ARTHROPODS

Created by The Good and the Beautiful Team

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The Good and the Beautiful CURRICULUM

Printed in Canada

UNIT INFORMATION

Science Journal

All The Good and the Beautiful science units include activities for a science journal. For each child, prepare a 1 in. to 2 in. 3-ring binder to function as his or her science journal. Tabbed divider pages can be used to separate the different units. Also, have wide-ruled paper and blank white paper on hand for journal activities. All completed journal activities are to be kept in the science binder. If desired, have the child create a cover and insert it under the clear cover of the binder.

Science Wall

All The Good and the Beautiful science units include vocabulary words to be placed on your science wall, which is a wall or tri-fold presentation board in your learning area on which you can attach the vocabulary words and other images. ***Cut out the vocabulary word cards at the beginning of the unit.*** The course will indicate when to place them on the wall.

Lesson Preparation

All The Good and the Beautiful science units include easy-to-follow lesson preparation directions at the beginning of each lesson.

Lesson Mini Books

Some lessons in this unit incorporate science mini books. If you bought the PDF download only, print the pages single sided. To assemble the mini books, cut them in half along the dotted lines, stack the pages together with the page numbers in the correct order, and staple twice along the left side.

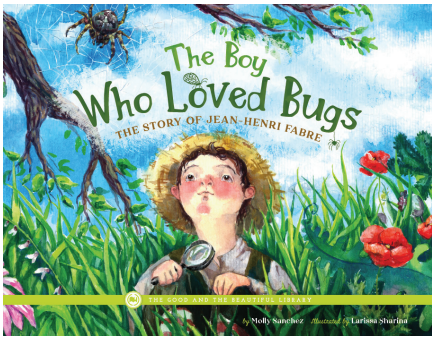
Unit Videos

Some lessons include videos that were created by The Good and the Beautiful. Have a device available that is capable of playing the videos from goodandbeautiful.com/sciencevideos.

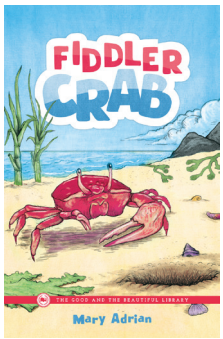
READ-ALOUD BOOK PACK
(OPTIONAL)

The four books below are optional read-aloud books that complement this unit. These books can be purchased as a book pack by going to goodandbeautiful.com/science and clicking on the *Arthropods* link.

The Story of Maria Merian
by Ashlee Klemm
Used in Lesson 10



The Boy Who Loved Bugs:
The Story of Jean-Henri Fabre
by Molly Sanchez
Used in Lesson 8



Fiddler Crab
by Mary Adrian
Used in Lesson 14

CORRELATED BOOKS

The Good and the Beautiful Library has several books that correlate well with the *Arthropods* unit. It can be a wonderful experience for children to read books on their levels related to the subjects they are learning in science. These books are both fiction and nonfiction and are organized according to reading level. Find the correlated books by going to goodandbeautiful.com and clicking on the *Arthropods* science unit product page.

GRADES 7–8

LESSON EXTENSIONS INFORMATION

How the Extensions Work

Each lesson has an optional lesson extension for children in grades 7–8. Complete the lesson with all the children, and then have the older children complete the self-directed lesson extension. These extensions are located at the end of the lesson.

Answer Key

The answer key for the lesson extensions can be found by going to goodandbeautiful.com/science and clicking on the *Arthropods* link.

Flexibility

The amount of time it will take to complete each lesson extension will vary for each child. The average time is about 10–15 minutes per extension. Parents/teachers and children may choose to omit parts of the lesson extension if desired. Encourage the children to stretch their capabilities, but also reduce work if needed.

Science Journal

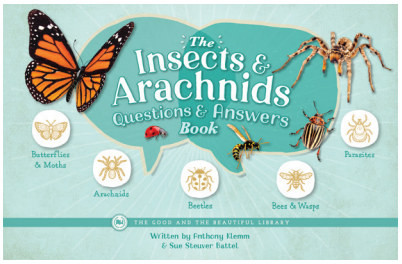
The extension pages are nonconsumable. The children will do their own work on separate sheets of paper and insert them into their science journal binders along with any science journal pages done during the lessons.

Children are encouraged to take ownership of their science journals and put forth effort to make their journals visually appealing. The journals will be something the children can treasure. The children should use color and illustrations where possible. Have them view the sample pages below.

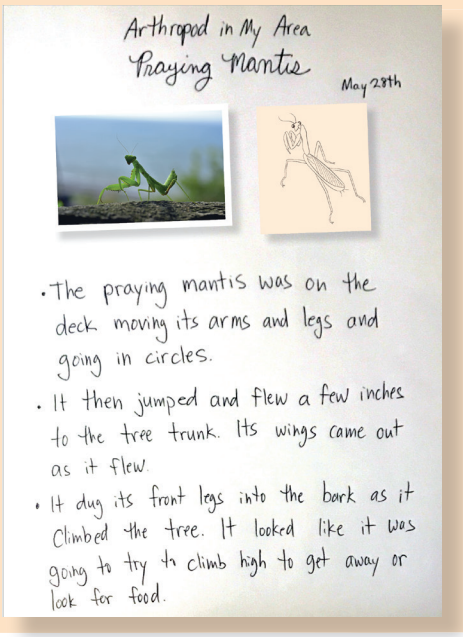
Taking Notes

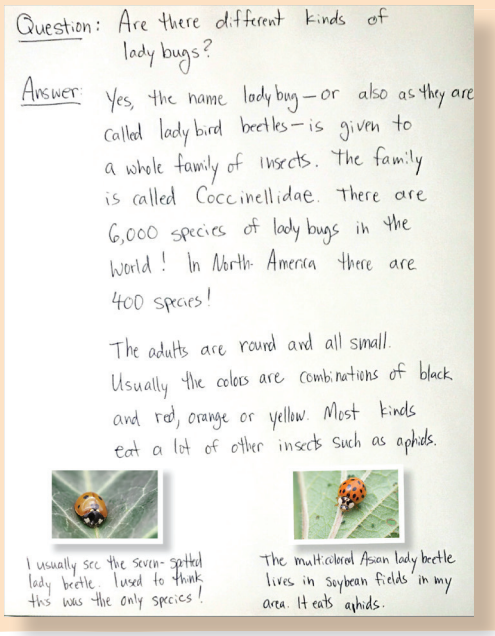
Some of the Grades 7–8 Lesson Extensions have the children summarize the material read. Teach the children to look for key information and summarize the most important points. Children can also add notes with their thoughts and the facts that are most interesting to them.

