

Bugs in our Backyard Coloring Book



Illustrated by
Rowan Graham Angelini,
with **Serena Graham**
Text by **Dave Angelini**

Biology in our own backyard

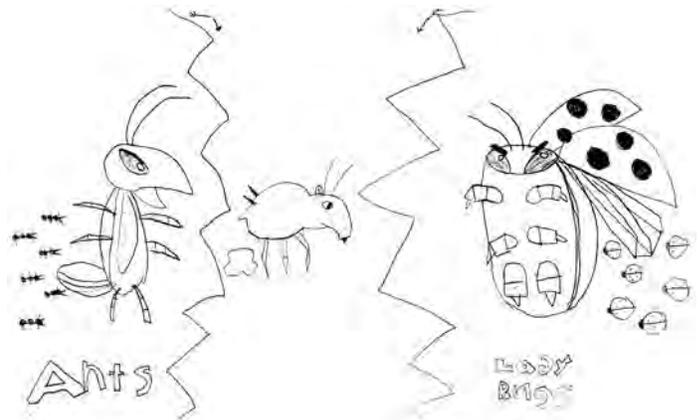


Bugs In Our Backyard is an educational outreach and collaborative research program, providing project-based learning opportunities for K-12 students– or anyone! Students of any age can become citizen-scientists by surveying the diversity of local insects and plants.

This coloring book is designed to introduce younger children to insects. We encourage teachers to present insects as interesting and beautiful animals, not creatures to be feared. The next pages provide some information on insects for teachers. Each coloring book page has some text for beginning readers. At the bottom of each page is more detail for older students and teachers interested in sharing some facts with their students.

Teaching ideas

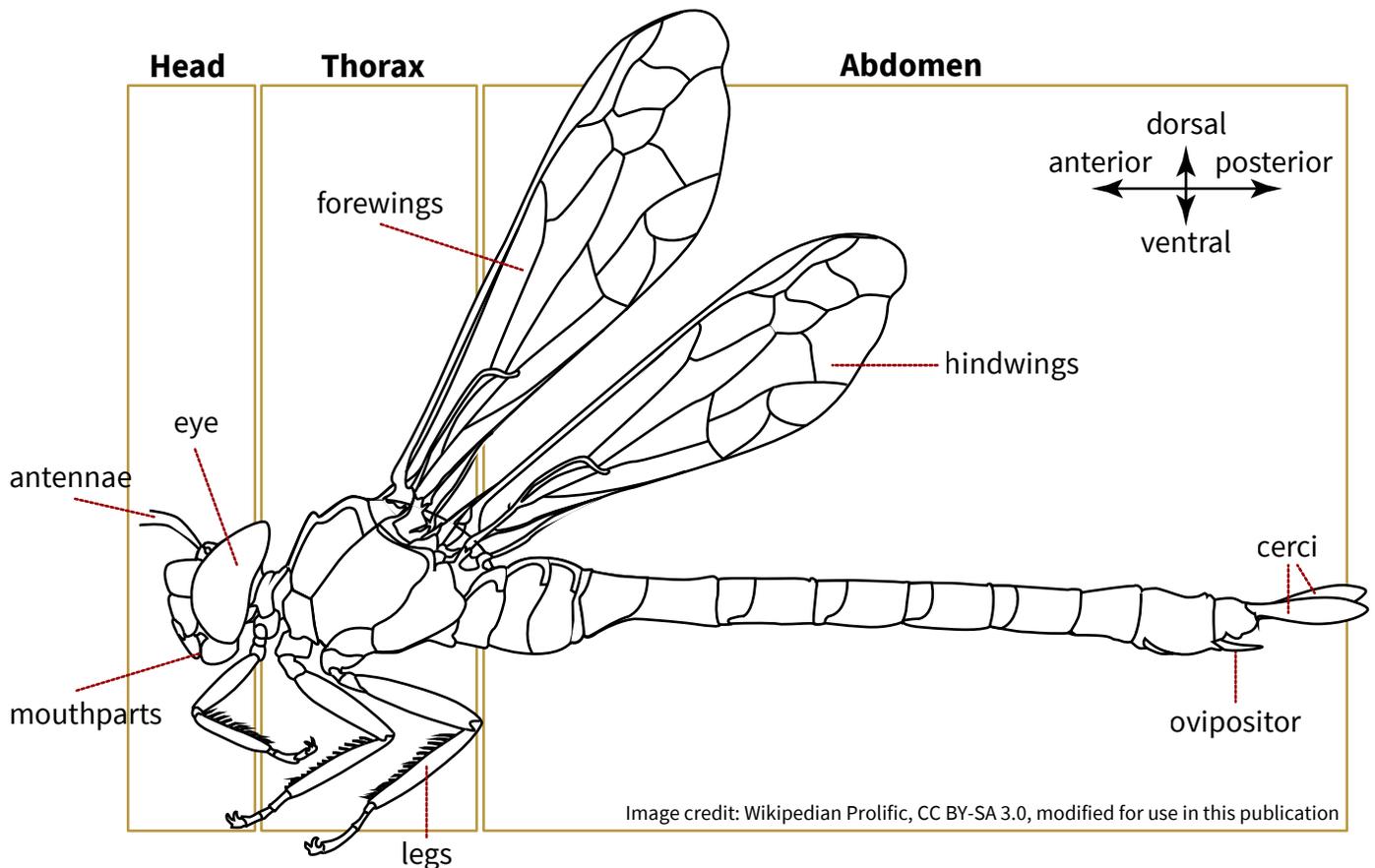
- Look for insects in a park, garden or by using an Internet search. Then ask students to color patterns they saw in person.
- Encourage students to draw the surroundings on each page. Where does each insect live? What does it eat? What might eat it?
- Talk about animal behaviors or natural history, and ask students to cartoon those ideas. The example here shows the conflict between ladybugs, which eat aphids, and the ants who protect them.



- For more ideas visit *Bugs in our Backyard* on-line

What is an insect?

Insects are the most common animals most people will encounter. They are critically important to the ecosystem. Insect are **arthropods**, animals with a rigid external skeleton, and a body with repeating segments. Some of these body segments have jointed appendages that serve many different functions, including detecting chemicals (smell), sound (hearing) and movement. Other appendages help in feeding (**mouthparts**), walking (**legs**), and flight (**wings**).

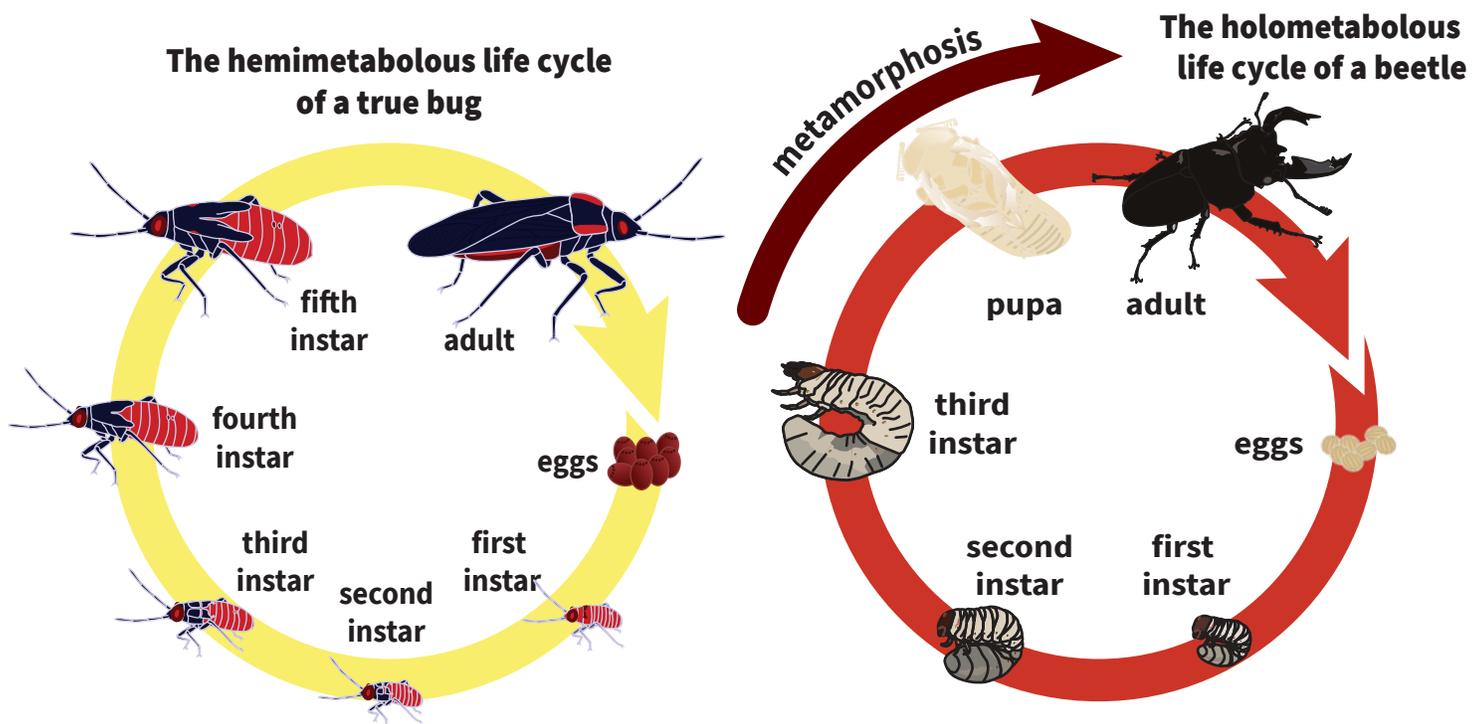


The bodies of all insects have three distinct body regions: a head, thorax and abdomen. The **head** has eyes and antennae for sensing the world and mouthparts for eating. The **thorax** has appendages used for moving around, such as legs and wings. Most adult insects have two pairs of wings. The **abdomen** contains most of the insect's organs. The abdomen often has no appendages, but there may be sensory cerci at the posterior. In some species, females have an appendage on the abdomen for laying eggs, called an **ovipositor**. Males of some species have **claspers** used to hang on to females during mating. In many insect groups, the wings fold back to cover the abdomen when the insect isn't flying.

