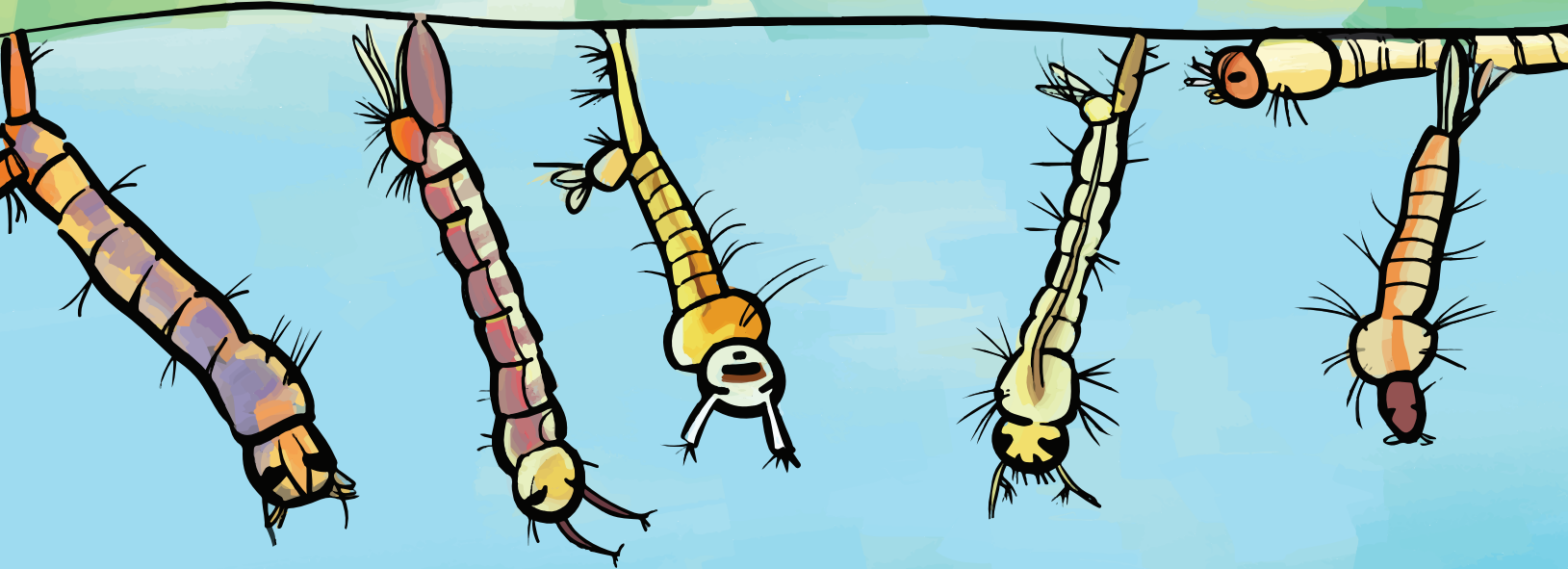
**25**

# Glossary

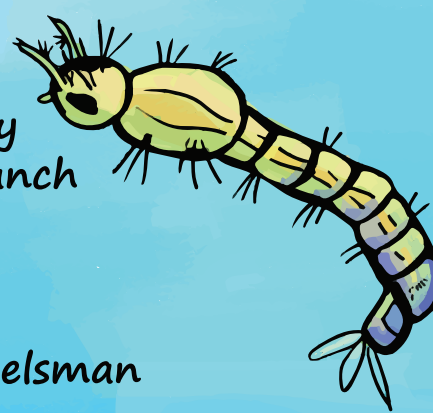
- Arthropod:** Animal without a backbone, typically has a segmented body and jointed legs/antennae.
- Biocontrol:** (Biological control): using an organism (such as wasps, bacteria) to help manage other organisms.
- Community:** A group of organisms that interact within the same ecosystem.
- Diversity:** A measure of the amount of different types of species living in an ecosystem.
- Ecology:** Study of the interactions of organisms with each other and their environment.
- Entomologist:** Bug specialist and expert identifier.
- Gallery:** In trees, a gap left in the wood that has been eaten away by insect larvae or other organisms.
- Habitat:** Type of area that is able to support the needs of a particular organism.
- Host:** Organism that supports a parasite that lives on or in the host animal.
- Invasive pest:** An organism that was introduced from another region that is able to successfully spread and outcompete native organisms.
- IPM:** (Integrated Pest Management): well-rounded scientific approach to management that relies on surveillance of pests and ecosystems to help to determine best methods of prevention and control.
- Larva/nymph:** Juvenile stage of insect development in complete (larvae, don't resemble adults) and incomplete (nymphs, resemble adults) metamorphosis.
- Lifecycle:** All changes and stages that an organism undergoes from life to death.
- Metamorphosis:** The cycle of development from egg to adult in certain animals, particularly insects.
- Organism:** Anything alive.
- Pathogen:** Microorganism that can infect and harm other organisms.
- Predator:** Animal that preys on other animals.
- Native:** An organism that has lived within a particular area for an extended period of time with established community relationships.
- Reservoir:** Organism that maintains pathogens in a state that can be transferred by vectors.
- Surveillance:** In IPM, routinely assessing a pest's population and status.
- Taxonomy:** The science of naming and classifying organisms.
- Vector:** Organisms such as mosquitoes and ticks that can transmit pathogens between animals.

## Learn more

- General ID:** [iNaturalist.org](http://iNaturalist.org)
- Tree ID:** <http://dendro.cnre.vt.edu/dendrology/main.htm>
- Insect ID:** [Bugguide.net](http://Bugguide.net) [Bugwood.org](http://Bugwood.org)
- Local Ecosystems:** <https://www.dcr.virginia.gov/natural-heritage/nchome>
- Parks:** [pwcgov.org/parks](http://pwcgov.org/parks) [dcr.virginia.gov/state-parks](http://dcr.virginia.gov/state-parks) [nps.gov/findapark](http://nps.gov/findapark)  
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