Optional Grades 7–8 Reading Book



We recommend the book *The Insects & Arachnids Questions & Answers Book* by Anthony Klemm and Sue Stuever Battel as extra reading for students in grades 7–8. This book can be purchased by going to goodandbeautiful.com/science and clicking on the *Arthropods* science unit product page.





SUPPLIES NEEDED

This section shows all supplies needed for **activities**. There are no experiments in this unit.

NONE

Lessons 1, 2, 3, 4, 8, 12

Lesson 5

- brown clay (optional)
- 1 glow stick per child
- small piece of silk fabric (optional)
- device to play a video

Lesson 6

- paper towel
- scissors
- handful of cheese puffs
- small bowl
- candy or snack (e.g., fruit snack, grape)
- 1 sesame seed for each child
- 1/8 tsp measuring spoon
- honey
- device to play a video

Lesson 7

- several cotton balls
- a few different scents (may use extracts or essential oils, such as peppermint, vanilla, almond, lemon, or cinnamon)
- 1 c honey
- 1/4 c peanut butter (or almond butter)
- 1/2 tsp pure vanilla extract
- candy thermometer
- saucepan
- baking sheet
- parchment paper

Lesson 9

- device to access the internet

Lesson 10

- device to play a video

Lesson 11

- ant farm, can be purchased locally or online

Lesson 13

- transparent tape
- a few drops of vegetable or olive oil

Lesson 14

- crayfish dissection kit (optional—can be purchased on Amazon.com or from other sources)

Optional Projects

Make Your Own Arthropod Trap and "Bug" Zoo

- small plastic container such as a yogurt cup or sour cream container
- piece of cardboard larger than the container
- 4 small rocks
- 2 medium rocks
- small piece of overripe fruit such as a banana, strawberry, or pear
- trowel or small shovel
- small artist's paintbrush (optional)
- clear jar
- magnifying glass (optional)
- 1 copy of "My Arthropod Observation Form" for each child (optional)

Insects as Garbage Disposers

- 2 clear jars
- 1 jar ring or rubber band
- piece of fine mesh material big enough to cover a jar opening to allow air in but keep insects out, such as cheesecloth, tulle netting, or pantyhose
- piece of soft, overripe fruit such as a banana, strawberry, or pear
- knife

OPTIONAL PROJECTS

You may choose to complete these projects at any point during the course.

Make Your Own Arthropod Trap and "Bug" Zoo

Activity Supplies:

- small plastic container such as a yogurt cup or sour cream container
- piece of cardboard larger than the container
- 4 small rocks
- 2 medium rocks
- small piece of overripe fruit such as a banana, strawberry, or pear
- trowel or small shovel
- small artist's paintbrush (optional)
- clear jar
- magnifying glass (optional)
- 1 copy of "My Arthropod Trap Observation Form" for each child, if desired (page viii)

Follow the instructions to make your own arthropod trap. You may find insects, spiders, or even pill bugs (crustaceans) in your trap. After you collect your arthropods, use a paintbrush (optional) to help transfer them into a clear jar for observation. If desired, have the children fill out the "My Arthropod Observation Form" and place it in their science journals. Once you have observed the arthropods for a day or two, release them outside.

Read to the children:

Entomologists are scientists who study insects. They use traps to gather insects for study. They also use traps to monitor where insects live. One insect monitored by entomologists is the western bean cutworm moth. The larvae do damage to farmers' corn and dry bean crops. Entomologists put out traps so they can see where and how many western bean cutworm moths are in an area. The scientists report what they find and work together to create maps. When farmers look at the maps, they can see if their area has any reports of the moths and can take steps to prevent the insects from damaging crops.

Sometimes families use traps to remove insects for various reasons:

- A fly strip in the garage to catch houseflies so they do not go into the house
- An ant trap to prevent ants in the kitchen
- A Japanese beetle trap to catch beetles that might damage the garden plants
- A bottle trap to catch wasps that may sting people on the porch

Here is how we will make our own arthropod trap.

Simple Pitfall Trap

1. Dig a hole the same size and depth as your container. A good spot will be on level ground with plants close by and in the shade. A wooded area or meadow is best. Arthropods are more active on warmer days.
2. Set the container in the hole. Make sure it is at or just below ground level. Fill in any space around the container so arthropods can crawl across the ground and into the container. Any space might make them turn around.
3. Place the small piece of fruit in the container.
4. Place four small rocks on the ground around the outside edge of the container.
5. Set the cardboard on the rocks to make a lid or roof over the container. The rocks should allow room for the arthropods to crawl underneath.
6. Use the medium rocks to weigh down the cardboard and keep it in place.
7. Wait a few hours or overnight before checking on the trap. You may need to check daily for several days to find arthropods.
8. When you find arthropods inside, use the paintbrush (optional) to help you gently move them from the trap to the jar for observation.

If you like, you can make more than one trap and set each in a different location.

OPTIONAL PROJECTS

Insects as Garbage Disposers

Activity Supplies:

- 2 clear jars
- 1 jar ring or rubber band
- piece of fine mesh material big enough to cover a jar opening to allow air in but keep insects out, such as cheesecloth, tulle netting, or pantyhose
- piece of soft, overripe fruit such as a banana, strawberry, or pear
- knife

Read to the children:

One of the important jobs insects do for our earth is to help decompose rotting materials. In this activity we will observe whether a piece of fruit decomposes more quickly when insects can get to it.

Here is how we will set up our decomposing activity.

Decomposition Jars

1. Cut the fruit in half.
2. Place each fruit piece in a jar.
3. Cover one jar with the mesh material and attach it by screwing on the jar ring or using the rubber band. Leave the second jar uncovered.
4. Set the jars outdoors in the same location. Choose an area where they won't get rainwater in them. Insects are more likely to visit the jars if there are plants nearby and if the jars are in the shade.

Check the jars every couple days as the fruit inside rots. Do you see insects or evidence of insects in the open jar? Which jar's fruit rots more quickly? Why do you think that happens?

My Arthropod Trap Observation Form

Date: _____

Location: _____

Season: _____

Type of habitat: _____

Examples: wooded, arid, grassy

Time of day: _____

Number of arthropods I collected:

What I collected [circle]:

Insect or Wingless Insect (6 legs)	**Arachnid** (8 legs)	**Crustacean**	**Myriapod**	**Something Else**
Examples: beetle, ant, springtail	Examples: spider, scorpion, tick	Example: pill bug	Examples: centipede, millipede	Examples: slug, worm, snail—these are not arthropods, but you might catch them

Record interesting things you observed. Here are some questions to think about. What colors are the arthropods? Are there any special markings such as spots? How big or how small are they? If you collected winged insects, do they have one pair of wings (two wings) or two pairs (four wings)? How many body sections do you see on each one (insects and wingless insects have three; arachnids have two)? Are the arthropods adults or in other stages?

