Pulse of the Planet

Sequoia and Kings Canyon National Park Lesson Plan

Setting:
Foothills of the western Sierra Nevada

Audience:
4th Grade

Duration:
45 minutes

Standards Addressed:
Life Sciences:
2.a, 2.b, 2.c, 3.a, 3.b, 3.c
Investigation & Experimentation:
6.a, 6.c, 6.d, 6.e, 6.f
Reading:
1.1, 2.1, 2.3, 2.4, 2.5, 2.6, 2.7
Mathematical Reasoning:
1.1, 2.1

Universal Concepts:
Change
Survival
Interconnectedness
Time

Vocabulary:
adaptation, phenology, phenophase, nurse tree, decomposer

Theme:
The study of species response to a changing environment by changing themselves is called phenology. Phenological changes are regular and seasonal, and can therefore be used to measure long-term trends, such as climate change.

Goal:
This lesson plan will teach you what phenophases are, how to observe them, and how to participate in a national phenophases monitoring project.

Objectives:
After completing this program participants will be able to:

1. Name three plant phenophases
2. Identify two examples of how phenology applies to animals
3. Explain one way climate change might affect a species
4. Access the California Phenology Project website

Materials:
1. Photographs of buckeye tree taken over the course of one year (attached)
2. Lilac monitoring trend sheet (attached)
3. Nature's Notebook plant monitoring sheet (attached). You will need to make copies of this sheet: one per student
4. Oak Woodlands Food Web activity (attached)

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Introduction:

How do you know when it is autumn? When it is best to eat turkey with family? When to look through your closet for winter boots and coats?

We have tools such as clocks and calendars that help us decide when to do certain things. We know it is autumn after the school year starts, when we put away our sandals and put on our new sneakers. But we also know it is autumn because the trees begin to drop their leaves. Birds migrate. Animals stuff themselves with food to prepare for the coming winter cold.

Each year, plants and animals experience seasonal changes. In spring, flowers bloom. In summer, bugs emerge. Acorns litter the ground in autumn, and animals grow thicker fur in winter.

The seasonal changes that we see in nature are called phenological changes. Today we will learn about these seasonal, phenological changes as they occur in the oak woodlands of California.

Learning to identify phenological changes as they happen will help us to understand the seasons as they come and go. Learning phenological changes is like learning a whole new calendar — timing, nature's way.

1. What is a season?
    A. There are four seasons each year: spring, summer, autumn, winter
    B. We now determine the seasons by the earth's position in relation to the sun
    C. Historically, we knew when seasons began or ended by observing the weather, the hours of daylight, and changes in the plants and animals around us
    D. Can you name some seasonal changes?

2. How might plants and animals react to seasonal changes? For example, after a long winter, how do snakes react to a warm, spring sun? They emerge from their dens
    A. Plants and animals react to the same seasons every year. So, we say that they have yearly cycles
        1. Think of a blue bird. What does a blue bird do over the course of the year? In the early spring, it migrates to find a cool home. In the late spring, it builds a nest and lays eggs. In the summer, it feeds its hatchlings and teaches them to fly. In the autumn, it migrates to find a warm, winter home
    B. **Phenology** is the study of the yearly cycles of animals and plants
        2. A phenologist would record each time the bird moved on to the next part of its yearly cycle. A phenologist would record when the bird migrated, when it began to nest, when it laid its eggs, etc.

C. We call each part of a plant or an animal's yearly cycle a **phenophase**

3. Do plants have phenophases, as animals do? Let us investigate a species common to our California oak ecosystem. This species is called the California Buckeye
   A. This plant is a large shrub or small tree native to California. It has gray bark, smooth leaves, and sweet smelling flowers. The buckeye requires plenty of moisture and is sensitive to periods of drought
   B. What is the summer season like in California's oak woodlands? Is it very dry? How do buckeyes survive in a hot, dry, Mediterranean climate with its drought-like conditions?
      1. California Buckeyes have developed an **adaptation,** or a survival strategy, to drop their leaves at the beginning of summer, before it becomes too dry
   C. The phenophases of the California Buckeye would be: blooming flowers in spring, dropping leaves in summer, forming fruits in autumn, and budding leaves in winter
   D. Both animals and plants have phenophases. Just as buckeyes drop their leaves in the summer rather than in the autumn, each species of animals and plants has phenophases unique to it

4. The California oak woodland ecosystem supports hundreds of plant and animal species. The dominant plant species include Coast Live Oak, Valley Oak, California Black Oak, and Blue Oak
   A. Many of the dominant plants are oaks. Oaks are the hub around which all other species revolve
      1. Oaks supply an abundance of food in the form of acorns. They also provide ample shelter, nesting sites, and shade
      2. How might different plants and animals benefit from oak trees?