Insect life cycles

Some insects have a complete metamorphosis, while others do not

Some insects have evolved a dramatic **metamorphosis**. In these **holometabolous** insect species, juveniles look very different from adults. Caterpillars, grubs and maggots are juvenile butterflies, beetles and flies. They may look wormy, but they still have a distinct head, thorax and abdomen. During their metamorphosis, these insects form a resting **pupa**, also known as a cocoon, or chrysalis, which is often hidden or camouflaged. In other insect groups, juveniles resemble adults, but are smaller and have rudimentary, non-functional wings.



Each juvenile stage is known as an **instar**. During these periods, an insect eats and saves energy as fat and protein. While a growing insect can expand a little, it is limited by its rigid external skeleton. Therefore, insects must shed their exoskeleton in order to significantly increase their size. Each instar ends with a **molt**, the process where the insect sheds its skin and exoskeleton. The series of pictures below show a dragonfly juvenile (far left) molting to become an adult (far right). Adult insects never molt again!

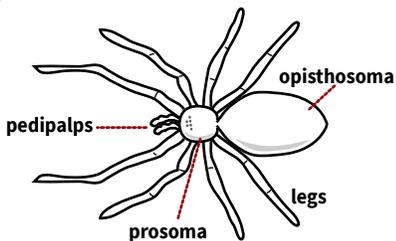


Image credit: Böhringer Friedrich, CC BY-SA 2.5, modified

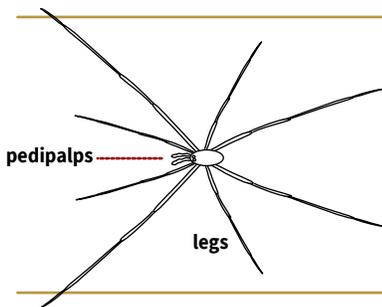
Things that are not insects

Some other arthropods in our backyard

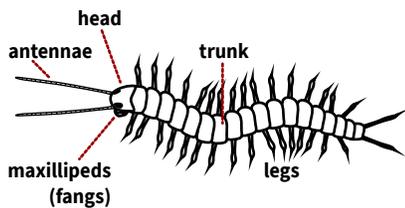
Insects are just one group of arthropods that have colonized the land. Many other animals, like spiders, millipedes and isopods can be found alongside insects. These animals can be worth exploring too! However, it is useful to know how to distinguish these creatures from one another. Here are some animals that are sometimes confused with insects. Notice the characteristics that make them unique.



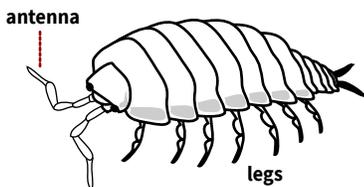
Spiders are arthropods with two body regions, a prosoma (sort of a combined head and thorax) and opisthosoma (or abdomen). Spiders can also be distinguished from insects because they have 8 legs and two pedipalps and two small chelicerae (or fangs) in front. Not all spiders spin webs!



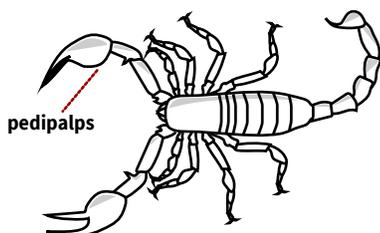
Daddy long-legs are relatives of the true spiders, however they make up a separate order called the Opiliones. Like true spiders, “daddy long-legs” or “harvestmen” have 8 long legs, 2 small pedipalps at the front and a pair of small chelicerae. They are not venomous and do not bite.



Centipedes and millipedes are easy to distinguish from insects because of their many legs! These arthropods can have venomous fangs, and they are often predators that hunt small insects and other arthropods in the leaf litter, under logs, and in basements.



Pillbugs, sowbugs, woodlice and roly-polies-- whatever you call them-- are isopods with 14 legs. They are mostly herbivorous crustaceans that have adapted to life on land. Females keep eggs and young in a pouch under their body. Some species roll up into a ball to protect themselves.

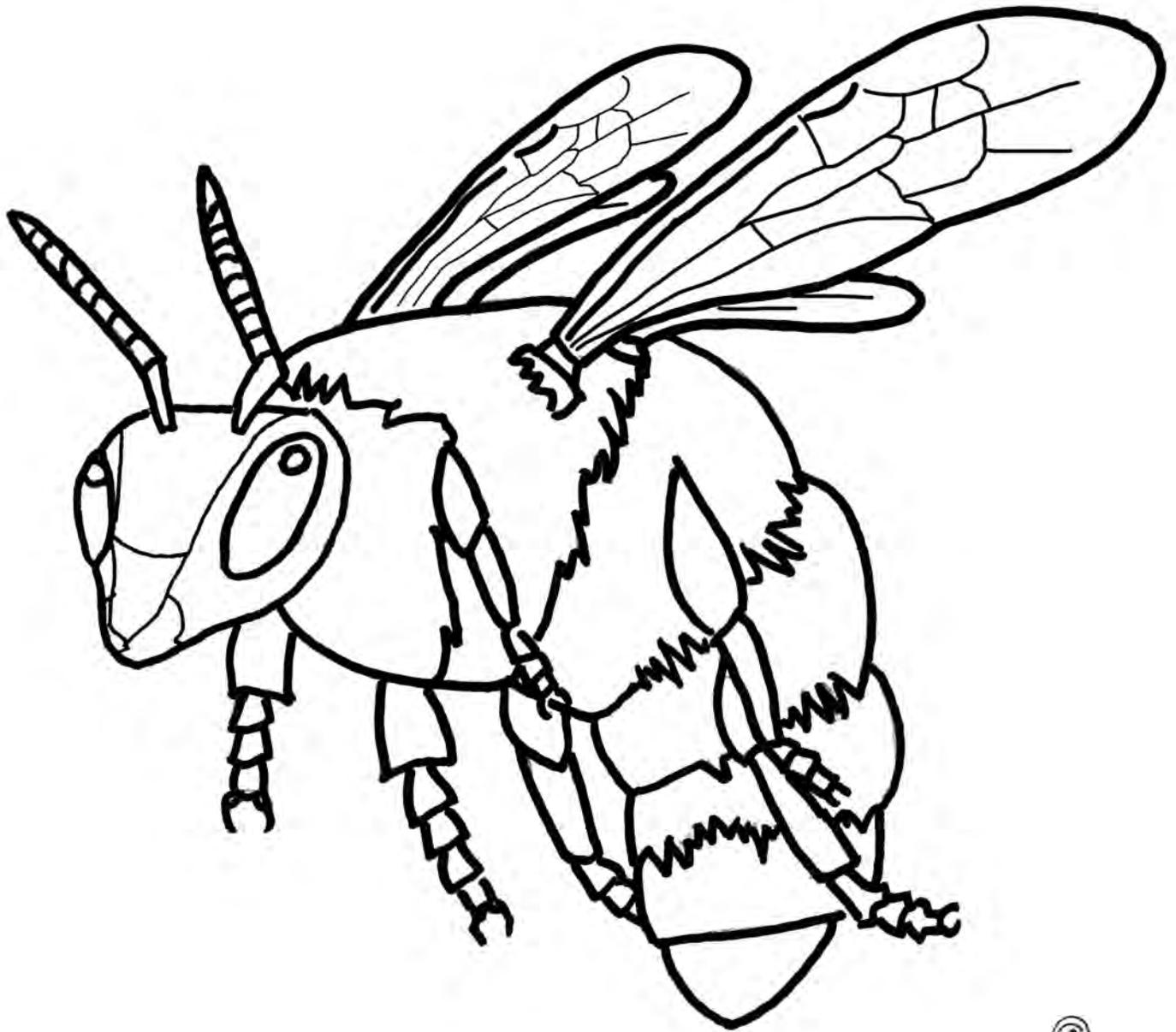


Scorpions are distantly related to spiders, but they evolved independently to live on land. These arthropods can be distinguished from insects by having 8 legs, 2 large pinching pedipalps and 2 small chelicerae (fangs), and a long barbed tail. Tiny pseudoscorpions are similar, but have no tail.



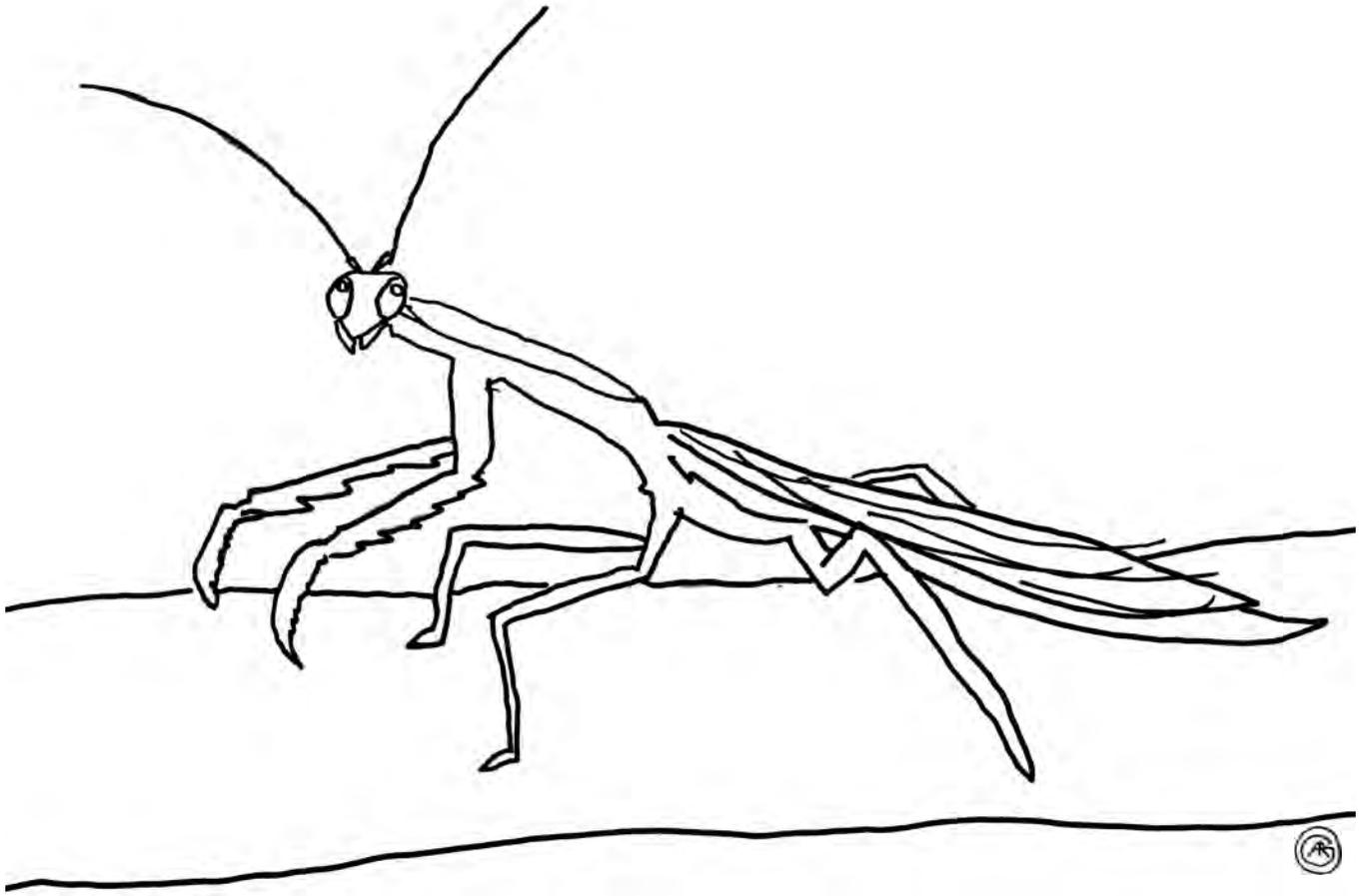
Butterflies are insects that drink nectar from flowers. Their colorful wings signal to other butterflies and to other animals.