Sketch one or more of the arthropods collected.

EXTENSION

Instructions:

1. Study the "Classification of Phylum Arthropoda" chart. In your science journal, ask and answer five questions based on the chart. (e.g., Q: Are wingless insects and winged insects in the same class? A: No.)
2. In your science journal, create a Venn diagram comparing the similarities and differences between millipedes and centipedes.
3. In your science journal, define and illustrate the word DETRITIVORE.

Classification of Phylum Arthropoda

- Phylum **Arthropoda**
  - Subphylum **Trilobitomorpha**
    - Class: Trilobita **(extinct)**
  - Subphylum **Chelicerata**
    - Class: Arachnida **spiders, ticks, scorpions**
    - Class: Pycnogonida **sea spiders**
  - Subphylum **Myriapoda**
    - Class: Chilopoda **centipedes**
    - Class: Diplopoda **millipedes**
  - Subphylum **Crustacea**
    - Class: Malacostraca **lobsters, crabs, shrimp, isopods**
    - Class: Maxillopoda **barnacles**
  - Subphylum **Hexapoda**
    - Class: Entognatha **wingless insects with recessed mouth parts**
    - Class: Insecta **moths, houseflies, hornets, beetles**

Millipedes

- Segmented body
- Many legs
- Have a more rounded body
- Breathe through spiracles
- Two pairs of legs per body segment
- Move slowly
- Primarily detritivores, feeding on decaying organic matter
- Do not bite humans
- Emit a stinky liquid as a defense
- Found on every continent except Antarctica
- Prefer moist environments

Centipedes

- Segmented body
- Many legs
- Have a more flat body
- Breathe through spiracles
- One pair of legs per body segment
- Known for speed
- Carnivorous; many paralyze prey with venom
- Can bite humans
- Found on every continent except Antarctica
- Prefer moist environments

Definition

Detritivore: An organism that feeds on detritus—the organic matter composed of decaying plants, animals, and feces. Detritivores are an important part of an ecosystem because they recycle nutrients by breaking down dead and decaying organisms. Examples of detritivores are fiddler crabs, dung beetles, and woodlice. (Bacteria and fungi are not detritivores.)

Did you know?

Arthropods can exist in extremely harsh conditions. For example, scorpions can survive even after being frozen in solid ice. A cockroach can live for a week without its head because it breathes through holes in its body segment. To survive harsh Arctic winters, the *Onychiurus arcticus* loses 40% of its body moisture, so it can survive without the water in its body freezing. A single drop of water is all it needs to revert back to normal.

EXTENSION

Instructions:

1. Read the articles "Inestimable Insects" and "Ticks" and copy the drawing of a tick into your science journal.
2. As you read the articles, write 3–4 questions that you would like to research. You will use these questions in the last lesson. Put a box around the questions in your journal and draw a question mark in or above the box.

Inestimable Insects

You may be surprised to learn that the largest group of animals in the world is insects. More than 900,000 species of insects have been discovered, and entomologists (scientists who study insects) estimate that there are still millions of species waiting to be discovered.

Picture this: there are about 8 billion people living on the earth today, but it is estimated that there are more than 10 quintillion insects! That's 10,000,000,000,000,000,000 insects! To put it another way, that's a ratio of 200 million insects for every human being.

Insect life spans can vary by huge amounts, from the insect with the shortest life span—the tiny mayfly that may live for only a couple hours—to a termite queen that is known to live for 50 years, or even 100 years according to some scientists!

To help categorize all of these different insects, scientists divide them into 24 separate orders. The largest order of insects is Coleoptera, which includes all species of beetles. Currently there are around 6,000 species of mammals specified, but there are more than 350,000 beetle species, and entomologists are discovering more each day! You will learn more about beetles in the next lesson.

Insects can be found on every continent—yes, even Antarctica. One determined insect, a midge called *Belgica antarctica*, survives in that harsh environment. At only 0.50 cm (0.20 in.) long, it can survive being frozen and is Antarctica's largest native animal.

Ticks

Ticks are one of the most unique, and dreaded, creatures in the world. While tiny, averaging just a few millimeters in size, ticks are well able to acquire their desired food source: blood. Often that blood comes from humans.

While frequently categorized incorrectly as insects, ticks are actually part of the arachnid family, due to their eight distinct legs and lack of antennae. Amazingly, some ticks can live up to 200 days without food or water!

Ticks have a fascinating way of acquiring new hosts to feed on, which is called questing. They crawl up plants to unbelievable heights—at least it's unbelievable if you are only 3 mm (0.12 in.) tall! Once at the top, they clamp on with their hind feet and raise their front feet into the air. When something, or someone, brushes by, they grab on and quickly climb until they find exposed skin to feed on. They often prefer to climb up to the thin skin behind the ears. Some ticks will even drop down onto their unsuspecting prey as it walks by.

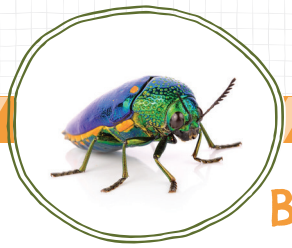
Unlike other blood-sucking pests, like mosquitoes, ticks feed for long periods of time. They wedge their teeth down into the skin of a host and remain attached there for days to eat. This can be dangerous to humans, since ticks can spread diseases like Rocky Mountain spotted fever and Lyme disease. It usually takes a tick 24–48 hours to transmit these diseases, so prompt removal of ticks is the best method of prevention.

You can prevent tick bites by wearing long pants and sleeves when you are hiking in heavy vegetation or by showering immediately when you get home. Remove any ticks you find as soon as possible, and don't forget to check your pets for ticks, too.

EXTENSION

Instructions:

1. Find the definitions for the words IRIDESCENT and MANDIBLE and record them in your journal.
2. Read the article "Beetles" and take notes in your science journal.
3. Choose at least one beetle to draw and color in your science journal.



Beetles

Belonging to the largest insect order, Coleoptera, beetles make up a huge percentage of all the living things in the world. Some scientists estimate that one in every four animals is a beetle. Beetles can be found nearly everywhere in the world, in all climates and ecosystems. British geneticist John Haldane once said, "If one could conclude as to the nature of the Creator from a study of creation, it would appear that God has an inordinate fondness for stars and beetles."

The variety of beetles is truly astounding. Many are beautifully decorated and show a range of bright, iridescent, or even metallic coloring. Beetles can be hard or soft, round or oblong, and flat or globular. The smallest beetle, the scydosella, is smaller than 1 mm (0.04 in.) while the titan beetle can grow to almost 178 mm (7 in.). However, there are some things all beetles have in common. All have six legs, and bodies divided into three sections: head, thorax, and abdomen.

