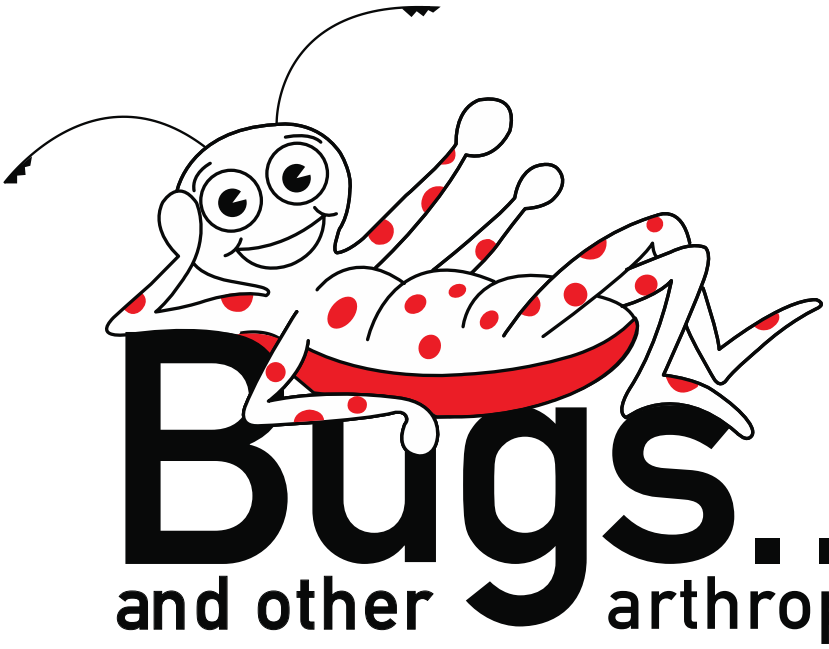

Bugs & Other Arthropods

EXHIBITION EDUCATIONAL SUPPLEMENT

This guide is a supplement to the exhibition. Its aim is to help teachers, parents, caregivers, and children visiting Staten Island Children's Museum to further explore topics and ideas about insects and other arthropods. Use it to help further your discussions, to make connections, and to spark creativity and curiosity before and after visiting the gallery.

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Contents

Big Ideas

Why an Exhibition About Bugs?

People often ask why Staten Island Children's Museum has an exhibition about insects and other arthropods. There are many good reasons to learn about this group of animals. Some people fear or avoid every bug, spider, or centipede—because of its unusual appearance or because they're concerned about being injured. However, the more you know about insects and related organisms, the more you will come to appreciate them. Insects and other arthropods are essential to the health of Earth's ecosystems, and whether you know it or not, we all rely on them to help sustain us.

Here are some surprising facts about insects and other arthropods:

- Arthropods and insects live on land, in water, and in air.
- There are more than a million known species of arthropods, and we are still discovering new species every year!
- Arthropods first appeared in the fossil record 500–600 million years ago, long before there were humans. (The earliest fossils of human (hominoid) ancestors only date back 6-7 million years.)

Why Do We Need Insects and Other Arthropods?

Insects are one category of arthropods, and they are largest single group of animals in the world. Insects include many beneficial organisms like pollinators. E.O. Wilson, a well-known insect scientist or entomologist once wrote, "Every third bite of food you take, thank a bee or other pollinator." Arthropods are an essential part of every ecosystem in which they live. We humans rely on the roles they fill within those natural systems. This group of organisms does more than simply pollinate plants! Arthropods, like ants, help turn over and aerate the soil. Arthropods, like pill bugs and termites, help to break down and recycle nutrients from dead wood and leaves. Spiders, harvestmen, and dragonflies eat potential insect pests like mosquitoes and flies. We rely on insects and other arthropods for much more than most people know.

Visiting the Exhibition

Learning Through Observation

We invite you to enter the world of *Bugs and Other Arthropods* and learn about these wonderful creatures and what makes them so cool!

The exhibition is for everyone. It supports making observations, asking questions, and using all the senses. While you are visiting, help your children understand first that science is a way of thinking about and understanding the world. Second, that insects and other arthropods are organisms that you can learn more about beyond your visit to the Staten Island Children's Museum (SICM).