Activity: Show the photographs of plants, animals, and microinvertebrates provided in this lesson plan to the students, ask them to name the featured species' relationship to oak trees

- Black bears, woodpeckers, squirrels, and humans eat acorns
- Insects (gall wasps, oak twig borer, ambrosia beetle) live in oak wood, on oak bark, and in acorns. Birds eat these insects
- Animals such as cougars use the shelter oaks provide to create a safe place to sleep. Plants such as manzanita use the shade oaks provide to grow. When an oak helps another plant to grow, that oak is called a **nurse tree**. Cougars also eat animals that eat acorns
- Oak leaves fall to the ground and decompose into soil, with the help of fungi, bacteria, and invertebrates. These organisms are known as **decomposers** (formicid ants, bdelloid rotifers, fungi). Oak leaves

provide the food for these creatures

3. John Muir said, "When we try to pick out anything by itself, we find it hitched to everything else in the Universe." An oak's phenophases affect the survival of other plants and animals
4. What would happen if an oak's phenophase happened early or late? For instance, tussock moth caterpillars eat oak leaves. Bluebirds eat caterpillars. What would happen to the bluebirds if the oak leaves budded two weeks too late? How would that impact the bluebirds' migration, nesting, and egg-laying?
    1. Another example: How would a delay in acorn production affect black bear hibernation?

5. Phenophases occur throughout the year partly as a response to other species' phenophases. I.e., a black bear can begin its hibernation phenophase after it has benefitted from the oak trees' acorn production phenophase. Phenophases also occur throughout the year as a response to temperature and daylight
    A. Because the seasons are fairly regular and predictable, phenophases are fairly regular and predictable. Can you predict when an oak might grow new leaves?
    B. But what if the oak grew new leaves in the winter, rather than in the spring? What might you say about the weather that winter? Temperature is higher than normal
        1. The timing of phenophases can help us draw conclusions about weather patterns and events

6. Climate Change refers to long-term, global temperature increase. While we know it will be warmer in California, we do not yet know what other changes we will see. We still wonder, will it be wetter or drier? Will there be stronger winds?
    A. By observing the phenophases of certain species, we can draw long-term predict tions about future weather and climate events
    B. Study the graph of lilac blooming and leafing dates at a site in Vermont that was monitored from the 1960s to the early 2000s (attached). While the individual years do not supply much information, we can see an overall trend of increasingly early blooms and leaves
        1. The earlier blooms and leaves indicate a warming climate
        2. Because the lilacs continue to bloom and leaf earlier and earlier, we can predict that Vermont lilacs will bloom and leaf even earlier in the projected future
    C. Phenology helps us to predict the effects of climate change
        1. What impact would an early-blooming lilac have on the ecosystem? We know that certain insect pollinators hatch in response to hours of sunlight, not temperature. Therefore, the lilacs might bloom before pollinators hatch — causing the lilacs to miss the opportunity to reproduce

2. What might happen if a plant fails to pollinate? There would be no seeds for animals to eat and no new plants could grow

7. Humans rely on phenology today
   A. What would happen if insect timing was off and pollinators failed to pollinate our food, such as orange trees?
   B. Medical professionals use phenology to estimate how much demand there will be for anti-allergy medications each year. Many Americans are allergic to plant pollen. Phenology monitoring ensures there will be enough medication to relieve coughing and sneezing during allergy season

8. You can participate in the California Phenology Project (CPP), which has implemented phenology monitoring all over California
   A. Citizen scientists monitor the changes of designated plants, both in parks and in their own backyards
   B. The plants are regularly monitored and the data is uploaded to the California Phenology website
   C. By having people like you monitor and record the phenophases of plants in their own backyards, scientists can use the data to determine how seasonal patterns are changing
      1. Why might we prefer to monitor plants rather than animals?
         b. Animals move around, making it hard for continuous monitoring
   D. How can you practice phenology at home?
      1. You can pick a plant—whether in a park or in your backyard—and record its phenology. The CPP has a list to help you decide which plant to choose. Up load your findings to Nature's Notebook via the California Phenology Project
      2. To access the phenology monitoring database, visit:
         http://www.usanpn.org/participate/observe