Head

As you can see from the images on this page, beetle heads come in an amazing variety of shapes and sizes, but most include mandibles, compound eyes, and antennae.

Mandibles are a pair of rigid, often toothlike forms that move horizontally to grasp and cut food. They can also be used in defense or to attack enemies and are typically much larger in male beetles than in female beetles.

Beetles' eyes are located on either side of the head and are made up of thousands of six-sided facets, each of which transports a small part of an image to the brain where the entire image is reassembled like a jigsaw puzzle. This type of eye is called a ***compound eye***. With some exceptions, beetles usually have poor eyesight, and they rely on other senses for survival.

On the head of every beetle, you can also find two antennae, although these can look drastically different depending on the species and are used for several different functions. Some beetles use their antennae to smell, detect motion, search for obstacles, balance, or even mate.

Thorax

The thorax is divided into its own three sections, each of which sports a pair of legs for six legs total.

Perhaps the most recognizable trait of beetles is the hardened suit of armor they wear on their backs. This is actually an outer set of wings called the ***elytra***, which protects a second set of softer hind wings. When a beetle needs to fly, it holds its outer wings to the side, allowing the hindwings to flap freely. Most beetles are clumsy fliers because of this unique wing construction. While insects like dragonflies can beat their wings more than 1,000 times a minute, a beetle usually averages only 30–60 times a minute.

While all beetles have six legs with each leg divided into five sections, each species has legs designed to achieve different purposes. These could be sharp claws for climbing, large back legs for swimming, or strong, flat front legs for digging. Some beetles have even developed powerful legs that allow them to jump when needed.

Abdomen

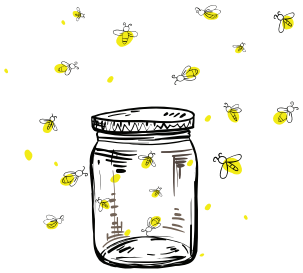
The final part of a beetle's body, located at the opposite end from the head, is the abdomen. There are no legs attached to the abdomen, but it is covered with several hard, telescoping rings, usually around nine or ten. Beetles, like all other insects, do not have lungs. Instead, small holes called spiracles are found along their sides. These tiny openings allow air to enter the beetle's body and be transported to the rest of the body through a system of tubes.

EXTENSION

Instructions:

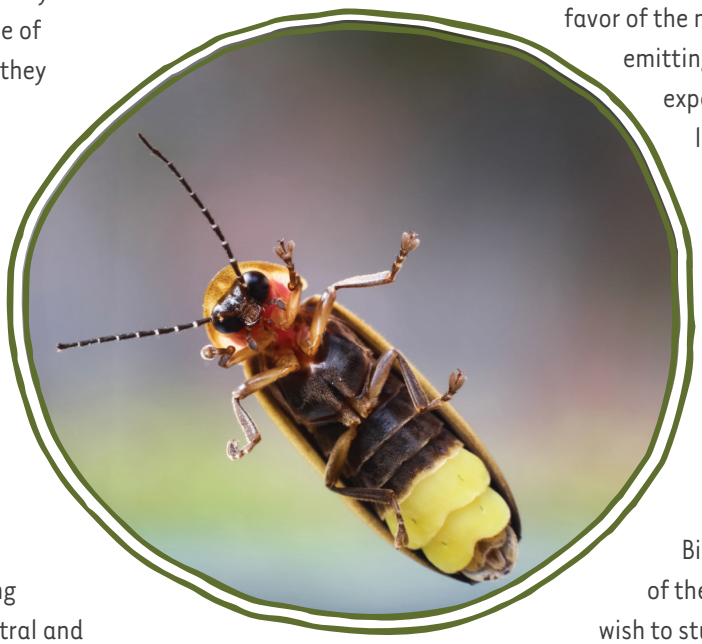
1. Read the article "Lighting Engineers." In your science journal, take notes and illustrate them.
2. As you read the article, write at least 3–4 different questions that come to mind. You will use these questions in the last lesson. Put a box around the questions in your journal and draw a question mark in or above the box.

Lighting Engineers



Fireflies are truly a wonder to behold as they float gracefully through the air, flashing their cheerful lights in the twilight, with some species flashing late into the night or until the morning light. Perhaps you've witnessed their captivating beauty while enjoying a warm summer evening outdoors. If you have, it will not surprise you to learn that the ancient Romans called them *stella volantes*—stars flying between heaven and earth.

Depending where you live, you may know these amazing creatures by the name of fireflies or lightning bugs, but they are actually neither flies nor bugs—they are beetles! These amazing soft-bodied beetles belong to the rather large Lampyridae family, which is comprised of about 2,000 different species. Most firefly species prefer warm to temperate humid climates, but they can be found on every continent except Antarctica, with the greatest species diversity being found in tropical Asia and Central and South America.



God designed fireflies with a stunning characteristic known as bioluminescence, which means they are able to produce their signature glow through a chemical reaction that occurs within their bodies. A firefly's light organ is found on the underside of its abdomen. When oxygen is drawn into the light organ's cells, it mixes with the heat resistant chemical luciferin, which is triggered to emit cold light by the enzyme luciferase. Firefly light is described as cold because virtually 100% of the energy is released as light rather than wasted heat. In fact, although there are many other bioluminescent creatures on the earth and in the sea, firefly light is often cited as the most efficient light in the world. The light is also within the color zone to which human eyes are most sensitive, inspiring modern chemists to create more efficient light bulbs. Now incandescent bulbs, which waste 90% of their energy in heat form, are being slowly phased out in favor of the much more efficient light-emitting diode (LED) bulbs that expend 80–90% of their energy as light.

Providing us with beautiful light displays and inspiration are not the only ways lightning bugs have proven useful to humans. Their luciferin and luciferase have other practical uses in science and medicine as well. Biotechnologists splice the DNA of these chemicals with genes they wish to study in order to illuminate the parts they are observing. The two chemicals are also used in the food industry to test food for microbial contaminants. In medicine they aid research on treatments for many conditions such as cancer, muscular dystrophy, and metabolic disorders. Luciferin and luciferase have even been used in the construction of electronic detectors for spacecraft tasked with searching for life in outer space!

Most, though not all, fireflies light up, but different species' light patterns vary in appearance and purpose. Lightning bugs flash or glow in shades of green, yellow, orange, red, and sometimes even blue. The males float through the air,

flashing every few seconds with the hope of seeing a female answering back with her own flash as she perches atop a tall blade of grass or a tree or shrub. Some species even have synchronous light patterns, meaning they all perform their light shows together as a group. But flashing fireflies are sending more than one message. They are also warning predators to stay away. Any animals bold enough to ignore this warning will be left with a taste so terrible that they aren't likely to repeat the mistake.