Organization of the Exhibition

SICM has selected five subjects to help you better understand and appreciate the fascinating world of insects and other arthropods. During your visit, these icons will help you navigate:

Taxonomy

Taxonomy is a tool, like a family tree, that scientists use to describe the evolutionary relationship among organisms.

Adaptation

Adaptation is a biological process by which a species becomes better suited to its environment through a process of natural selection over time.

Environment

Environment is the surroundings or the ecosystem where insects and other arthropods live and upon which they rely.

Life Cycle

Life cycle refers to change in an animal's life, including reproduction and development. Insects and other arthropods undergo a transformation of either partial or full metamorphosis during their life cycle.

Social Insects

Social insects are those, like ants, termites, and wasps, that live in a cooperative family group, divide the labor, and have overlapping generations.

Taxonomy

Understanding Arthropod Groups

How do scientists know so much about the history of arthropods? They are following a trail of evidence found in fossils. Fossils are the recognizable remains, such as shells, bones, tracks, and impressions, of plants and animals preserved in rocks formed from sediments. By studying both fossils and modern animals, scientists have pieced together the evolutionary relationship among different groups and species. Connected by a common ancestor, this family tree is called their taxonomic relationship.

Arthropods, both those known from prehistoric fossils and those alive today, can be classified into five major subgroups (or subphyla) based on their characteristics:

Insects (subphylum **Hexapoda**) and several closely related groups are six-legged organisms that include bees, beetles, and butterflies.

Crustaceans (subphylum **Crustacea**) are in a large, diverse group of segmented animals that includes crabs, lobsters, shrimp, krill, barnacles.

Millipedes and **Centipedes** (subphylum **Myriapoda**) are in a group of arthropods that live on land and have many legs.

Arachnids and **Horseshoe Crabs** (subphylum **Chelicerata**) are part of a diverse group that includes spiders, scorpions, and mites.

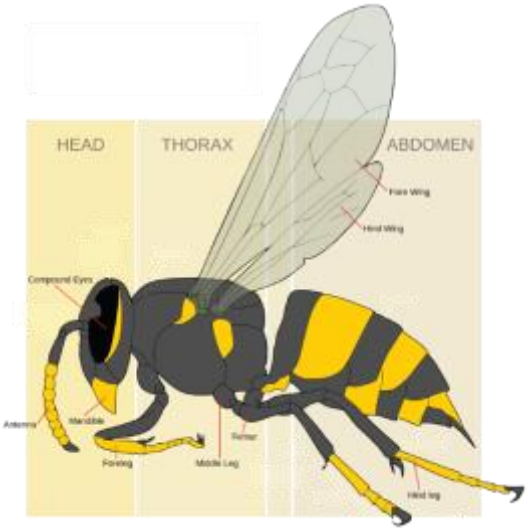
Trilobites (subphylum **Trilobitomorpha**) were ancient marine animals that are known from fossils; the group is now extinct.

Adaptations

Arthropod Anatomy

Arthropods have evolved to include a wide variety of shapes, sizes, colors, and habits that make them suited to the environments where they live. They have a set of five characteristics in common:

(1) segmented bodies
(2) hard external skeleton or exoskeleton
(3) jointed legs
(4) many pairs of limbs or legs
(5) right/left symmetry



Wasp Anatomy permission GFDL / CC 3.0

Over time, insects and other arthropods have evolved to develop characteristics like camouflage, specialized diets, and some unusual styles of living. These adaptations are a part of what makes them interesting.