9. Let's practice identifying and recording a plant's phenology for Nature's Notebook. (Pass out copies of attached monitoring sheet)
   A. What sort of phenophases do you think we will see? (Find a shrub or tree and fill out the monitoring sheet)
      1. Assist students if they are incorrectly filling out the sheet. Instructions are located online at http://www.usanpn.org/node/2246#record_plants

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Conclusion:

Thank you for helping me monitor today! Now all of you have the tools to recognize phenophases and to record them on your own. If you decide to become a citizen scientist and to participate in the California Phenology Project, the information you collect will help paint a complete portrait of the way plants are changing across the United States. You can help scientists make connections between temperature and phenophases, between climate change and the long-term health of our ecosystems. Scientists, park rangers, and conservation managers will use the data you find to help protect nature. With your help we can be better equipped to keep ecosystems like our oak woodlands healthy! As the seasons change, remember how important timing is, not only in our own lives, but in all of nature.

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Vocabulary

Adaptation: A change in form or behavior that helps an organism live successfully in a particular environment

Phenology: The study of the timing of seasonal changes in nature

Phenophase: A specific seasonal change for a species. For example: Oaks have bud burst, increasing leaf size, leaves, flowering, fruiting, colored leaves, and leaves falling

Nurse Tree: A tree that protects or fosters the growth of other smaller trees.

Decomposers: Organisms that break down dead or decaying organisms

Bibliography:

"California Phenology Project | CPP: California Phenology Project." *California Phenology Project | CPP: California Phenology Project*. <http://www.usanpn.org/cpp/>.

“Sequoia and Kings Canyon National Park”. <http://www.nps.gov/seki/index.htm>

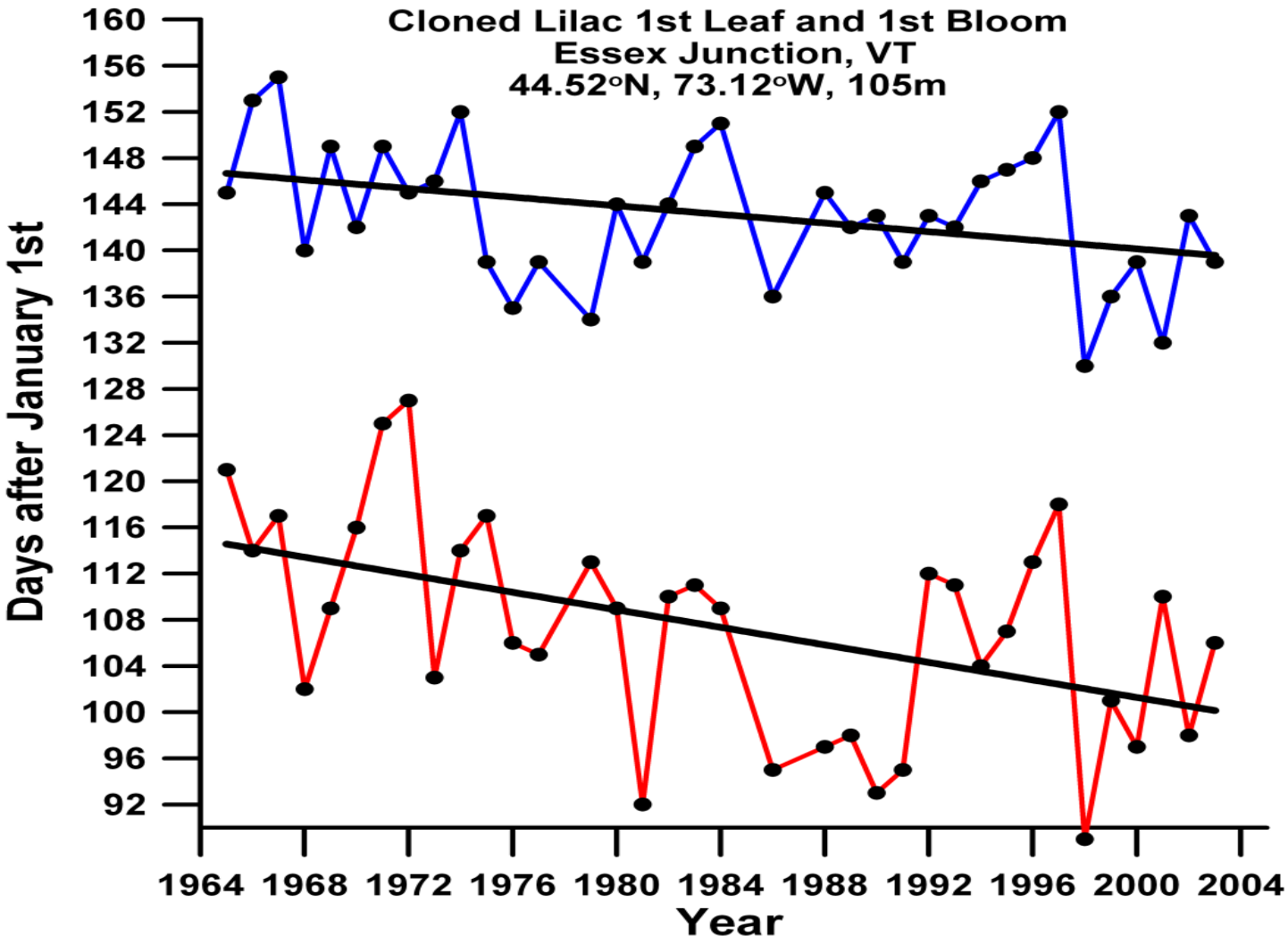
Pavlik, Bruce M., Pamela C. Muick, Sharon G. Johnson, and Marjorie Popper. *Oaks of California*. Los Olivos, CA: Cachuma, 1991. Print.