Butterflies and moths (order Lepidoptera) are important pollinators. As they move between flowers, drinking nectar, they also move pollen between plants, allowing the plants to reproduce. The colorful wings of a butterfly, like this monarch, warn potential predators that they do not taste good. Some butterfly species have spots on their wings that look like the eyes of birds or mammals, to frighten predators. Some male and female butterflies also signal one another with colorful wings.



Bumble bees are large fuzzy insects that eat pollen and nectar from flowers. By moving pollen between plants, they help the plants reproduce.

Bumble bees (genus *Bombus*) are cute enough to be flying pandas! They are important pollinators in cooler climates. Their large size and fuzzy coats insulate them, but they can shiver to make heat. Bumble bees are also social. Each spring a queen produces daughters who work together as workers in a colony. They raise more workers, new queens and males before winter. Bumble bees can sting, and they warn predators with contrasting black, yellow and red colors.



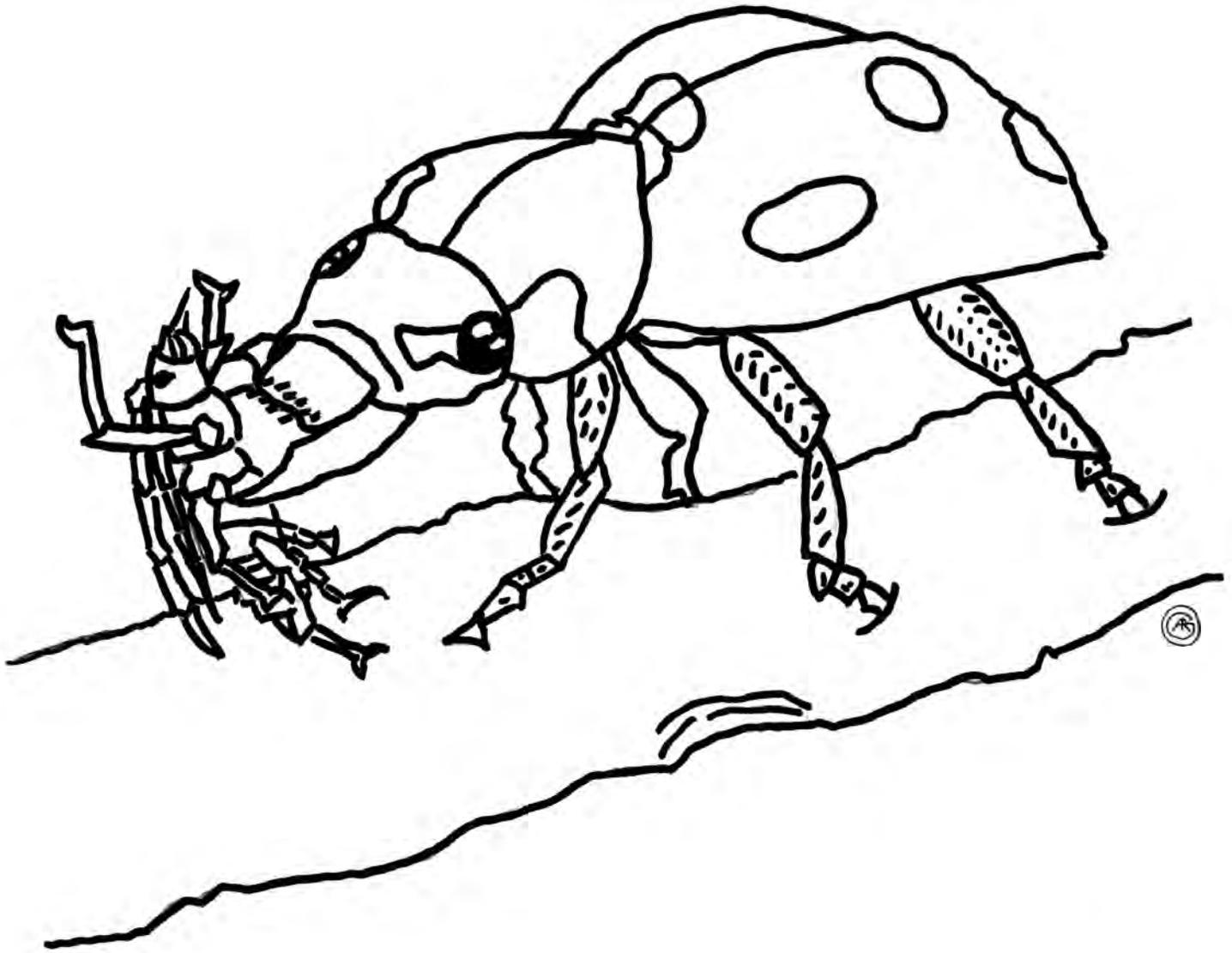
The **Praying Mantis** is a large insect that hunts other insects. They look like leaves or twigs and ambush their prey.

Mantids (order Mantodea), like the praying mantis, hunt with their large raptorial front legs. Many species ambush prey and are camouflaged to resemble their environment. However a few species actively chase their prey. All mantids have large eyes and excellent vision. Females lay eggs on plants in a mass that forms a large, hard structure, resembling a gall.



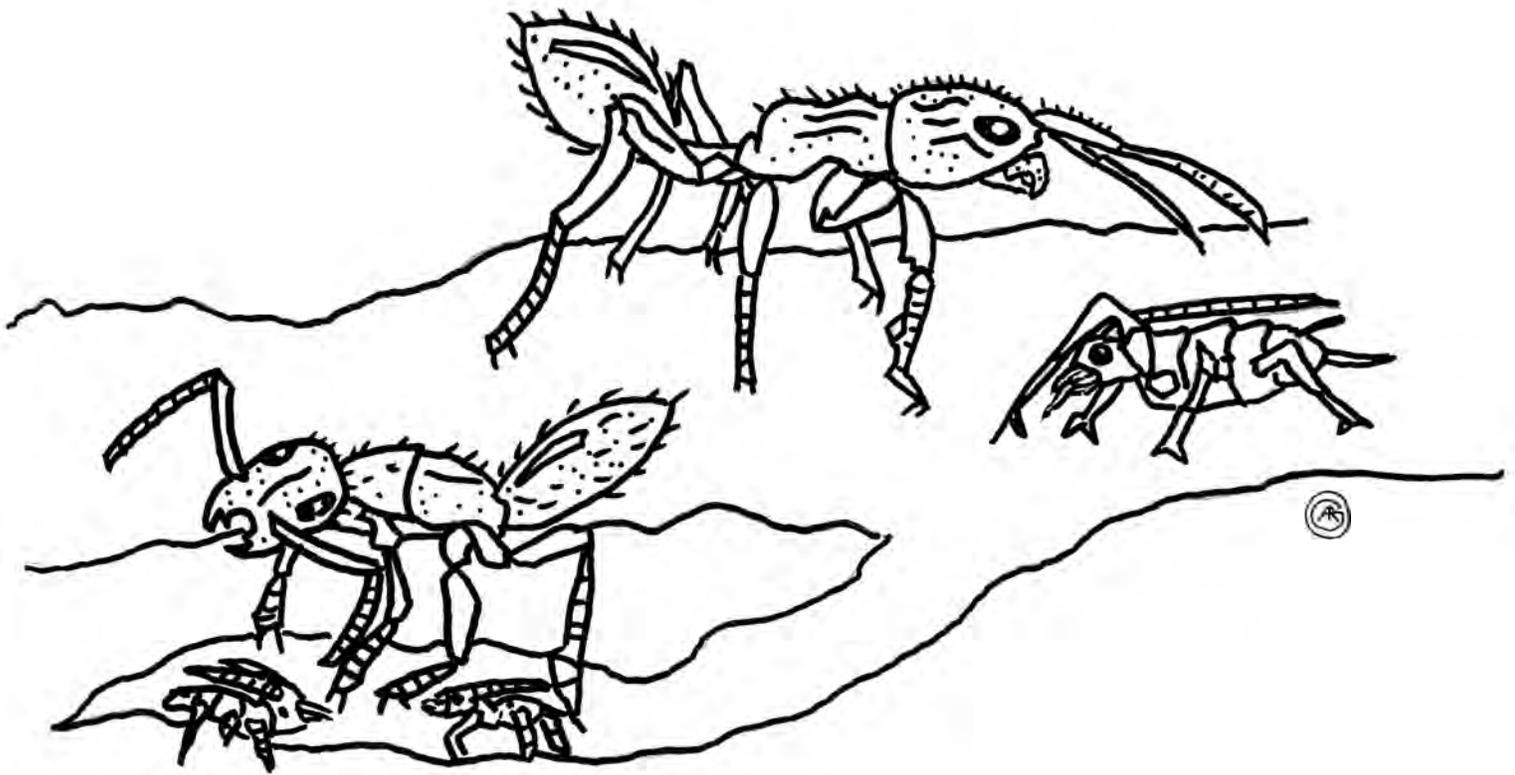
Mantids live in many places across the world.
Some look like plants, but this
Orchid Mantis looks like a flower.

