All About Mountain Pine Beetles

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Scan this QR code to watch a video about mountain pine beetles!

[Deep Look – It's a Goopy Mess When Pines and Beetles Duke it Out]

A transcript of the video is available in English, along with closed captions.

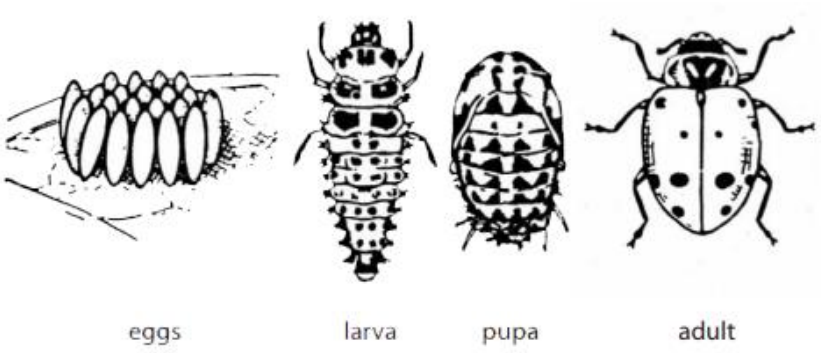
What are bark beetles?

Spruce beetles are a species of bark beetle very similar to mountain pine beetles. They are the same size as mountain pine beetles, but their wings a little more brown than black like a mountain pine beetle's wing. Davis, S. (2024). Colorado State University.

Mountain pine beetles are very small beetles that live in the Rocky Mountains. Adult mountain pine beetles are about 4mm, or about as big as a pencil eraser is tall. They are a type of beetle called **bark beetles** because they live under the bark of trees. There are about 2,000 different species of bark beetles that scientists have identified. All of these beetles are very small and attack different species of trees right under the bark. Luckily, their names can give you a hint as to what type of tree each species will attack. Pine beetles like to attack pine trees, spruce beetles like to attack spruce trees, elm beetles like to attack elm trees. You may have even heard of other bark beetles before; European elm bark beetles are responsible for spreading Dutch elm disease to the United States in 1930, which almost killed all elm trees in North America.

Beetles are insects that go through **complete metamorphosis**. This means that they have four stages

in life: egg, **larva**, **pupa**, and adult. Butterflies are another insect that most people are familiar with that also go through complete metamorphosis. Just like a 'baby' butterfly is a caterpillar, a 'baby' beetle is a grub and both of them look nothing like their adult parents. Other insects that go through complete metamorphosis are moths, flies, bees, ants, and fleas. This is different than **incomplete** (or simple) **metamorphosis**, where the 'baby' insect just looks like a miniature version of the adults. A great example of an insect that goes through incomplete metamorphosis is grasshoppers and crickets. The best way to tell if an insect goes through complete or incomplete metamorphosis is to compare the 'baby' version to the adult. If the 'babies' look completely different from the adults, they are an insect that goes through complete metamorphosis. The words larva and pupa are Latin, which means that when there is more than one of them (plural), we say larvae (pronounced 'lar-vee') and pupae (pronounced 'pew-pee'). So you would have one larva or two larvae.

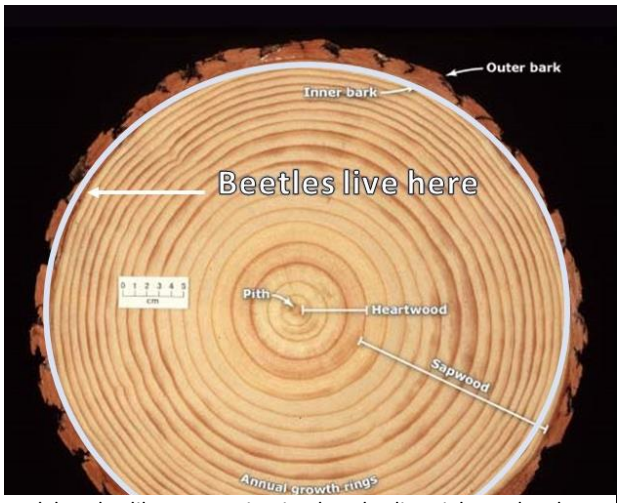


The four stages of complete metamorphosis. Adults lay eggs, which hatch into larvae. When larvae are old enough, they will become pupae, which allows them to completely rebuild their bodies and emerge as adults. Department of Entomology, University of Kentucky. https://entomology.ca.uky.edu/content/entomology-master-gardeners-part-2.

Where do mountain pine beetles live?

These beetles are native to the Rocky Mountains and can be found across the western regions of the US up into Canada. Even though they are considered a serious threat to forests, they are native to Colorado and are not an **invasive species**. Mountain pine beetles are a type of bark beetle, which means that they live right under the bark of a tree, in a layer called the inner bark.