Usually when a female answers a male's flash, she is inviting him to be her mate, but things aren't always what they seem in the firefly world. In some species within the genus *Photuris*, a flashing female may have something else in mind: dinner. Nicknamed *femmes fatales*, they will mimic the flash patterns of species in the closely related genus *Photinus* to lure the males within reach of their hungry mouths. But these carnivorous females are not the only fireflies prone to trickery. Some *Photuris* males attract mates by pretending to be the *Photinus* males that females of their own species prefer to snack on, but when she flies down expecting a meal, she is surprised to receive a mate instead. The *Photinus* male will sometimes imitate the flash pattern of the *Photuris* female. By pretending to be one of his own predators, other males of his species are scared away, thus ridding himself of some of his competition for a mate.

Although some fireflies do eat other fireflies, most do not, and they have never been observed eating any other type of insect. Although scientists aren't completely sure what most adult fireflies eat, they believe that some feed on the pollen and nectar of nearby plants while others may eat nothing at all. This is possible because fireflies only live a few weeks in the adult phase. Most of a lightning bug's life cycle is spent in the larval stage underground where the adult female lays its eggs. During this one- to two-year period, the young glowworms are carnivorous. They spend their time hunting slugs, snails, and worms, injecting their prey with a fluid that paralyzes and begins to digest them.

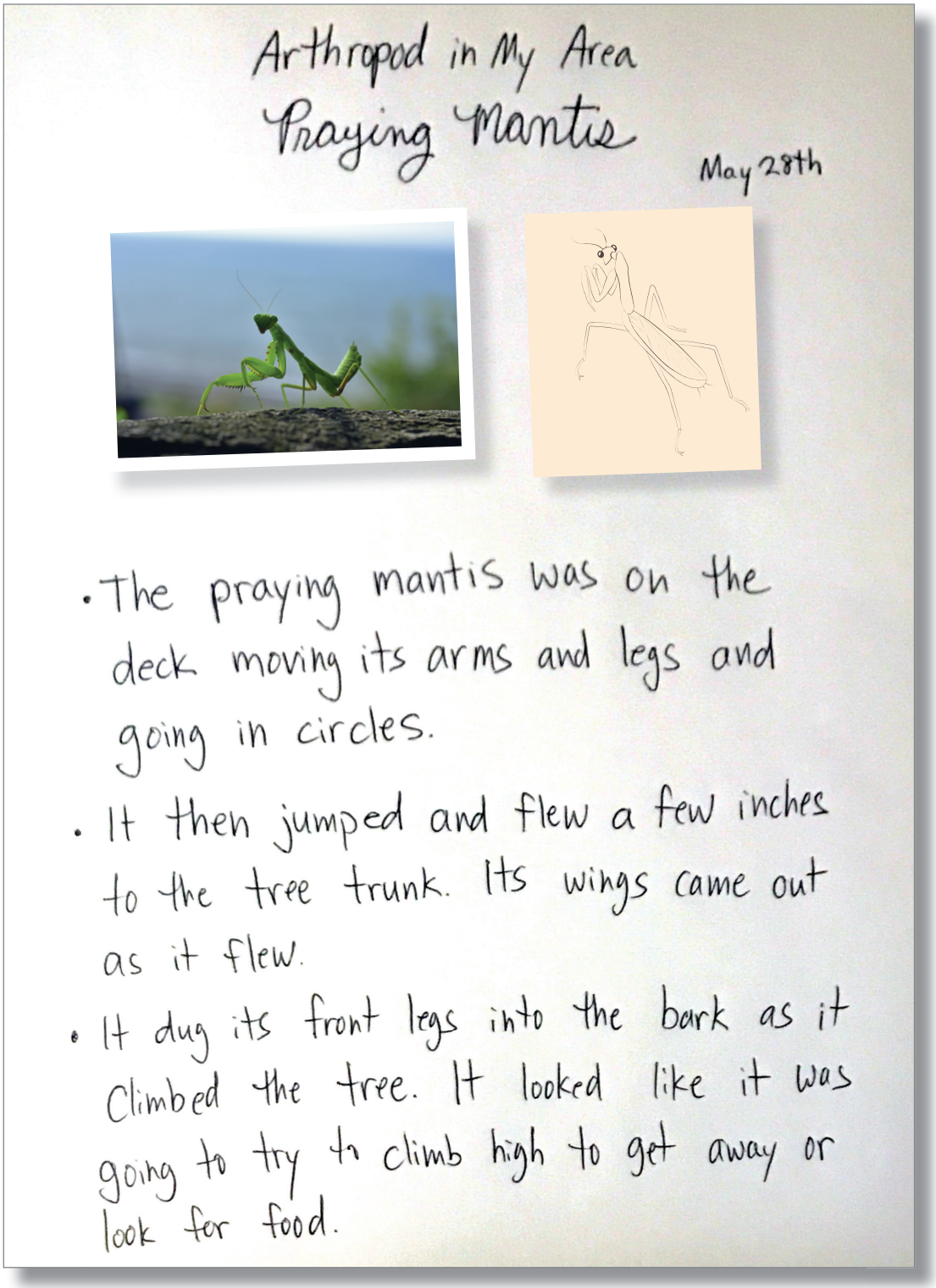
Fireflies are fascinating to observe up close, but special care must be taken since their populations are dwindling due to habitat loss and light pollution. It is best to catch them with a net and place them in a jar with a damp paper towel for humidity and a lid that has air holes. After observing them for no longer than a day or two, let them go at night when they're most active, so they can join in the luminous dance of their kind once more.

EXTENSION

Instructions:

1. Create an "Arthropod in My Area" journal page. Find any type of arthropod outside your home, at a park, etc. Study the arthropod for at least 20 minutes.
2. Take a picture, if desired. Illustrate the arthropod. Observe and write about the arthropod's behavior.

Example "Arthropod in My Area" Journal Page



Arthropod in My Area
Praying Mantis
May 28th

- The praying mantis was on the deck moving its arms and legs and going in circles.
- It then jumped and flew a few inches to the tree trunk. Its wings came out as it flew.
- It dug its front legs into the bark as it climbed the tree. It looked like it was going to try to climb high to get away or look for food.

EXTENSION

Instructions:

1. Read the article "Barnacles."
2. In your science journal, create a "Q&A" in which you ask and answer five questions based on the information you read. Put a box around the questions in your journal and draw a question mark in or above the box.