Mantids (order Mantodea), like the praying mantis, hunt with their large raptorial front legs. Many species ambush prey and are camouflaged to resemble their environment. However a few species actively chase their prey. All mantids have large eyes and excellent vision. Adults of many have wings and are able to fly. In some species the wings have colorful eye-spots used to frighten potential predators.



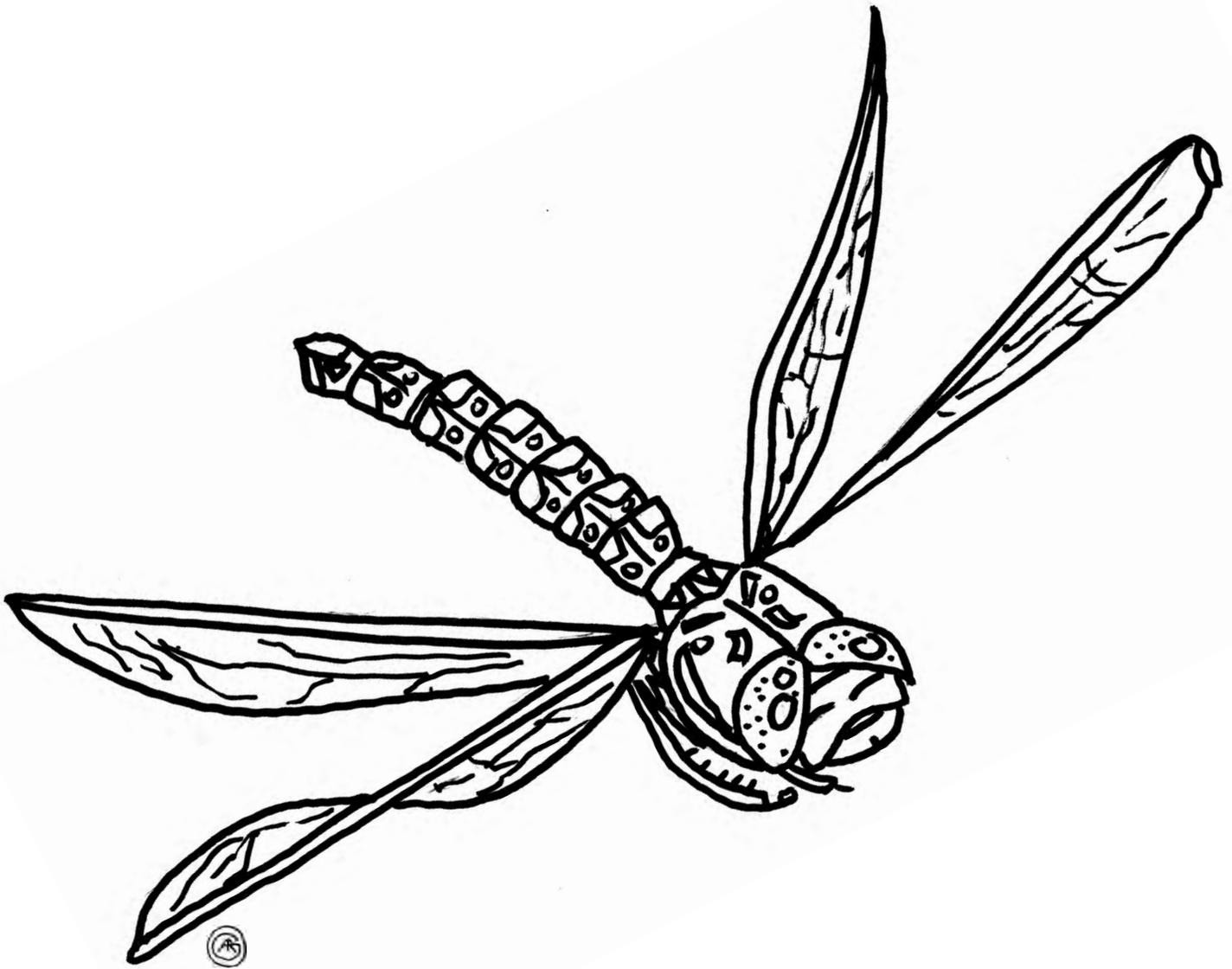
Ladybugs are beetles. They are predators that eat other insects. Ladybugs often help people, because many of the insects they eat are pests.

Ladybugs, or ladybird beetles (family Coccinellidae), are a common group of beetles found across the world. They are predators of many plant pests, such as scale insects and aphids. For this reason, they are often released near crop plants to help eliminate pests. The shell or elytra of a ladybug covers a pair of wings. Different species have different numbers of spots and different colors. Learn the patterns of your local native species, and see if you can distinguish them from exotic ladybugs.



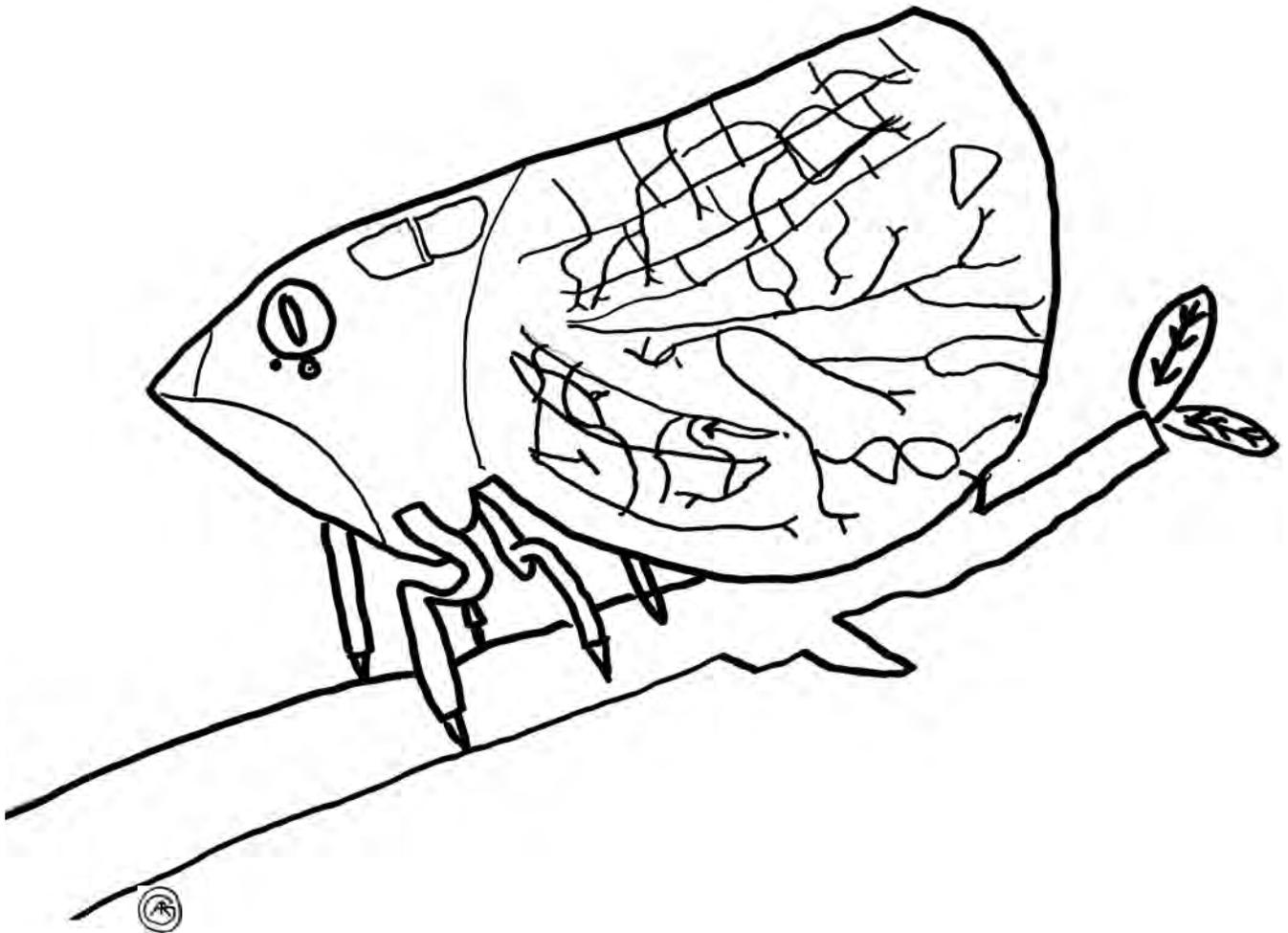
Ants are social insects that work together to find food. Different ants collect food from plants, scavenge or hunt. Some ants also tend aphids.

Ants (family Formicidae) are one of the most numerous kinds of animals on Earth. Some ants protect aphids and collect honeydew from them. Honeydew is a sugary substance the aphids produce as waste. Ant colonies can include millions of workers. Only a queen ant will produce offspring, and in most species, each colony has one queen. Periodically, the colony will produce new queens and males who fly away to found new colonies.