They can attack almost any type of pine tree but will not eat **deciduous trees** (trees with leaves like oaks and maples). If there are too many pine beetles in a forest, they may start attacking other **coniferous trees** (trees with needles) that are not pine trees, like spruce trees or fir trees.

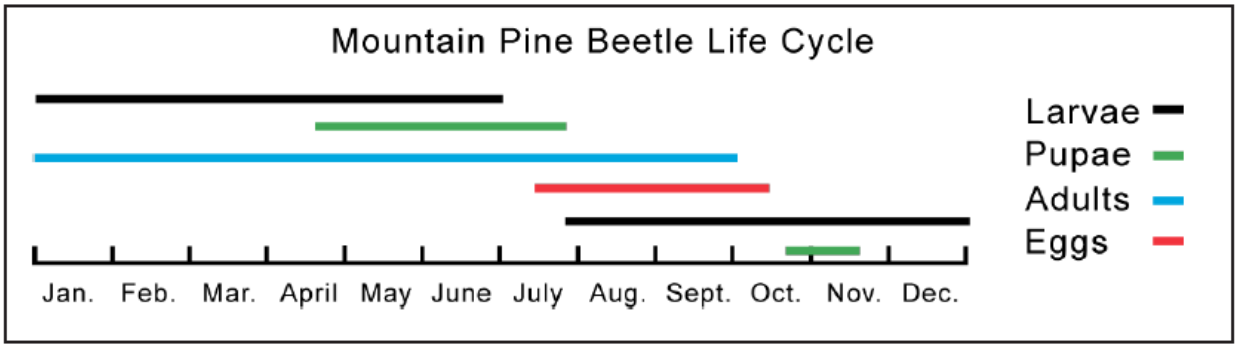


Bark beetles like mountain pine beetles live right under the outer bark of trees, within a layer called the inner bark. Unlike other types of beetles, they are not chewing through the wood of trees.

The outer bark layer of a pine tree pulled back showing the tunnels of mountain pine beetles. These tunnels are being dug through the inner bark layer and are near the surface of the tree. Marc DiGirolomo, US Forest Service.

When are mountain pine beetles active?

In the late spring, millions of pine beetles emerge from under the bark of the pine trees where they grew up. Females will start to fly around looking for a new tree. Once they find one and chew through its bark layer, the adult beetles mate. After mating, adult beetles will begin to chew tunnels under the outer layer of the tree's bark, and lay eggs throughout late summer to the fall. These eggs hatch within a few weeks, and the larvae dig their own tunnels into the inner bark layer until the spring. This means that the beetles spend the winter as larvae in their tunnels inside of the tree. If there is a very cold winter when there are many days in a row where the temperature drops below -30° F (-34° C), many of the larvae freeze and die, which can help keep the population of pine beetles in check. Once spring arrives, the larvae become pupae, and after a few weeks the pupae hatch into adults who are ready to leave and find new trees.



The life cycle of mountain pine beetles over the course of a year. Adults will lay their eggs from July through October. The larvae hatch from these eggs a few weeks after being laid and will live under the bark of the pine trees until they become pupae in the late spring. The pupae will develop for the rest of the summer until adults emerge in July to mate and start the cycle over again. A few of the adults may live long enough to overwinter again. Johnson, 1982 via US Forest Service 2011.

A pine beetle being flushed out of a pitch tube. A healthy tree will be able to produce enough pitch to prevent the beetle from chewing through the layer of outer bark.

How do mountain pine beetles attack trees?

In years where there are not too many beetles, females can be picky. They'll choose trees that are bigger and prefer species like lodgepole or ponderosa pines. In other years when there are more beetles than normal (we call them outbreak years), competition for the 'best' trees is fierce – too many of the beetles are trying to get to the bigger pine trees, so the females are forced to try smaller trees. In years where there are extra-large outbreaks, the beetles may have to try trees that aren't even pine trees, like spruce trees. Imagine the forest is a restaurant and the trees are items on a menu. If there aren't too many people at the restaurant, everyone can pick their favorite things to eat. However, if a thousand people suddenly showed up at the restaurant, the restaurant would run out of the most popular things on the menu first and you'd be forced to eat something else that you didn't want as much.

Once a female beetle finds a tree, she will start to chew into the tree to get under its bark. Even though they're trees, the pines have a trick up their sleeves to stop the female pine beetles from chewing through their bark. Once a female beetle starts attacking a tree, the tree starts to release a sticky substance called **pitch**.

The pitch starts to spill out where the beetles are attacking, washing them away so they can't get through the bark. If a pine tree is healthy, it can produce enough pitch to wash out most of the beetles that attack it, so it does not become overwhelmed.