"Nature's Notebook: Observe Plants and Animals." *USA National Phenology Network*. <http://www.usanpn.org/participate/observe>.

“Welcome to Project BudBurst." *Project BudBurst*. <http://neoninc.org/budburst/>.

Muir, John. *My First Summer in the Sierra,*. Boston: Houghton Mifflin, 1911. Print.

Attached materials:



Lilac Graph

Phenology is an indicator of environmental change

Blue Line= Date of First Flower

Red Line=Date of First Leaf

Trees and Shrubs *Deciduous (with pollen)*

nature's notebook

Nickname: red maple-1
Species: red maple
Site: test
Year: 2012
Observer: _____

Directions: Fill in the date and time in the top rows and circle the appropriate letter in the column below.
y (phenophase is occurring); **n** (phenophase is not occurring); **?** (not certain if the phenophase is occurring).
Do not circle anything if you did not check for the phenophase. In the adjacent blank, write in the appropriate measure of intensity or abundance for this phenophase.

	Date:	Date:	Date:	Date:	Date:	Date:	Date:	Date:
Do you see...	Time:	Time:	Time:	Time:	Time:	Time:	Time:	Time:
Breaking leaf buds	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Leaves	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Increasing leaf size	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Colored leaves	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Falling leaves	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Flowers or flower buds	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Open flowers	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Pollen release	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Fruits	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Ripe fruits	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Recent fruit or seed drop	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____	y n ? ____
Check when data entered online:	☐	☐	☐	☐	☐	☐	☐	☐
Comments:								