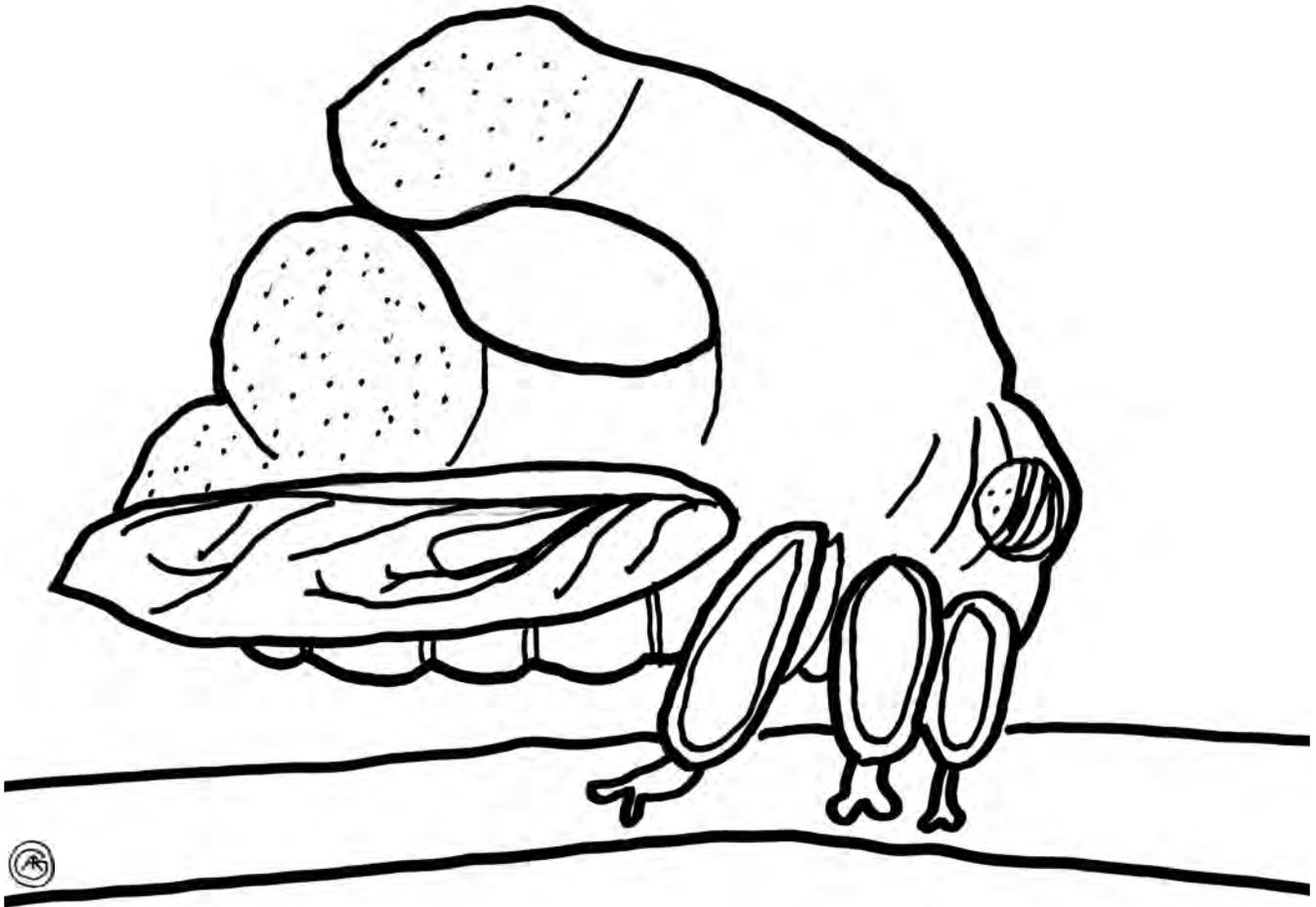
Dragonflies are colorful and nimble hunters.
They catch other flying insects in mid-air.
They are like tigers of the sky!

Dragonflies (order Odonata) often hunt small flies and other insects in meadows and over ponds. Juvenile dragonflies live underwater where they are also active predators of aquatic insects. They will even eat small fish and tadpoles. Adult dragonflies have large eyes and excellent vision to allow them to hunt in the air and to evade their own predators. Dragonflies beat their wings in a figure-8 pattern as they fly, just like hummingbirds.



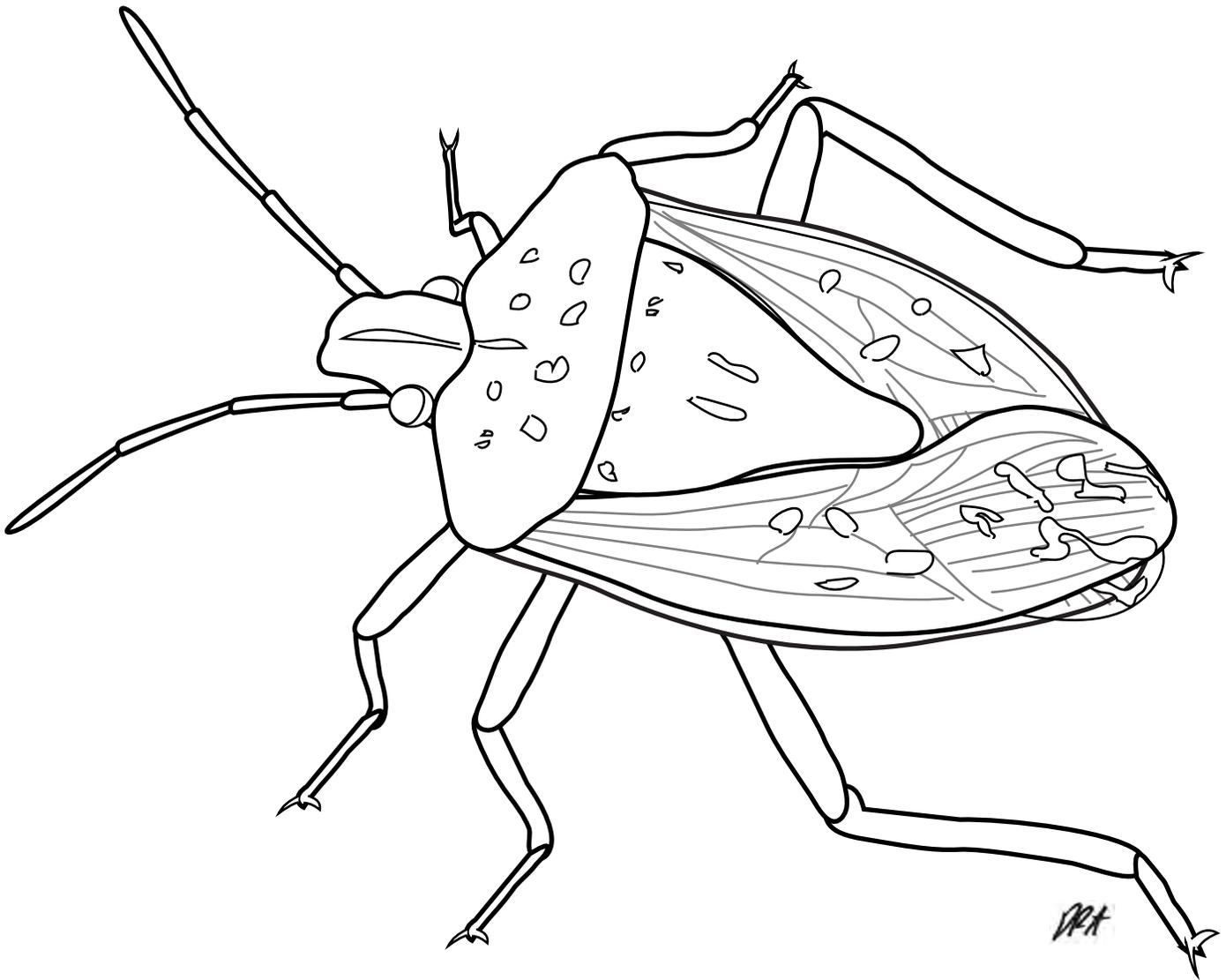
Planthoppers are insects that feed on plants. They hide by looking like parts of plants, such as thorns or dry leaves.

Planthoppers (infraorder Fulgoromorpha) and Treehoppers (Membracidae) get their name for being some of the fastest jumpers in the animal world. Most are small, less than 1/8 inch (3 mm) long. Many species have shapes that resemble plant parts, but some are dramatically colored or have wiry wax filaments on their tail end. Some planthoppers are crop pests, but most treehoppers and planthoppers are harmless to humans.



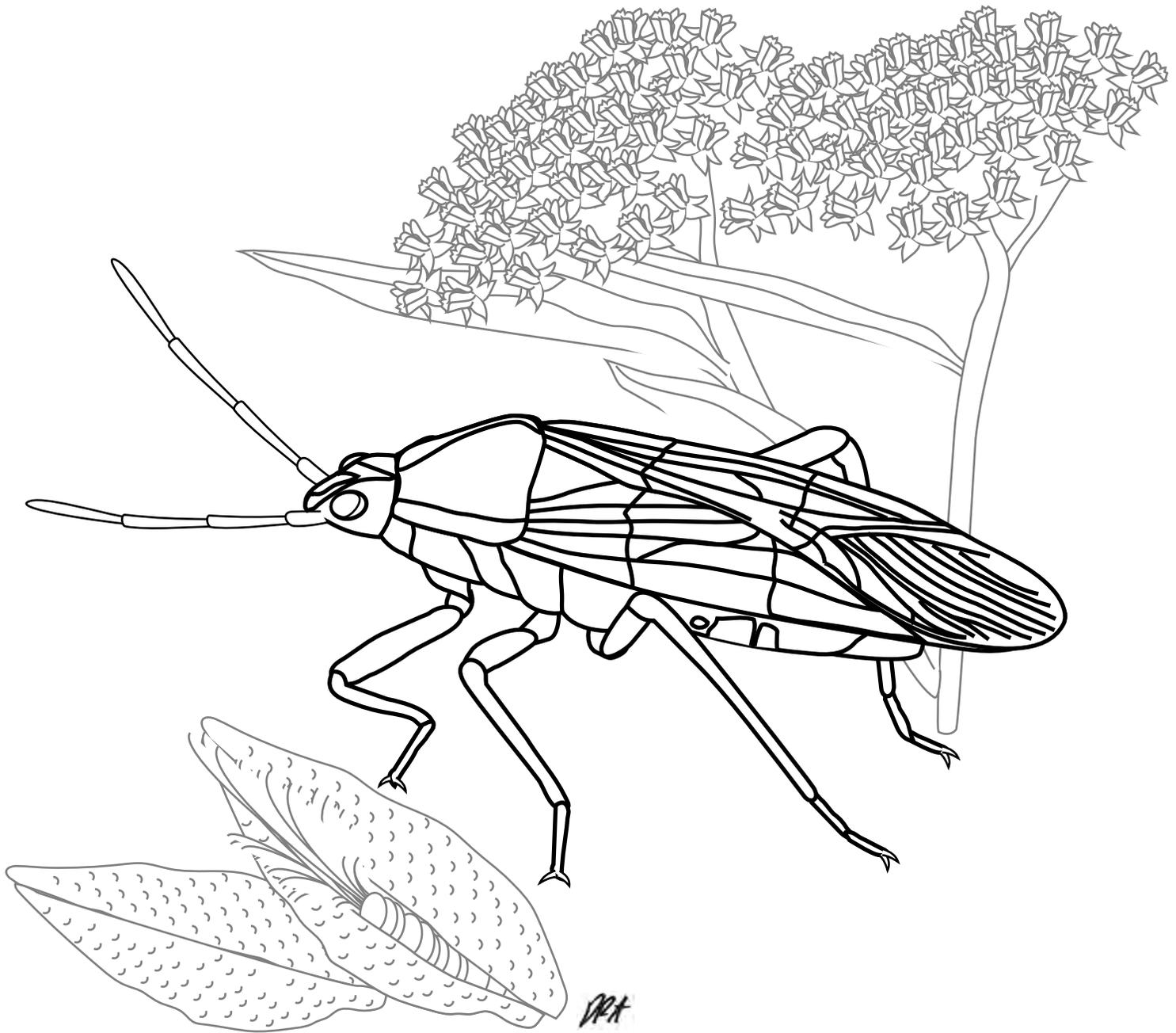
Treehoppers drink sap from plants.
Some hide by looking like plants. Some are
colorful. Some look like ants, wasps or thorns.

