Beetles Are Supercool!

Understanding the Life Cycle of Mountain Pine Beetles

Meet Dr. Jesse Logan:
I like being a scientist because of the excitement of learning new things and the rewards of being creative. I became interested in natural resources as a young boy enjoying the out-of-doors in the Rocky Mountains.

Meet Dr. Barbara Bentz:
I like being a scientist because I enjoy the art of discovery. I became interested in natural resources when I was a young child, traveling and camping with my family.

Thinking About Science
Many plants and animals live in annual cycles. They respond to temperature changes and changes in the length of the day. Some scientists are interested in studying the effect of these seasonal changes on the life cycle of plants and animals. The science that investigates these effects is called phenology (fe näl uh je). The science of phenology also investigates the influence of climate on the life cycle of plants and animals. This is important, because many scientists now believe that our climate is changing. In this study, the scientists were interested in understanding how a change in climate might affect the life cycle of a particular species of beetle. Because they could not wait a hundred or more years...

Glossary:
annual (an yoo ul): Covering the period of 1 year.
climatic (kli met): The average condition of the weather at a place.
larva (lar vuh): Wormlike feeding form that hatches from the egg of many insects.
metabolize (mu h ta buh iz): Chemical changes in a living body that provide energy to the cells for survival, growth, and reproduction.
carbohydrate (kär bo hydrat): Starches and sugars that are used as food by animals.
resin (rez in): Cloudy, sticky substance that oozes from some trees.
pupa (pyoo puh): Intermediate stage of insect growth between larva and adult.
phloem (fle em): Tissue that transports nutrients from the leaves to the rest of the plant.

Pronunciation Guide
a as in ape
ä as in car
e as in me
i as in ice
o as in toil
ü as in fur
ñ as in sing
for the climate to change, the
scientists used a computer
program to predict what
might happen.

Thinking About the
Environment
Mountain pine beetles
(Dendroctonus ponderosae
Hopkins) are
sometimes supercool! This is
what scientists call the beetles’
ability to "chill out" during
the cold winter months, dur-
ing their larva stage (Figure 1).
During the winter, the beetle
larvae live in the interior of
pine trees. Because mountain
pine beetles are composed
partly of water, they must
have made adaptations to
keep from freezing in the cold
of winter. When water freezes,
it forms six-sided crystals. The
crystals have sharp edges that
could damage the other struc-
tures inside of the beetle.
Mountain pine larvae have
found a way to metabolize
carbohydrates, which contain
water, into glycerol (glisér ol)
during the winter months.

Glycerol is a form of alcohol,
and therefore will not freeze –
it is insect antifreeze! When
the temperatures turn warm
again, the larvae turn the glyc-
erol back into carbohydrates.
Carbohydrates are a source of
energy for the beetles.
Mountain pine beetles have
adapted to cold conditions,
and this allows them to sur-
vive.

Introduction
Mountain pine beetles live
for only 1 year. Most of the
year is spent "chilling out" in
a condition scientists call
supercool. Because they live in
high mountain environments
where it is very cold, they
spend most of their short life
span being supercool. That
does not give them much time
to lay eggs and reproduce.
When these beetles reproduce,
they lay eggs in the phloem of
pine trees (Figure 2). These
eggs become the larvae that
live in the phloem during the
cold months. In late summer,
pupa become adults and
emerge from the pine trees. As
adults, the beetles must bore
holes in other pines trees so
they can lay their eggs. When
they bore holes in the trees and
lay eggs, the beetles usually kill
the tree. Pine trees produce
resin to repel the beetles. To
successfully lay their eggs, the
beetles must work as a team.
They bore holes in pine trees
in large numbers (Figure 3).
When you think about it, you
can see that the population
of mountain pine beetles needs
to coordinate its activities. If each
individual beetle did these
things on its own schedule, the
species would not survive.

Mountain pine beetles are
part of an ecosystem. When
beetles kill a stand of weak-
ened trees, natural fire may
follow. When fire burns the
trees that have been killed by
the beetles, the area becomes
favorable for new trees to
grow. This helps the forest to
renew itself. On the other
hand, when beetles kill a stand
of trees, there are fewer trees
that can be used for wood
products for human needs.

Remember that mountain
pine beetles are dependent on
warm weather to reproduce,
and they only have part of one
summer to lay their eggs
before dying. If the climate
changes in the future, how will
the beetles adjust? The scien-
tists in this study wanted to
explore how mountain pine
beetles detect when it is time to
emerge from pine trees. This
information would help the
scientists to predict what
might happen to the beetles if
the climate changes in the
future.

Figure 1. The life stages of the mountain pine beetle, including
egg, larva, pupa, and adult.
Reflection Section

- Think about the variation in springtime temperatures. How do scientists know that the first very warm day is not the signal used by the beetles to emerge from the trees? What would happen to the beetles if they emerged from the tree on the first warm day?