Typical Arthropod Bodies

Insects	Spiders	Crustaceans	Other Arthropods
A body divided into 3 parts: • head • thorax • abdomen	A body divided into 2 parts: • cephalothorax • abdomen	A body divided into 2 parts: • cephalothorax • abdomen	Many other types of body plans
1 pair of antennae	No antennae	2 pairs of antennae	1 pair of antennae
3 pairs of legs	4 pairs of legs	Usually 8 pairs of walking and feeding legs	More than 3, 4, or 5 pairs of legs

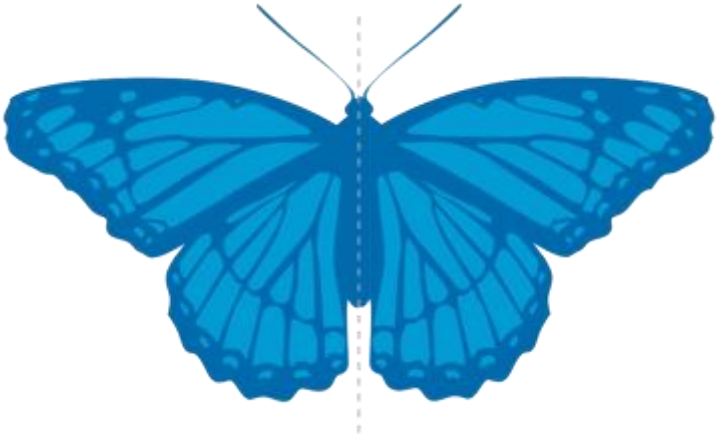
Amazing Skeletons

Arthropods don't have bones, but they do have amazing skeletons! Their hard layer or shell is like a skeleton on the outside of their body. It is called an exoskeleton and made from a protein called chitin.

Because the exoskeleton is made of a rigid material, it does not grow when the animal does. To overcome this, an arthropod periodically sheds its hard-outer layer in a process called molting. When the animal has outgrown its exoskeleton, the older layer cracks open and the animal pulls itself out. It has a new soft exoskeleton that will expand and harden.

Symmetry

The left and right sides of an insect or other kind of arthropod body look the same. This trait is a defining characteristic of arthropods. Each side is the mirror image of the other; this is called bilateral symmetry. Looking at butterflies, moths, dragonflies, and other winged insects is a great way to see symmetry in action.



Butterfly bilateral symmetry by Bea.miau / CC 1.0

Protective Coloration

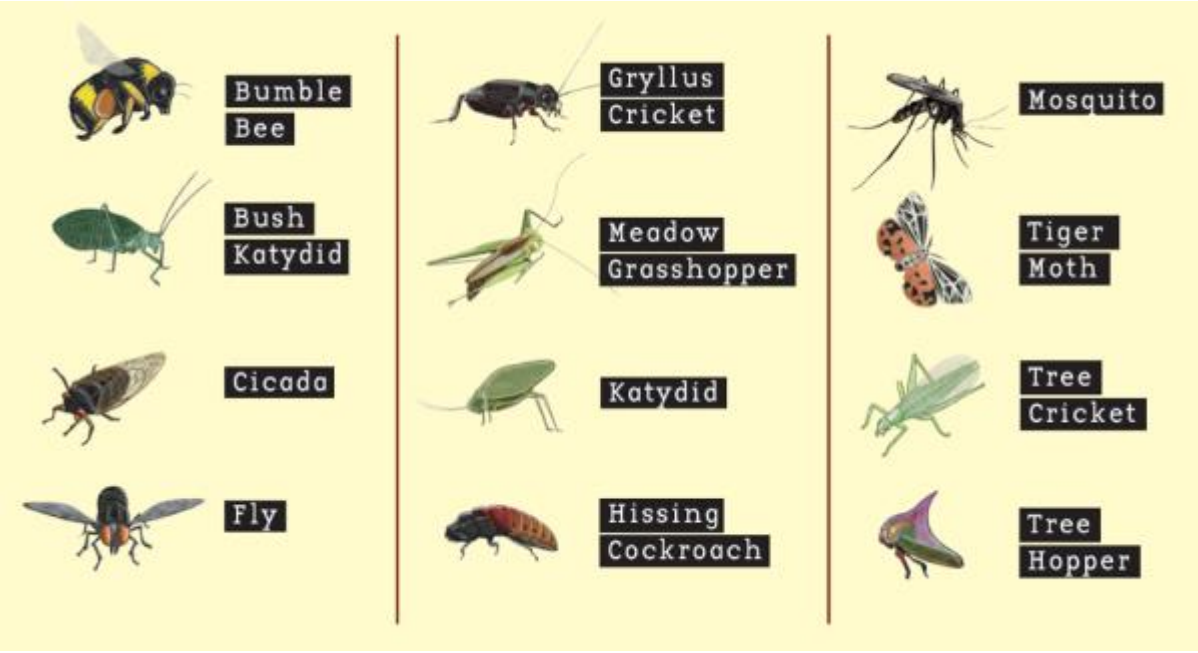
Colors, patterns, or features that hide an animal, protecting it from being eaten by predators, are known as camouflage. Some species also add behaviors and movements to complement their protective coloration. What looks like a leaf swaying in the breeze may be a giant leaf-shaped insect. Successful camouflage helps an animal blend into its background, whether that is a colorful flower, green leaves, brown bark, or speckled sand.