Treehoppers (family Membracidae) are closely related to planthoppers. The two insect groups are similar in many ways. However, treehoppers tend to be larger and have species with more dramatic shapes, often mimicking insects that predators avoid, like ants and wasps.



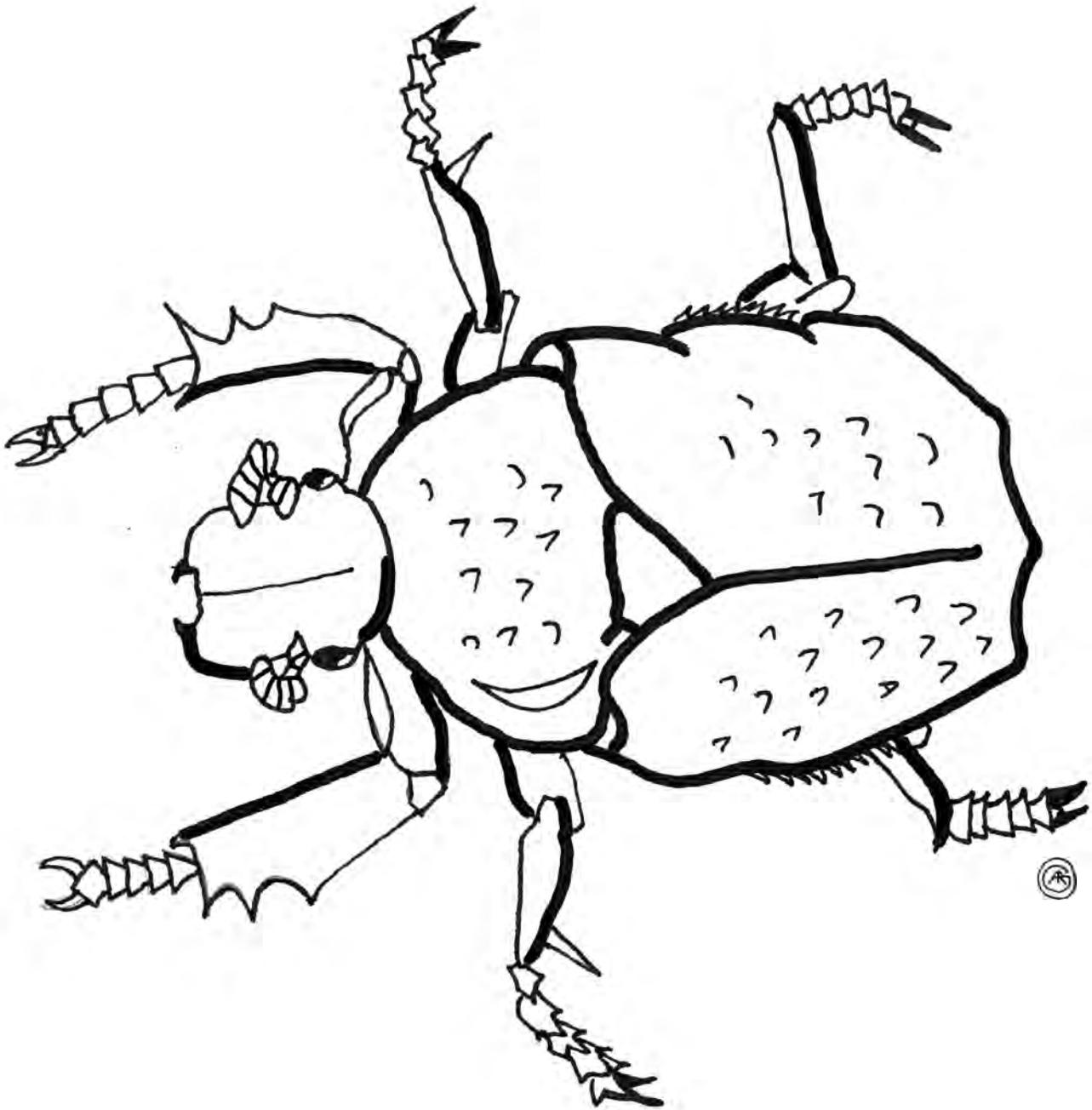
Stink bugs feed on sap or seeds from plants. Some hide by blending in with plants. Some are very colorful. They ward off predators with smell!

Shield bugs and stink bugs (family Pentatomidae) are large insects that feed on different plants. They have a long trunk that they use to pierce into plants. Many species are serious crop pests. The brown marmorated stink bug is now spreading across the eastern United States.



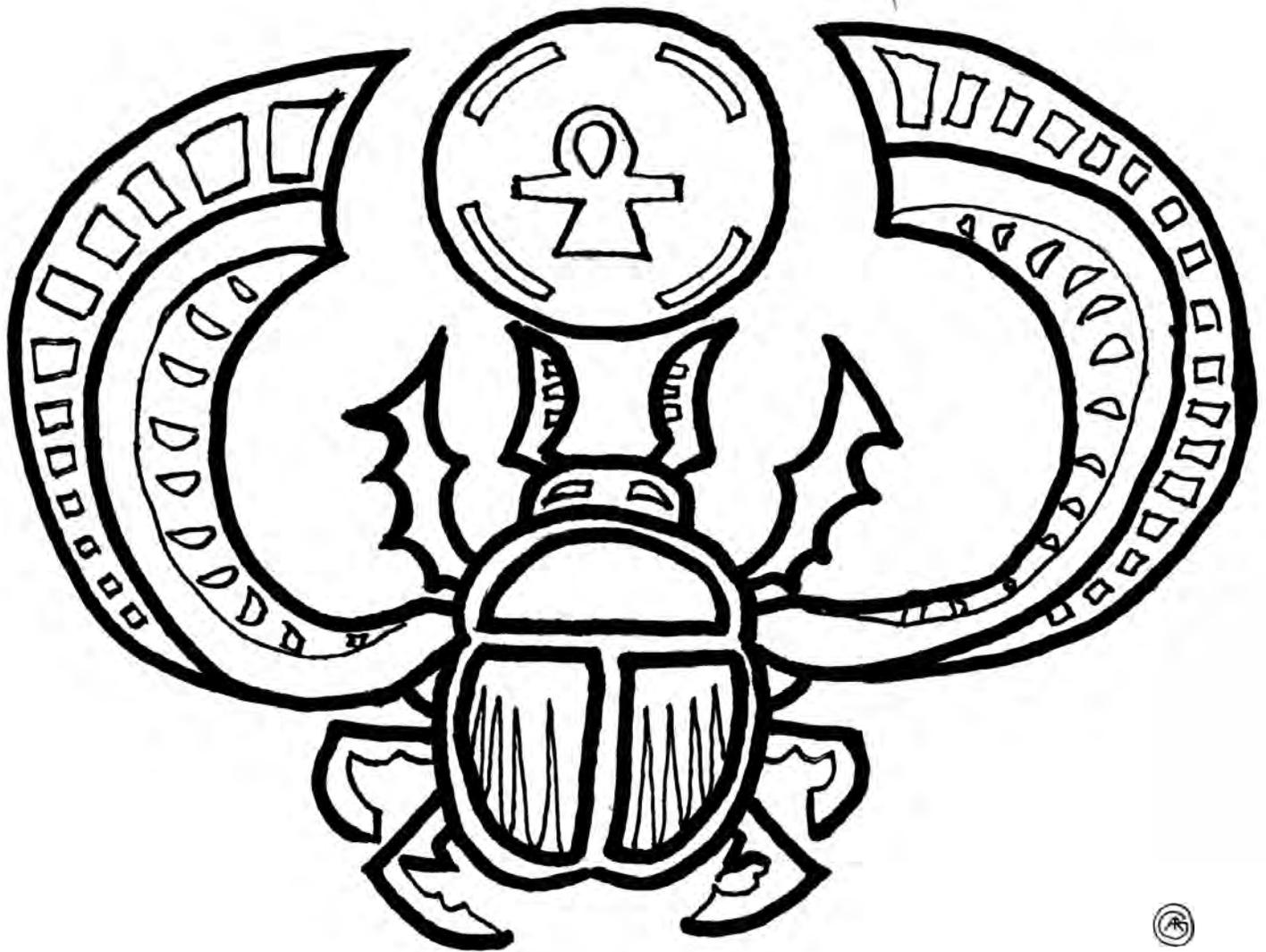
Milkweed bugs are colorful insects that live on milkweed plants. Most animals cannot eat milkweed, but the bugs can!

Milkweed bugs (genus *Oncopeltus*) are immune to a poison produced by milkweed. The bugs keep the poison in their bodies. If a predator eats a bug it will learn to avoid them in the future. The bugs warn potential predators with black and orange, yellow or red coloration. Some milkweed bugs fly thousands of miles every year, just like monarch butterflies, to spend winters in warmer climates.