- When an ecosystem is balanced, it is healthy. A balanced ecosystem means that everything depends on everything else, and no one plant or animal takes over the rest. The pine beetle/pine tree ecosystem is usually balanced between the beetles and the pine trees. This is because the beetles select the weakest trees in which to lay their eggs. Then, the weaker trees die and make room for new, healthier trees. In what ways could the pine beetle/pine tree ecosystem become unbalanced?

Methods

To understand the scientists’ methods, you will have to think about the complexity of the beetles’ life cycle. Thousands of adults must emerge from pine trees at the same time in the late summer. They must emerge after all danger of frost is gone. They cannot wait too long past that date, because they only have a short time to lay eggs before they die in the fall or winter. All of them must bore holes into the pine trees at the same time, or the pine trees will successfully repel them with resin. The scientists needed to know the temperature for the whole life cycle of the beetles (How many days is that? – Hint: Re-read the first sentence of the Introduction.)

The scientists used measurements of the temperature that were made every hour of every day for a year. (How many measurements did they use?) They used measurements for 4 different years. (Now multiply the number of measurements by four – how many measurements did they use?)

The scientists already knew a lot about the beetles’ life cycle. Using a computer program that contained all of the temperature measurements, they guessed what would happen to a beetle if it emerged from a tree’s interior on every day of the year. Using the computer program, they were able to identify which days would be the best ones for the beetles to emerge. Then, they added 2.5 °C to each of the
They did this to simulate what might happen when the climate changes in the future, since the general trend is for the Earth to be getting warmer.

**Reflection Section**

- What are the advantages of using a computer program to simulate the emergence of the beetles? Could the scientists have done the calculations by hand? Why or why not?

  - What do you think will happen to the beetle population if the temperature rises by 2.5 °C?

**Results**

The scientists found that temperature was the most important factor affecting the emergence of beetles from pine trees. They predicted that if global warming occurs (represented by the addition of 2.5 °C to the temperatures), mountain pine beetles could move farther north and into higher mountains. This means that their range could expand. The scientists also predicted that if mountain pine beetles live in warmer climates, they may produce a larger number of eggs. Changes in temperature could also change the timing of their life cycle. The beetles would probably not always emerge from the trees at the same time. Unfortunately for the beetles, this would mean that the teamwork they use to lay their eggs in pine trees would not be as strong.

**Reflection Section**

- If global change creates warmer temperatures in the future, what do you think might happen to the population of mountain pine beetles? Why?

  - If the population of mountain pine beetles begins to increase, what might happen to the population of pine trees? Could any changes be balanced by the lack of beetle teamwork? Why or why not?

**Implications**

It is clear that global climate change would cause a change in the ecosystem that includes mountain pine beetles and pine trees. The scientists believe that studying mountain pine beetles may help people understand if and how the global climate is changing. If populations of beetles living in high mountain environments are monitored, any change in their patterns of emergence, egg laying, or range might indicate a change in climate. The scientists believe that the mountain pine beetle is a good indicator species for environmental change.

**FACTivity**

Did you know that beetles are one of the most numerous types of life forms on Earth? Beetles live everywhere across the Earth, except in the open ocean. And, beetles are even older than the dinosaurs! To be so successful, beetles have many advantages that help them survive. In this FACTivity, we are going to get to know beetles close up! Get a bug box (a clear plastic box with plenty of room for air). Look outside in your school yard or at home for beetles. Find a beetle, and gently put it in the bug box. After you observe the beetle, you should release it back outside, in the same place where it was found.

We will examine three parts of the beetle: the back legs, the wings, and the mouth. See the
When Scoring Zero Wins

As the pine beetle research shows, climate change will change conditions for the living creatures of the Earth. One way to slow climate change is to reduce the production of carbon dioxide, or CO₂. Carbon dioxide is produced by cars, buses, and any other thing that burns fossil fuels. The Olympic Winter Games of 2002, or any event with many people, requires a lot of vehicles. Can you guess what that means? Right! Lots of carbon dioxide! Planners of the 2002 Games wanted to find a way to keep carbon dioxide emissions from the 2002 Games at zero. It sounds impossible, doesn’t it? This is how they did it. Along with using the latest in emissions-reducing technologies, they asked large companies and individuals to reduce their energy consumption equal to the amount the Olympic Winter Games of 2002 would produce.

Now, get a large piece of paper and draw the beetle you are observing. Use crayons to complete the drawing. You may want to focus your drawing on one of the three parts that we examined above. When you have finished drawing the beetle, don’t forget to release it back into the same place where you found it!


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Websites:
http://www.usu.edu/~beetle/