There are other forms of protective coloration. When one species looks like an animal that a predator would choose to avoid—something dangerous, poisonous, or bad tasting—that is called mimicry. Some species, like milkweed bugs and monarch butterflies, absorb bad tasting toxins from the plants they eat. Their bright colors warn off potential predators. Eyespots, large colorful spots found on the wings of some moths or butterflies, are another way to avoid being eaten. These bright markings, or warning coloration, may help to scare hungry predators like birds.

Insect Communication

Insects and other arthropods use many forms of communication from scent to sound. Why do insects make sounds? Most have a purpose—to attract a potential mate, establish a territory, or send a warning. (For example, the sound the museum's hissing cockroach makes is intended to frighten off a predator).

Insects produce sound by rubbing body parts together, which is called stridulation. Katydids and crickets rub the rough inside edges of their wings together, while grasshoppers make sound by rubbing their hind legs against their front wings. The classic summertime sound of cicadas is made by the insects vibrating air across a pair of "drums" on the sides of their abdomen.



Insect sounds / © Staten Island Children's Museum

Environment

Role of Arthropods in Ecosystems

Insects and other arthropods make up 90% of the animal kingdom, and their biology and ecology are critical to the healthy functioning of Earth's ecosystems. Species in this group provide essential services, including pollination, pest control, wildlife nutrition, and decomposition. Their lives directly impact human lives in many positive ways. Removing arthropods from an ecosystem would be an environmental disaster. Yet we are in danger of doing just that with many species, especially our native bees.

Pollination

Plants and pollinators have evolved together. Flowers attract insects and communicate through scent and color. To reproduce, or make seeds, flowering plants must be fertilized. Bees, butterflies, and other types of insects gather sweet flower nectar, accidentally collecting male pollen grains on the hairs that cover their body. With each successive flower visited, the pollen is spread, it brushes off onto the female part of the next flower.

Most foods come from flowering plants. Pollen movers, or pollinators, like bees, butterflies, flies, and moths are essential to plants. Most of our flowering plants and nearly 75% of all our food crops are pollinated by these hard-working animals. Without pollinators, we would not have the varieties of food we enjoy today!

Imagine not having each of these arthropods around:

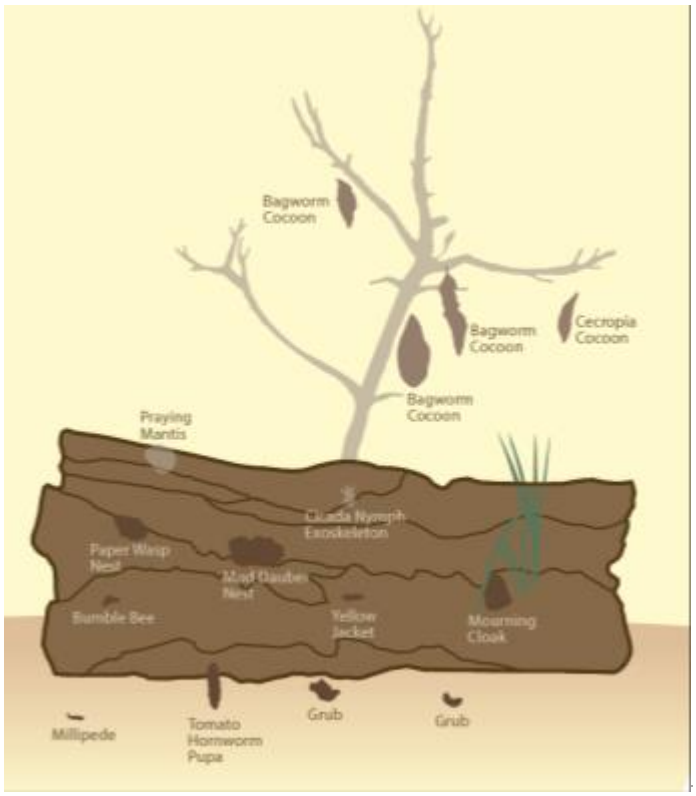
Ants	Complex relationships with plants and ecosystems, including aerating the soil.
Bees	Pollinate flowering fruit trees and vegetables. Make honey and wax.
Butterflies and Moths	Pollinate flowers and are food for songbirds and other animals. Domesticated silk moths produce fiber for cloth.
Carrion Beetles	Critical species that feed on dead animals, helping to tidy up ecosystems.
Cockroaches, Millipedes, and Termites	Help to break down dead trees and recycle leaves and other plant material.
Dragonflies and Other Aquatic Insects	Eat and help control the mosquito population.

Flies	Pollinators and a source of food for salamanders, frogs, and birds.
Grasshoppers and Crickets	Plant-eating insects that serve as food for birds and small animals.
Praying Mantises and Ladybugs	Feed on harmful garden bugs, including aphids and other insects that destroy crops.
Spiders	Predators that eat insects and are, in turn, food for other animals.

Insects in Winter

One of the wonders of nature is the seemingly complete disappearance of insects once the temperature drops below freezing. Where do insects go in the winter? Some species, like monarch butterflies, move south or migrate. Other species like praying mantis reproduce and leave eggs, the adults die. Still others hide underground or in the leaves to hibernate. Hibernation is a special, very deep sleep in which an insect's metabolism remains just high enough for it to stay alive. Tree bark, dead logs, and brush piles can be a wonderful winter homes for insects. The first insects you see in the spring, like the mourning cloak butterfly, overwinter as adults in tree holes or other shelters until the temperature rises above freezing.

Use this diagram to help you find the hibernating insects:



Insects in Winter / © Staten Island Children's Museum

Life Cycle

Metamorphosis

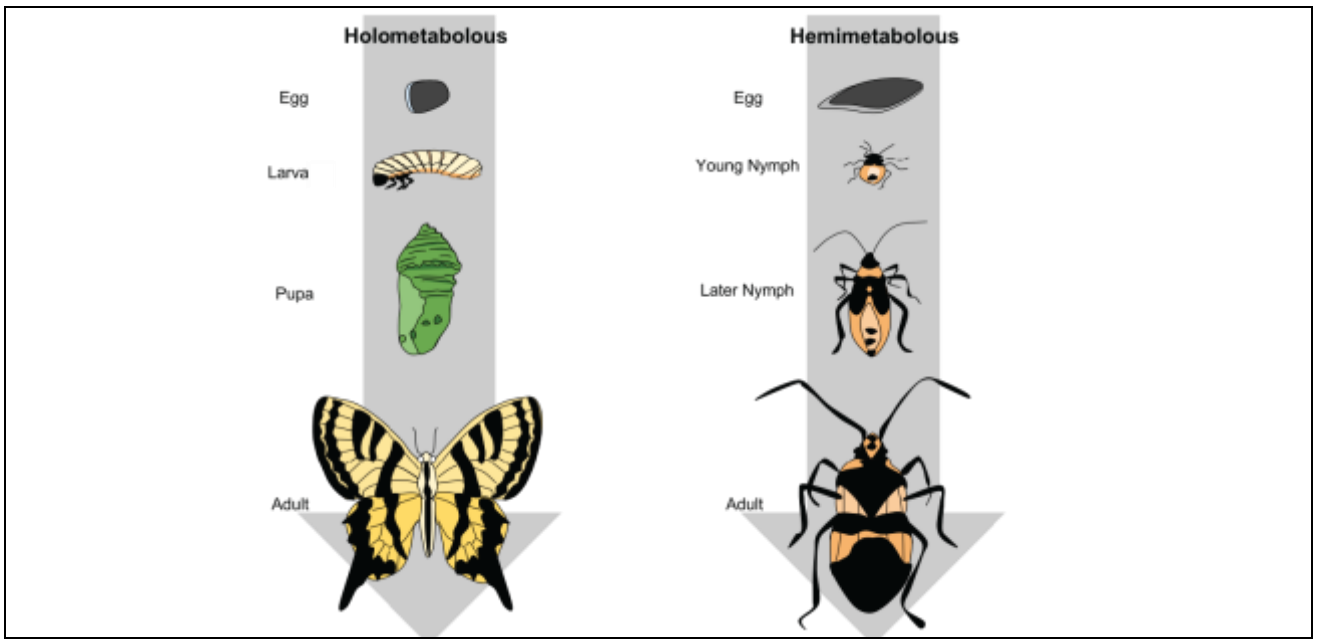
There are two distinct life cycles for insects: The first begins with a fertile egg that hatches into a larva. The young may not look much like the adult. The juvenile insect eats, grows, molts, and then gets bigger until it is ready transform, or undergo complete metamorphosis, and become an adult. The larva starts out very small but grows quickly due to the large amount of food it eats. A butterfly or moth is a good example; the larva called a caterpillar looks very different from the adult.