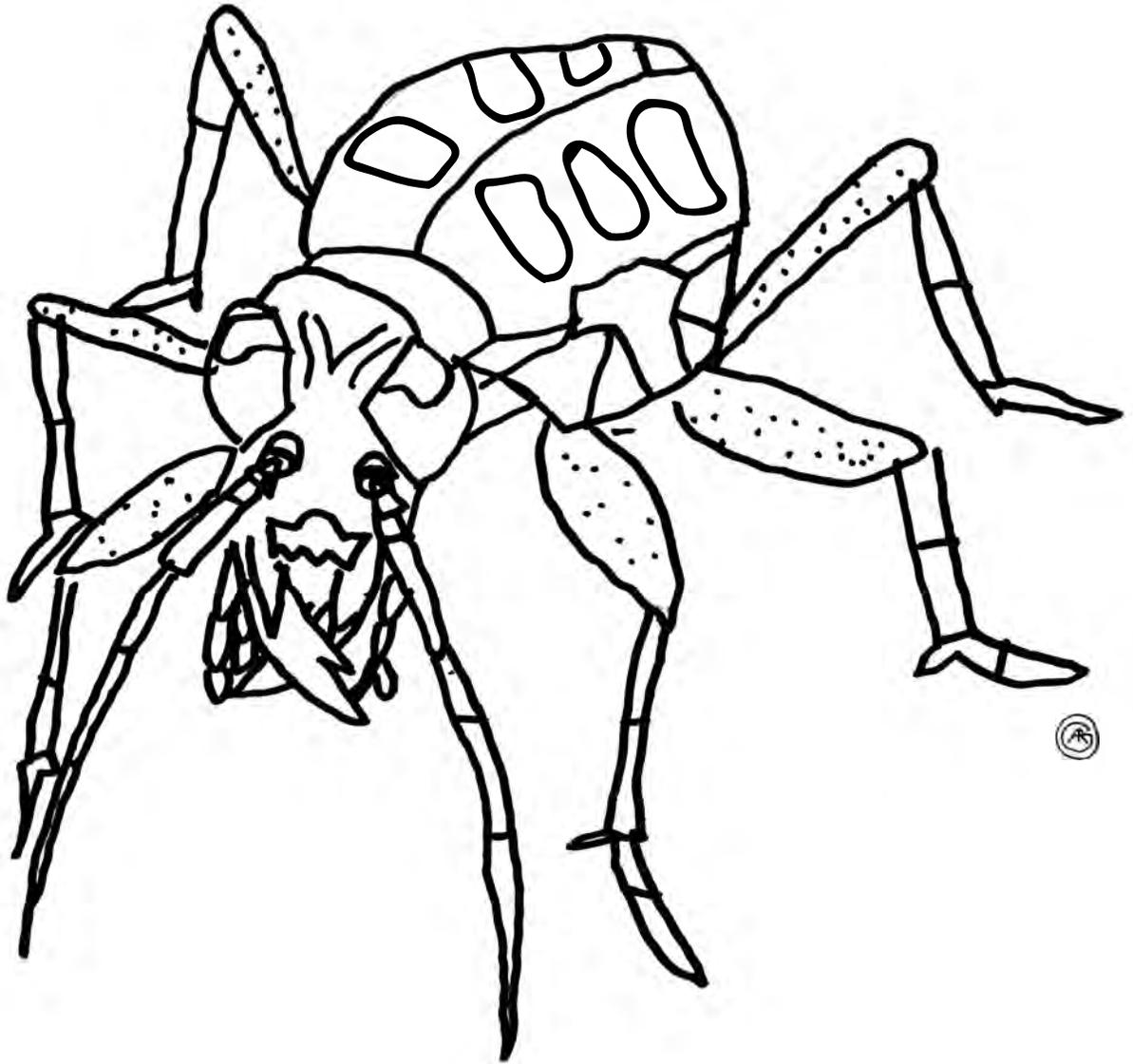
Scarabs are large beetles.
Many are colorful. Some are shiny.
They can be found all over the world.

There are more species of beetles in the world than any other group of animals. There are about 30,000 species of scarab beetles (family Scarabaeidae). They range widely in size from about $\frac{1}{16}$ th inch to more than 6 inches in length (1.5 - 160 mm). Some male scarab beetles have elaborate antennae used to search for female beetles. Many species of scarab are scavengers. Some specialize eating particular plants, like grapevines. Some species only eat the dung of large mammals.



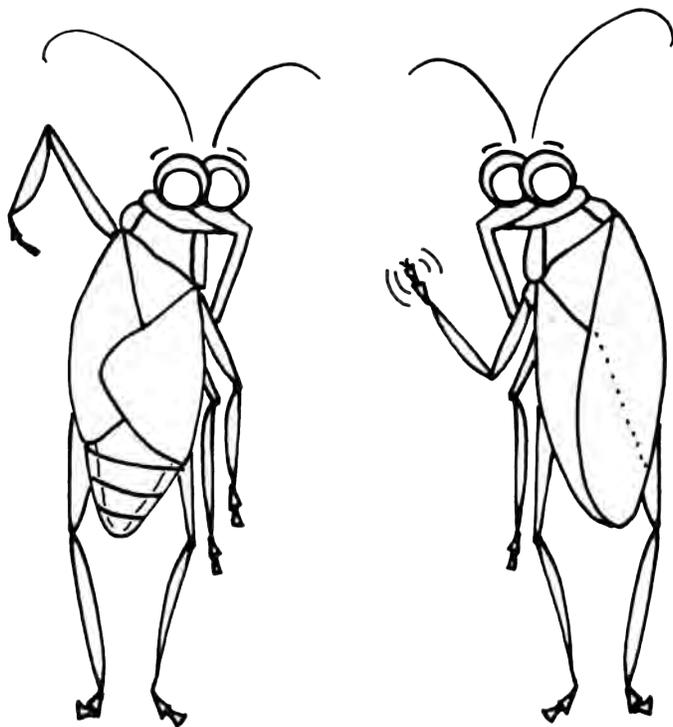
In ancient Egypt people revered scarab beetles.
In stories, they said that the sun was pushed
across the sky each day by a scarab.

The dung beetle species *Scarabaeus sacer* is a scarab that was considered sacred by the ancient Egyptians. Males of this species collect animal dung, and roll it into a ball. As he rolls the dung ball, a male will navigate to his burrow using the sun. At night he will use the moon or even the Milky Way to navigate. Once at the burrow, females will lay eggs on the dung ball, and the juvenile beetles will grow as they eat the dung. This process helps recycle nutrients in the environment.



Tiger beetles are colorful, fast-moving predators. They can run and fly as they chase their prey, such as flies, caterpillars, and grasshoppers.

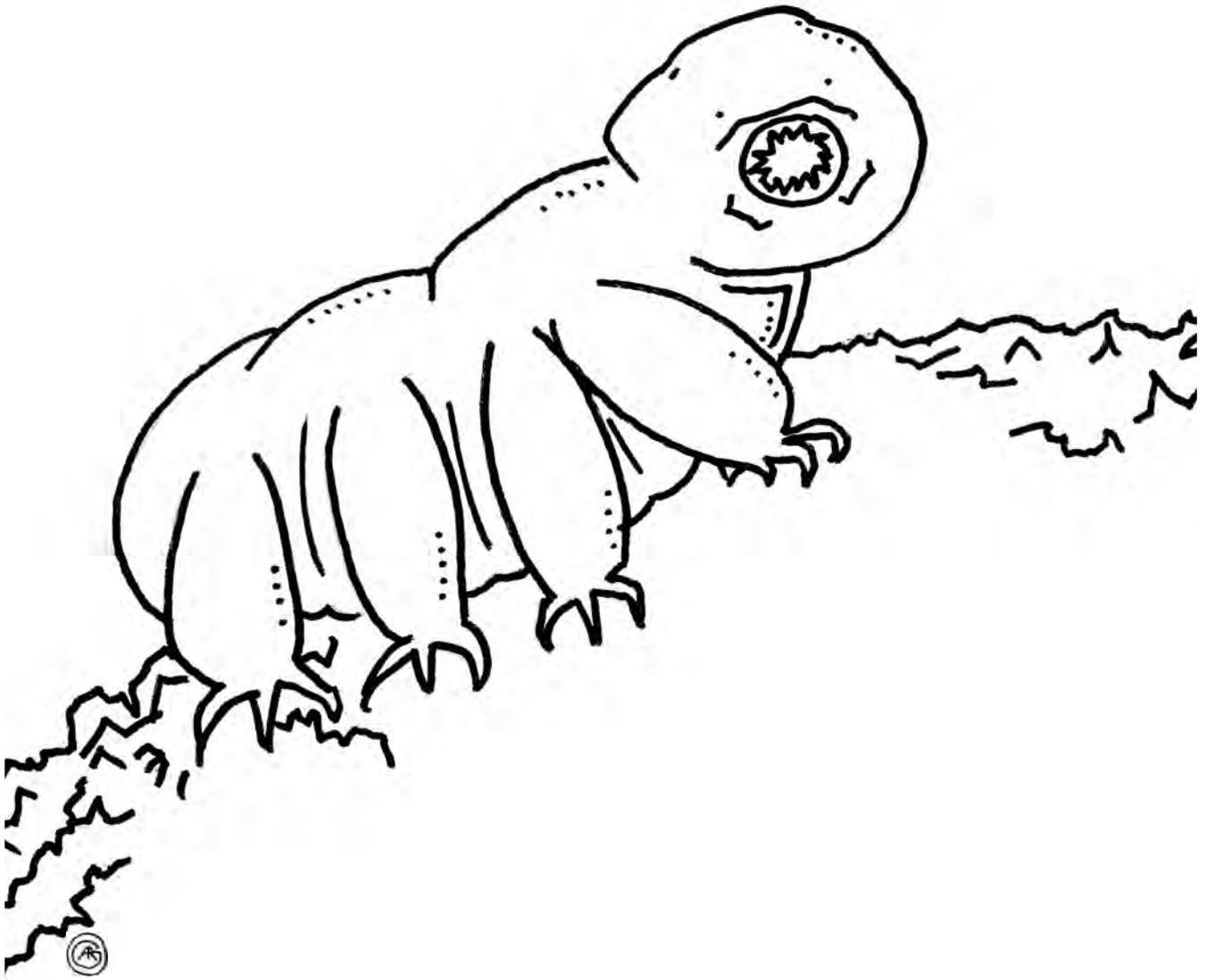
Tiger beetles (subfamily Cicindelinae) have strong jaws that they use to capture their prey. Many species are very colorful. Some have a metallic shine that make them very eye-catching, but these colors may actually warn off their own predators. Tiger beetles are fast and agile enough that they are very hard to catch!