Barnacles

Kingdom: Animalia

Phylum: Arthropoda

Subphylum: Crustacea

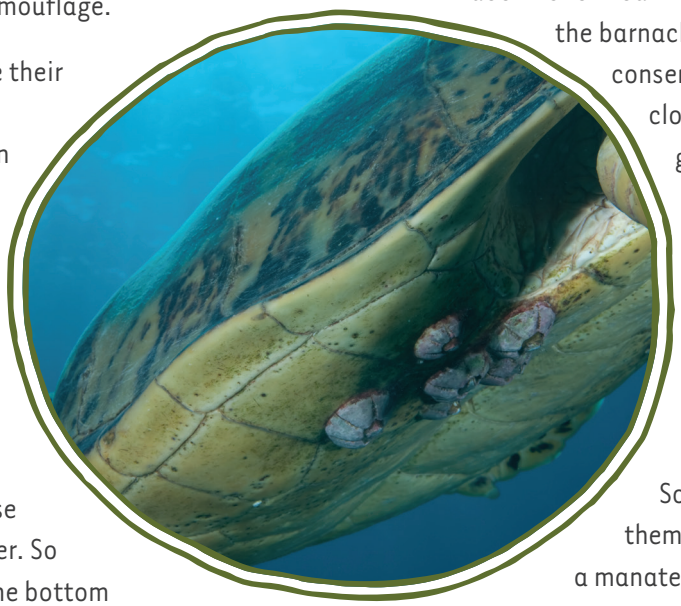
Class: Maxillopoda

Subclass: Thecostraca

How would you like to be permanently cemented to a rock, head down, and have to eat with your feet? Well, barnacles don't seem to mind those things.

There are more than 1,200 types of barnacles, and they can be found on almost any solid surface that gets covered with seawater. They can be brown, pink, orange, green, yellow, or covered with stripes. The color of a barnacle usually matches the color of the habitat in which it lives, giving it good camouflage.

Newborn barnacle larvae leave their parents' shells and are free-floating. They feed on plankton until they find an object to attach themselves to for life, such as a dock, boat, rock, whale, or even on the shell of a sea turtle or crab.



If the barnacle attaches to an animal, the animal is not hurt in any way. Barnacles can cause big problems for boats, however. So many barnacles can grow on the bottom of the boat that it increases the drag (the net force opposing forward movement), greatly increasing how much fuel boats use. In fact, the US Navy estimates that barnacles can result in as much as 40% more fuel consumption for large ships. Barnacles can also plug drains and ruin equipment on boats. Many boat owners regularly scrape barnacles off their boats. There is also a special kind of paint that kills barnacle larvae, but it can make the water toxic for other sea creatures. Scientists are still looking for good solutions to the problem of barnacles on boats.

Barnacles are filter feeders. They use their feathery appendages to draw water into their shells. Then they strain food particles out of the water.

A baby barnacle secretes a powerful glue-like liquid that hardens like cement when it attaches itself to something hard. Most kinds of barnacles then grow an outer shell. Five plates encircle many barnacles, and a "door" is formed with four more plates that the barnacle can open or close. To conserve moisture, a barnacle closes its plates when the tide goes out.

Barnacles vary in size. The more a barnacle eats, the more it grows. Like lobsters, barnacles shed their shells when they need larger ones.

Some barnacles attach themselves to manatees. When a manatee heads to fresh water, the barnacles cannot survive and they die. Once they fall off, they leave scars on the manatee's back.

EXTENSION

Instructions:

1. Read the article "Jean-Henri Fabre and the Life Cycle of the Field Cricket."
2. Choose three sentences about the life cycle of the field cricket and copy them in your science journal with space underneath. Imagine you are Jean-Henri Fabre and you wish to convey the beauty of the cricket in a factual, yet interesting way. Rewrite the sentences you chose in a way that would capture the interest of a casual reader.

Jean-Henri Fabre and the Life Cycle of the Field Cricket

Jean-Henri Fabre was a French entomologist in the late 1800s to early 1900s. From an early age, he was fascinated by the beauty of the butterflies and grasshoppers he observed in the natural world. As an almost-complete autodidact (someone who is self-taught), Fabre dedicated his life to the study of insects and arachnids. He focused on observation and taking detailed notes but avoided drawing general conclusions about what he noticed, as he was solely there to record the facts. His written works did not follow the typical dry, scientific structure of other factual books at the time. Fabre had a lively, biographical style to his writing, and his passion for communicating the intricate details of the behaviors and life cycles of the insects he studied is manifest in his written work.

One of the insects Fabre studied in great detail was the field cricket. He prepared a flower pot with soil and a glass lid and made careful observations, from the female laying her eggs to his failed attempt to feed lettuce to the new crickets. Eventually, Fabre released "five or six thousand Crickets, an attractive flock, to be sure," into his yard and described the result as a "massacre so great that the colonies . . . were so far decimated that I could not continue my observations." In other words the crickets, no longer under the protection of the glass lid, were exterminated by their natural predators—lizards, ants, gnats, dung beetles, and wasps. The life cycle of the field cricket is made fascinating by Fabre's colorful descriptions and comparisons.

Life Cycle of the Field Cricket

The life cycle of the field cricket lasts from late spring to early fall. There are only three stages, which Fabre describes in great detail in his book *Social Life in the Insect World*. During the egg stage in late spring, the female lays 50–100 eggs in a perpendicular position a few inches into the soil. Fabre described the eggs as "a curiosity, a tiny mechanical marvel" because they have a piece like "a skull cap which forms the lid." Along the lines of this cap is where the eggs break and the nymph "issues forth like a jack-in-the-box," about two weeks after being laid. Thus begins the second stage of the cycle. The nymph is a flea-sized cricket, "pale all over, almost white," which burrows to the surface of the soil and nimbly hops away in search of food. Once the nymph has molted 8–10 times and has grown into a "splendid ebony black" adult cricket, it has arrived at the third and final stage of its life. At this point, the males begin to chirp, rubbing their back legs together in an attempt to attract a mate. Fabre's appreciation for the sounds of crickets signifying the beginning of summer is apparent in the way he describes crickets as the "choristers of spring" and compares their song to that of the crested lark, a beautiful summer bird. Once the crickets mate and the female lays her eggs, they die from the cold in the fall, and the cycle begins again.

EXTENSION

Instructions:

1. Read the article "Eastern Black Swallowtail."
2. In your science journal, record the key information you will need to identify Eastern black swallowtails. Include information such as host plants, physical markings, and size. Then trace the butterfly at the bottom of this extension and label its different parts.