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Black Bear

Acorn Woodpecker

California Ground Squirrel

Cougar

Whiteleaf Manzanita

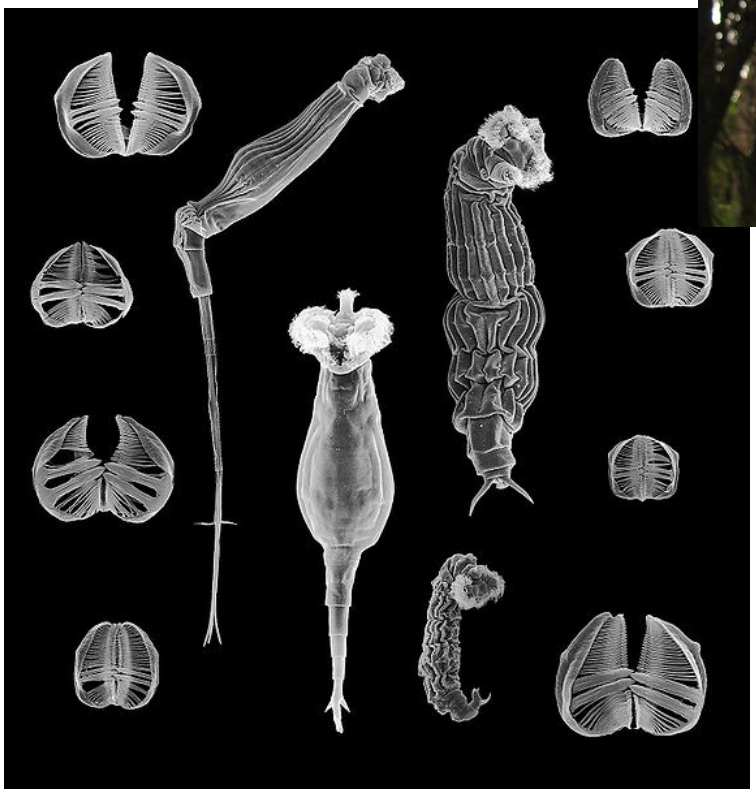
Gall Wasps

Oak Twig Borer

Ambrosia Beetle

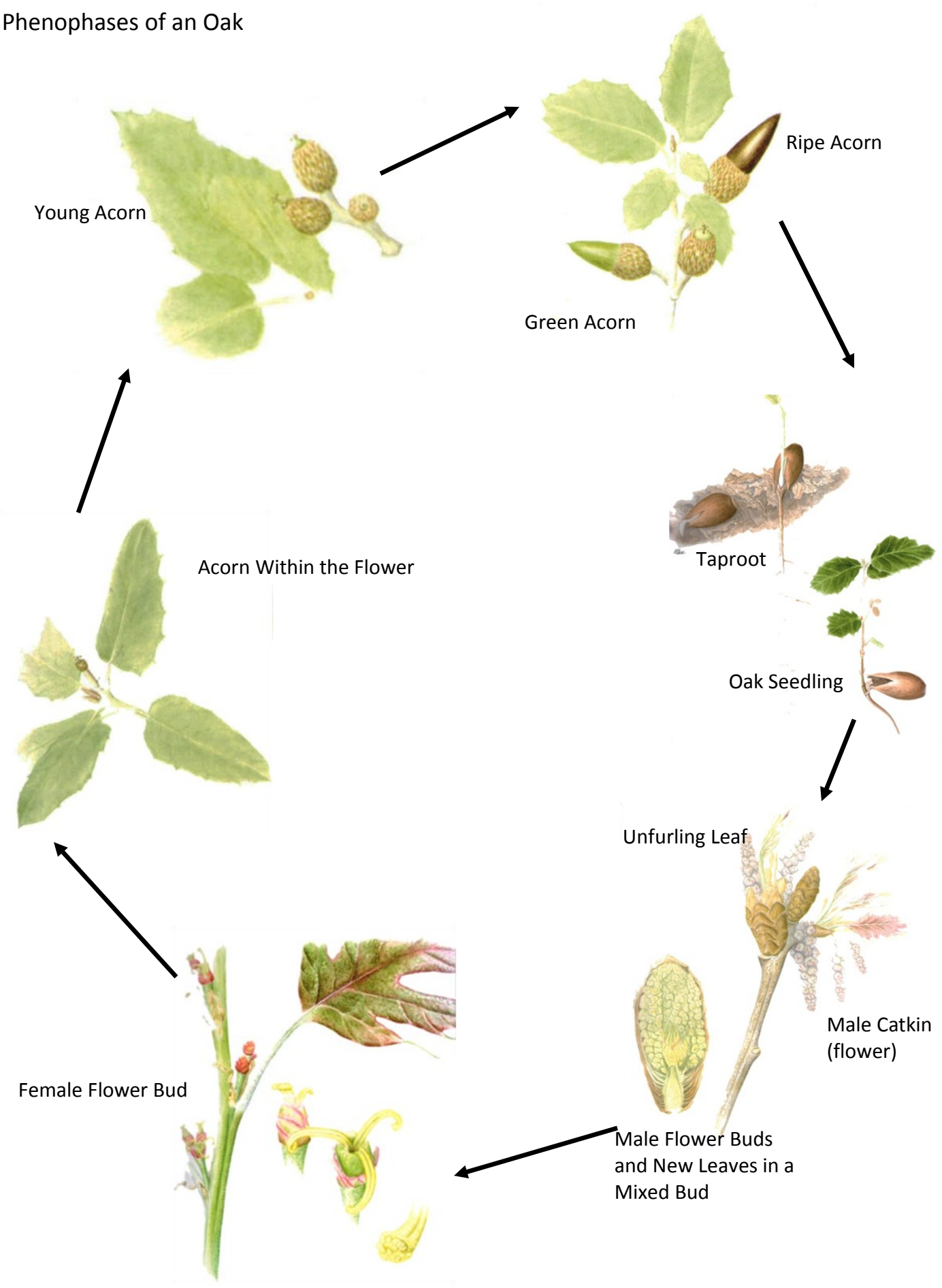
Formicid Ant

Fungi



Bdelloid Rotifers

Phenophases of an Oak



Phenophases of a California Buckeye

Budding Leaves

Blooming Flowers

Forming Fruits

Increasing Leaf Size

Dropping Leaves