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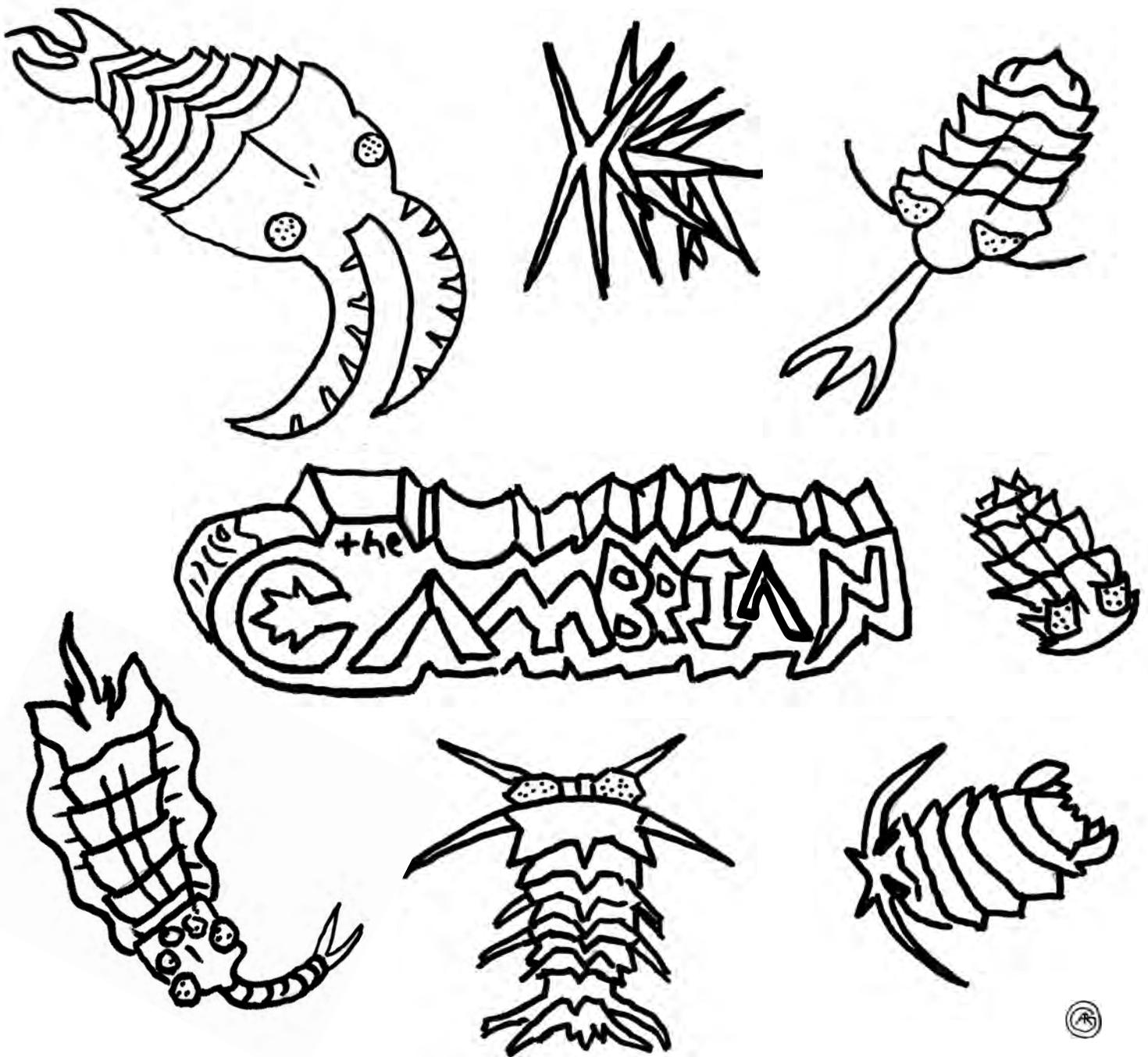
Soapberry bugs can grow up to have long or short wings, depending on where they grow up. Long-wing bugs can fly to new plants.

Red-shouldered soapberry bugs (*Jadera haematoloma*) are common in cities in the temperate United States. In this species wing development is plastic. It depends on the amount of nutrition juveniles get. Short-wing bugs are more common when bugs are well-fed. They cannot fly, and stay near where they were raised and produce more offspring. Low nutrition more often produces long-wing bugs, who can fly away in search of better places to lay their eggs.



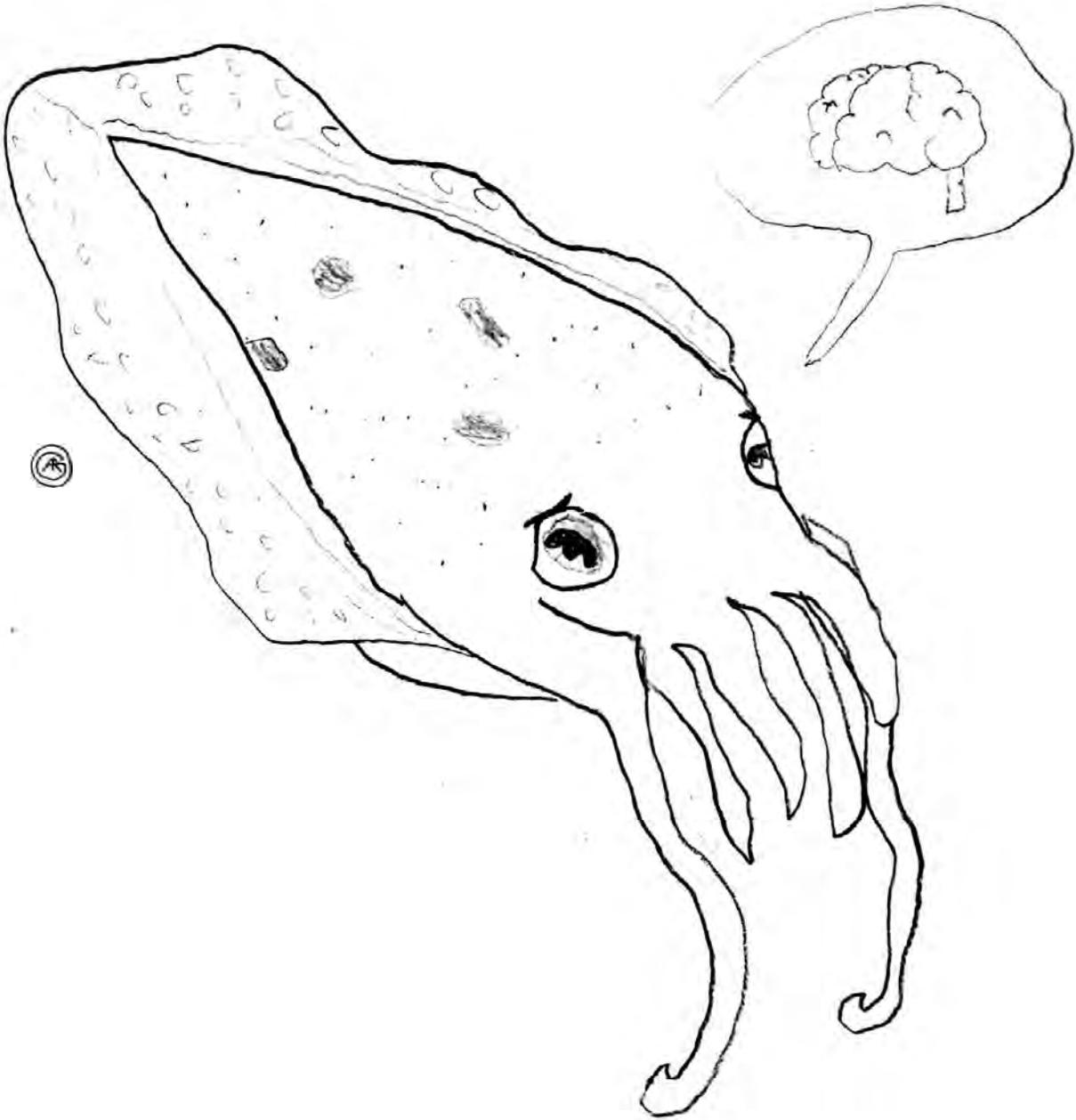
Water bears are not insects. They are tiny animals that live on moss and lichens and in ponds. They are very tough and have even survived in space!

Water bears or tardigrades are members of the phylum Tardigrada, which are related to arthropods. They are also known as moss piglets. They have no jaws, but some species have sharp spines to puncture tough algal cells. Tardigrades can survive being completely dried out. In this state, they can also survive high and low pressure and strong radiation. They have even survived after being exposure to the vacuum of space.



The Cambrian Period was a time in the Earth's past when animals first appeared in the oceans. Many strange arthropods were there.

The Cambrian Period was about 541 to 485 million years ago. The first fossil animals appeared at this time. Many of these animals are thought to be arthropods and related creatures. Clockwise from the upper left, these include the large predator *Anomalocaris*, the tiny velvetworm-like creature *Hallucigenia*, two kinds of trilobites, the crustacean *Marrella*, another trilobite, and the strange five-eyed *Opabinia*, which hunted with a long flexible proboscis.



Cuttlefish live in the tropical ocean. They are very smart and colorful. They can change color and texture to hide or talk to each other.

Yes, cuttlefish (family Sepiida) are not insects. But we thought they were interesting too! They are related to squid and octopus. Cuttlefish change the color of their skin using three layers of different pigment cell types. They can even change the polarization of light reflected from their skin. Their eyes are also very sensitive, and it is likely that they have elaborate systems of signals to communicate among individuals and to warn potential predators.



Okay, we're just having fun now. Insects don't wear t-shirts! But why don't insects get as large as people? The largest insects in the world don't weigh more than about a quarter pound (100 g). Insects don't have very efficient organ systems for respiration. Our lungs allow blood to absorb oxygen and get rid of carbon dioxide, and our heart rapidly circulates the blood to all our cells. Insects rely on a system of tubes from pores in each body segment. So their size remains limited.

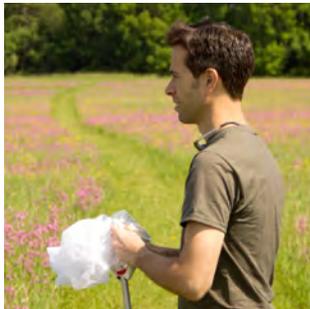
The people behind the project



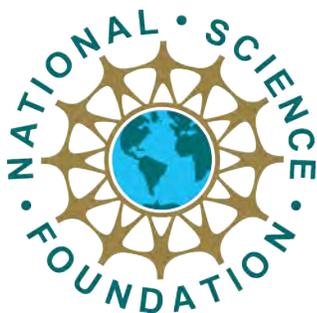
Rowan Graham Angelini is a kid interested in drawing, Legos, music, skiing, and bugs. He was 12 years old when he drew most of the illustrations for this book.



Serena Graham is a biology instructor at Colby College. She has worked as a scientific illustrator, marine mammal trainer, fisheries observer, and as a researcher in neurogenetics.



Dave Angelini is a geneticist and a professor of biology at Colby College in Waterville Maine. He studies insects to understand how genes and environmental influences shape the diversity of life.



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