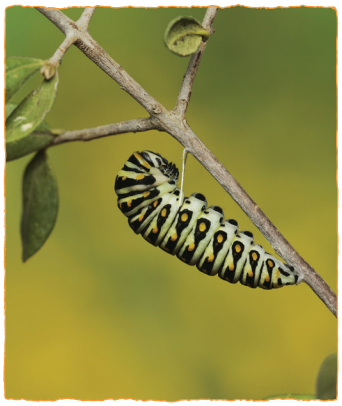
Eastern Black Swallowtail

Eastern black swallowtails (also known as black swallowtails) are one of the most common swallowtails in North America. You may find them across Southern Canada, throughout most of the Eastern and Midwestern United States, as far west as the Rocky Mountains, and south into Northern Mexico. Eastern black swallowtail caterpillars feed on a small variety of native and introduced plant species, but in home gardens, they may be found on the leaves of dill, parsley, fennel, carrot, and celery.

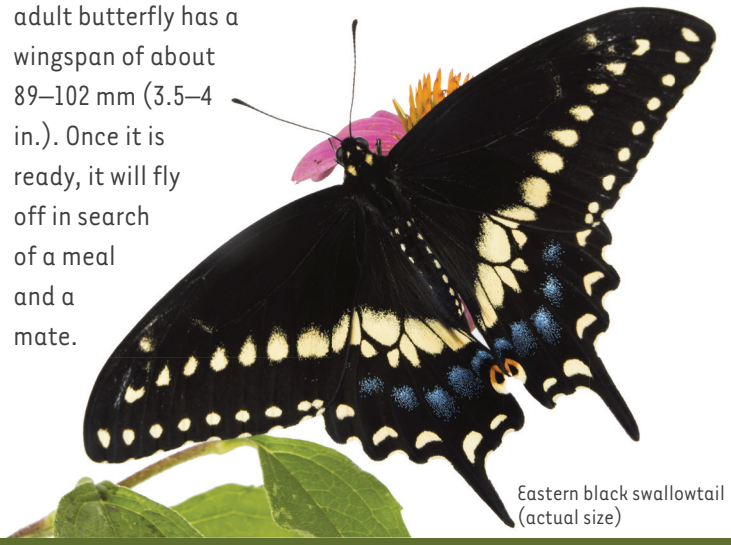
Black swallowtails start life as 1 mm (4/100 in.) pale yellow spherical eggs laid singly on one of their host plants. You can usually find them attached to the underside of young foliage. The egg darkens in color as the caterpillar inside develops until it ecloses (hatches) after about 4–9 days.

The tiny first-instar caterpillar is only about 2 mm (8/100 in.) long at this point. It's black with a white band around its middle. It will eat what remains of its egg and then go on to begin eating the leaf on which it has found itself. Eventually it will grow too big for its skin, become very still, and then walk right out of its old skin, leaving it behind in a clump. This is molting. After resting from all the effort required to walk out of its skin, the second-instar caterpillar will turn around, eat its old skin, and carry on eating and growing until it is time to molt all over again. It will repeat this three more times as it grows larger and larger over the course of about 10–20 days.

When the caterpillar, now about the size of an adult pinky finger, is ready to pupate (make a chrysalis), it will begin to wander and look for a safe place. Many will leave their host plants for the first time. Once it has settled on the location, it will begin to create a thick pad of silk. Then it will attach its back end to this pad by firmly pushing its cremaster, a hook or hooks at the hind end that help it attach, against the silk. It works much like Velcro®. It will then create a girdle of silk around itself with the two ends attached like the silk pad. Finally, it will release all of its feet, lean back, and begin the work of preparing to shed its skin for the last time.



The caterpillar is now a pupa. It will either remain in its chrysalis for 9–18 days, or, if it is late summer, it will remain for several months and overwinter. When it ecloses, its wings are damp and soft. It will hang upside down for several hours as it pumps fluid into its wings and allows them to harden. The adult butterfly has a wingspan of about 89–102 mm (3.5–4 in.). Once it is ready, it will fly off in search of a meal and a mate.



Eastern black swallowtail (actual size)

EXTENSION

Instructions:

1. Read the article "The Wonders of an Ant Colony." In your science journal, take notes and illustrate them.
2. As you read the article, write at least 3–4 different questions that come to mind. You will use these questions in the last lesson. Draw a box around the questions in your journal and draw a question mark in or above the box.

The Wonders of an Ant Colony

If you've ever bent down to observe an anthill, one of the first things you may have noticed is that these tiny creatures always seem to be very busy. They are constantly on the go, scurrying to and from their underground lairs. Where are they going in such a hurry, and what are they doing down there in the darkness of their network of tunnels? Let's take a closer peek into the lives of these fascinating arthropods.

Of all the insects, ants are the most plentiful. There are more than 12,000 known species, and they live all over the world with the exception of Antarctica, Greenland, Iceland, and some islands. They are able to adapt to environments where other insects cannot and live underground as well as inside hills, wood, and houses. Although there can be as many as half a million ants in one colony, food shortages are no problem because they are not picky eaters. Ants eat a variety of sugars, plants, fungi, and other bugs. Army ants even work together to prey upon birds, reptiles, and some mammals. Some species live only a few weeks, but others can survive from a few years to decades, far surpassing the typical longevity of most insects. Ants are also very intelligent, organized creatures. They are the most highly developed of all social insects. While the activity surrounding an ant colony may look chaotic to the untrained eye, each ant has a vital role. The caste system of each colony is composed of at least three major jobs: queens, males, and workers. The 200+ species of army ants require an additional fourth job—soldiers, of course! The large army ant soldiers are necessary to continue their nomadic lifestyle of marching on, only stopping to build temporary camps called bivouacs.

At the heart of every ant colony lies at least one queen, though sometimes there can be many. A queen is not likely to be seen above ground unless she is a new winged female, taking to the skies to mate with a winged male. Afterward, the male has fulfilled his purpose and usually dies. The queen will begin a new colony, where she will lose her wings and settle into the chamber in which she will continuously lay eggs to ensure the survival of her colony. One queen can lay hundreds or even thousands of eggs every day, which can add up to millions in her lifetime. No colony will survive without a queen, so she has many attendants to see to her every need. Workers ensure that she is fed and groomed, and there are always guards posted just outside her chamber. The eggs and larvae are housed in separate chambers where they are cared for by workers who act as nannies.

Workers, all of whom are female, are essential to the operation, upkeep, and defense of a colony. Like humans, ants need to fill many occupations to build successful communities. Builders can construct and repair mounds or hills, and excavators have excellent stamina that allows them to dig tunnels very quickly. The foragers who venture out in search of food possess incredible strength, with some species capable of lifting up to 50 times their body weight. That would be similar to an average 13-year-old lifting a small pickup truck! Although insects don't usually come to mind when we think of cleanliness, ants take it very seriously. Ants tend to live in places that are prone to containing mold and parasites, so they groom themselves every few minutes with their oily saliva. Sanitation workers clear the tunnels and chambers of litter and drag their dead away to prevent disease. And if any one of the aforementioned workers receives a serious injury on the job, it will be thrown out with the litter. Otherwise, a nurse will give aid, perhaps by amputating a broken leg with her jaws or licking wounds to prevent bacterial infections. Although each job is highly specialized, it's not uncommon for a worker to make career changes as she grows older.