But not all pine trees are healthy. If a female mountain pine beetle finds a pine tree that can't produce enough pitch to wash her out, she will chew all

A clump of pitch made by a ponderosa pine tree to defend itself against an attacking insect like a mountain pine beetle.

the way through the tree's bark. If that happens, she releases a chemical called a **pheromone** that signals to other mountain pine beetles that there is a weak tree. This chemical signal can travel for miles, and over the course of a day hundreds or even thousands of pine beetles will fly in from around the forest to start attacking the unhealthy tree.

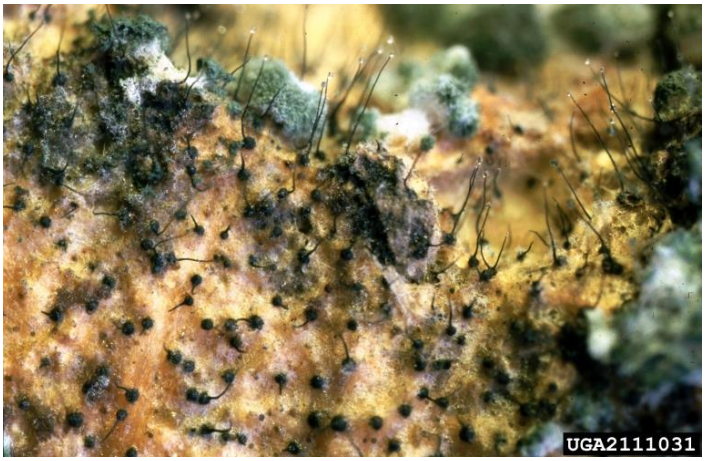
When a beetle successfully chews through the bark of a pine tree, she will release a pheromone that attracts other pine beetles from miles around. Together, they overwhelm the unhealthy pine tree.

What makes a tree 'healthy'?

There are a few things that can make a tree become too unhealthy to be able to fight off mountain pine beetles. The first thing is water – it takes a lot of water for a pine tree to be able to make enough pitch to wash out most of the beetles attacking it. If the forest doesn't have enough water for all the trees (like during a drought), many of the pine trees will not be able to make enough pitch to fight off pine beetle attacks. Another thing that can make a pine tree too weak to resist pine beetles is if the trees are sick or stressed. There are dozens of things that can make a pine tree sick, and a sick tree will have a harder time defending itself against attacks from other things like pine beetles. If a tree is too weak to fend off a few pine beetles, it is definitely too weak to fight off the thousands of beetles that show up after females start releasing their pheromones!

Once a bunch of the other beetles start to show up at a weakened tree, the pine beetles will mate and start to chew through the tree's bark. Pine beetles like to live under the tree bark because it keeps them safe from things that eat them, like birds, squirrels, and other insects while they tunnel through the tree. Females will lay eggs on the edges of their tunnels, and once the eggs hatch the larvae will start chewing their own tunnels.

Why are they digging tunnels?



A microscope image of blue stain fungus as it produces spores. These spores could end up in the grooves of an adult mountain pine beetle to infect a new pine tree.

Even though the pine beetles are chewing tunnels right under the bark, they don't eat the tree. Instead, they bring their own food. Adult pine beetles have special grooves or pouches next to their mouth that carry the **spores** of a certain kind of **fungus**. This fungus is called blue staining fungus, and it starts to spread into the wood of the tree. The beetles are actually eating this fungus, not the wood that they chew up. Over time, the fungus makes the tree even sicker and stains the wood of the tree blue-grey.

What happens to the tree after the beetles leave?

Between the damage caused by the beetles tunneling and the infection of blue stain fungus, most trees that have been attacked by mountain pine beetles end up dying. The tunnels cut into the tree by the beetles, which are called **galleries**, stop the tree from being able to move nutrients up and down its length. A good way to think of this is imagining the tree is a giant straw – if you poked a bunch of holes in a straw, you wouldn't be able to pull juice (or nutrients) up through it.

On the left you can see the galleries made by the larvae of mountain pine beetles. If you look at the wood in between the galleries, you can see that it's been stained a blue-grey color. This is more obvious in the photo on the right and shows that blue stain fungus brought by the adult beetles has infected the whole tree.

The blue stain fungus also causes problems for infested trees. After the beetles spread the spores of the fungus in the inner bark layer, the fungus grows to infect the tree deeper into its wood. Fungi are a group of organisms that include things like molds and yeasts and they form webs made up of millions of tiny threads called **hyphae** (pronounced *hi-fee*). The total clump of hyphae that make up a fungus are called **mycelia** (pronounced *my-seely-ah*). The mycelia of blue stain fungus clog up the sapwood of the pine trees. This is another problem for

an infected tree because the sapwood is the part of a tree that moves water from the roots up into the rest of the tree.

To continue the example of the tree as a straw, this would be like stuffing a bunch of cotton into the straw. So a tree that has been infested with mountain pine beetles works as well as a straw that has thousands of tiny holes punched in it and is stuffed with cotton!

A pine forest with a serious mountain pine beetle outbreak. In a normal year, only a few old and sick pine trees would be killed by bark beetles. When there are more bark beetles than a forest has evolved to support, many of the trees can die which can increase how frequent forest fires are. The number of dead trees in a forest also changes how intense a forest fire is and how fast it can spread. One of the major elements that changes the number of mountain pine beetles in a forest is the influence of climate change.

Why are there so many mountain pine beetles now?

This is a question that many researchers are trying to answer! An **ecosystem** is a group of living organisms in a delicate balance with the non-living things around them. When something changes in this balance, the entire system can shift and change as a result. Mountain pine beetles are a critical part of a pine forest ecosystem. If they were to suddenly disappear there could be too many trees in the forest, especially old and sick trees. This could make the forest overcrowded and disturb the balance of the forest ecosystem. However, too many beetles can also upset the balance. When there are too many pine beetles in a forest, we call that an outbreak. There was a large outbreak of mountain pine beetles in the Rocky Mountains from 2008 to 2013, and scientists were able to observe what happens when this ecosystem becomes unbalanced. Bark beetles produce lots and lots of babies every year, and these babies are one of the balancing forces that keep the number of unhealthy trees correct in a forest. The beetles,

in turn, are kept in balance because most of them (up to 98%) die from the cold over winter. However, climate change has made the winters less cold, which means more of their babies survive the winters which then means there are more beetles that can make even more babies. This is just one example of the ways climate change is upsetting the balance of ecosystems around the planet.

Now that you know more about mountain pine beetles, let's do an activity to explore these ideas. Please return to the main educational kit packet.

Glossary

Bark beetles – a type of small beetle that belongs to the family of weevils (Curculionoidea). Bark beetles are all very small (about the length of a pencil eraser), and each species specializes in attacking one type of tree. For example, mountain pine beetles specialize in attacking pine trees.

Complete metamorphosis – a type of development where insects complete four life stages (egg, larva, pupa, and adult). The easiest way to tell if an insect goes through complete metamorphosis is to compare the juvenile or 'baby' stage to the adult – insects that have a completely different body type than the adult go through complete metamorphosis.

Larva – one of the two juvenile stages of insects that go through complete metamorphosis. Larvae emerge from eggs and are often soft and squishy. Examples of larvae would be caterpillars, grubs, and maggots.

Pupa – the juvenile stage of complete metamorphosis between larva and adult. During the pupa stage, insects turn into a living goo inside of a pupal case that eventually reforms into the body of the adult insect. Scientists are still learning how pupae do this! Examples of a pupa would be the chrysalis of a butterfly or the cocoon of a moth.

Incomplete metamorphosis – a type of development where insects complete three life stages (egg, nymph, and adult). The easiest way to tell if an insect goes through incomplete metamorphosis is to compare the juvenile or 'baby' stage to the adult – insects that have juveniles that look like smaller versions of the adults go through incomplete metamorphosis.

Invasive species – species that are not native to an ecosystem that causes (or is likely to cause) harm to the ecosystem, the economy, or to human health. An example of an invasive species that has been in the news a lot would be the Japanese beetle or the spotted lanternfly.

Deciduous trees – trees that have leaves that they shed every fall. This would be something like an aspen, cottonwood, or maple tree.

Coniferous trees – trees that have modified their leaves into needles and stay green year round and produce cones. This would include pine trees, fir trees, and spruce trees.

Pitch – a thick and sticky substance that trees produce to help protect themselves from damage to their bark, especially from attacking insects.

Pheromone – a chemical signal that plants and animals use to communicate to each other over long distances.

Spores – small particles that fungi use to grow in new places, like the seeds of a plant.

Fungus – a kingdom of organisms that are not animals or plants. Fungi grow through a network of threads, and a few of them use mushrooms to reproduce. Other fungi are things like molds and yeasts.

Galleries – the series of tunnels that are made by animals (especially insects) as they burrow, in this case through living layers of trees. Beetle galleries are usually made up of a main tunnel that the female digs with branching tunnels made by her larvae. You can sometimes tell what species of beetle was in a tree based on the kind of gallery they leave behind.

Hyphae – a web of super fine threads made by fungi as they spread and grow. Hyphae are only one cell thick and can look like a bunch of fluff that spreads through whatever the fungi are growing in.

Mycelia – when you look at a fungus in total (including all its hyphae), this is the mycelia. If you think of a mushroom, that only makes up about 1% of the total body of the fungus; the other 99% of the fungus is made up of the mycelium that spreads through billions of strands of hyphae underground or through the wood of trees!

Ecosystem – a group of organisms living in a balance with the non-living things around them.