EXTENSION

Instructions:

1. Read both of the articles below. Using the internet or reference books, research an arthropod that may have a medicinal use other than what is mentioned in the first article.
2. In your science journal, write 3–5 sentences reporting on the arthropod you found and how it can be used for medicinal purposes.

Modern Medicinal Uses for Arthropods

Arthropods have been used to treat medical conditions for thousands of years, dating back to ancient times. Many of these uses have proven to be no more than folklore, such as the idea that eating a stick bug can help a person lose weight or that eating a hairy tarantula can help someone regrow hair on his or her head. However, certain arthropods like spiders, maggots, and even wasps are still used today, and scientific research continues to support the theory that some of these medicinal uses may actually be legitimate.

Spider silk, which spiders use to make their webs, can be used in the formation of skin grafts and ligament implants.

Fly larvae, also known as maggots, can be set upon an infected area of skin. They will eat only the necrotic tissue (cells that have died and can cause infection), which helps a wound heal faster.

The venom from a wasp found in Brazil weakens the membrane of cancer cells and eventually causes holes, through which vital parts of the cell begin to leak. Without these vital parts, the cancer cell cannot live or reproduce.

As scientists continue to research the use of arthropods in the field of human health, surprising benefits will come to light. Keep an eye on reputable sources for biological current events to remain updated on these medical advances!

Sexton Beetles: Nature's Cleaning Crew

Not only can arthropods be ingested, given as medicine, or placed directly on the skin to treat medical conditions, but some insects like the sexton beetle work to make our environment safer for us. Without scavengers (animals that feed on dead plant or animal tissue), carrion, the decaying flesh of dead animals, would be found infecting the environment in woods and on roadsides. These substances are not safe for humans to touch or ingest, so the sexton (or burying) beetle, which buries and eats carrion, plays an important role.

Sigmund A. Lavine wrote about their interesting habits in his book *Wonders of the Beetle World*, describing the beetle's process of finding, carrying, and burying a dead animal. First, the female sexton beetle picks up the scent from the dead animal flesh and hurries to claim it. She rolls over on her back and uses her feet to push the animal several inches away from its original location. Next, she uses her front feet to dig a furrow until she finds a spot soft enough in which to bury the carcass. Either alone or with the help of a male sexton beetle, she pushes the carcass to the hole she started and continues to dig dirt from underneath the body. Once the body has been buried below the surface, the female beetle digs a tunnel in which she will lay about fifteen eggs. The adult beetles feed on the carcass and regurgitate food to nourish the new larvae once they hatch. Over time, the carcass is consumed and can no longer be toxic to living beings.

EXTENSION

Instructions:

1. Read the article "Spider World Records."
2. Explain to a parent or another person what you learned.

Spider World Records

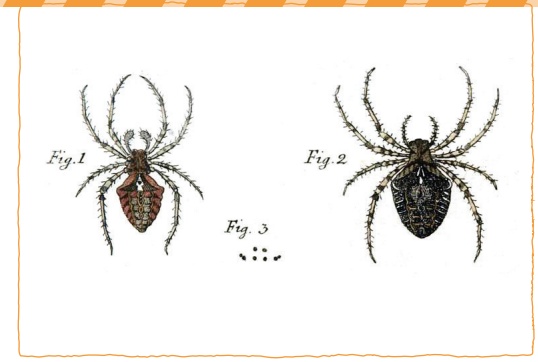
Adapted from "Record Breaking Achievements by Spiders and the Scientists Who Study Them," October 31, 2017, *www.ncbi.nlm.nih.gov*

First Arachnologist in History—Carl Alexander Clerck (1709–1765) Although reports about spiders can be found in very old writings such as those of Aristotle and Pliny, according to Bonnet (1955) the father of modern arachnology was Carl Alexander Clerck, author of the first book on spiders using the binomial system of nomenclature, *Svenska Spindlar*. His book was published shortly after the seminal *Systema Naturae* of Carl von Linné (Carl Linnaeus), which marks the beginning of the binomial system of nomenclature.

Most Prolific Arachnologist—Eugène Louis Simon (1848–1924) In terms of publications, the most prolific arachnologist was the French naturalist Eugène Louis Simon. Over his lifetime he authored more than 270 spider-related scientific works, and he described (or revised the status of) 5,633 species—although some of them were later synonymized or considered *nomen dubia*, meaning the names were eventually rejected.

Largest Living Spiders—*Theraphosa blondi* and *Heteropoda maxima* The Goliath birdeater, *Theraphosa blondi*, is possibly the largest known spider by mass. According to Guiness World Records (2017), a single reared individual reached a leg span of 28 cm (11 in.) and a weight of 170 g (6 oz). The giant huntsman spider, *Heteropoda maxima*, discovered in caves in Laos, is possibly the largest known spider by leg span—up to 30 cm (12 in.). With a total body length up to 4 cm (1.5 in.) and a leg span of more than 10 cm (4 in.), females of *Nephila komaci* (Araneidae) are the largest known orb-web spiders.

Best Ballooners—Most Spiders Many spiders, especially small species or immature stages, disperse by releasing one or more silk threads to catch the wind (the so-called ballooning behavior). Airborne dispersal is particularly widespread amongst higher spiders in the entelegyne subgroup. Distances traveled by spider ballooners can reach greater than 1,000 km (621 mi), as testified by sailors who reported spiders caught in their ships in the middle of oceans. Possibly, the longest distance covered with ballooning is 3,200 km (1,988 mi) for an unidentified linyphiid spider.



Orb-Web Spiders

Eugène Louis Simon

Goliath Birdeater

EXTENSION

Instructions:

1. In several extension assignments for this unit, you wrote questions that you would like to research. Choose one of the questions you wrote down, or think of another question about arthropods that you would like to research.
2. With the permission of a parent, research online and/or in books, and then write a journal page that answers that question.

Example "Researching a Question" Journal Page

Question: Are there different kinds of lady bugs?

Answer: Yes, the name lady bug – or also as they are called lady bird beetles – is given to a whole family of insects. The family is called Coccinellidae. There are 6,000 species of lady bugs in the world! In North America there are 400 species!

The adults are round and all small. Usually the colors are combinations of black and red, orange or yellow. Most kinds eat a lot of other insects such as aphids.

I usually see the seven-spotted lady beetle. I used to think this was the only species!

The multicolored Asian lady beetle lives in soybean fields in my area. It eats aphids.