Complete metamorphosis

Other insects take a different path. The egg hatches as a nymph, or larva that looks a lot like a miniature adult. With each molt, the nymph becomes bigger and looks more like an adult. A grasshopper is a good example of this type of insect growth and development. This second type of life cycle is called incomplete metamorphosis.

Incomplete metamorphosis

Complete Metamorphosis	Incomplete Metamorphosis



Two types of metamorphosis / CC-BY-SA-4.0

Social insects

Ant Colony

There are over 12,000 known species of ants. Ants play an important role in every ecosystem where they are found. Ants are remarkable social organisms. When you see an ant mound in a crack in the sidewalk, you're only seeing a tiny portion of the animals' home and only a fraction of the number of individuals living there.

An ant colony may be less than a few feet or hundreds of feet across. Each colony is made up of rooms called chambers, and these are connected by tunnels. In a colony, each ant has a role to play. The soldiers guard and defend the colony. Workers clean, feed, build, remove garbage, and move the eggs from chamber to chamber depending on temperature and humidity. The queen is the only ant in the colony that lays eggs. The workers, soldiers, and the queen are all related females.

Workers **Soldier** **Queen** (with and without wings)

*Leafcutter ant (*Atta cephalotes*) castes by Gamekeeper / CC BY-SA 3.0*

Bee Hive

The SICM has a colony of bees on exhibit in *Bugs and Other Arthropods*. A clear plastic tunnel allows the bees to move from their home, or hive, out through the window to the outdoors to find their food: flower nectar and pollen.

Like most insects, bees are active only when the air temperature is warm enough. When the temperature is above 50˚F (10˚C), it is warm enough for the bees to forage for their food. When the weather is below that, the bees will stay in the hive and feed on stored honey. If the temperature gets very warm, you may see the bees flapping their wings near the entrance of the hive. They fan their wings to move warmer or cooler air. They are like live heaters and air conditioners

As with most social insects, the bee hive has a queen bee. She lays the eggs and is the mother of all the bees that you see here. She is almost always surrounded by worker bees that help to feed, clean, and protect her.

The hive may contain the following types of bees:

Queen

Drone

Worker

Bees / © Staten Island Children's Museum

Helpful Resources

Helpful family-friendly set of websites for basic background information about insects and other arthropods:

American Museum of Natural History Explore Ology
http://www.amnh.org/explore/ology/search/(keyword)/insect

Animal Diversity Web
http://animaldiversity.org/

Bug Guide
http://bugguide.net

Accessible information about protecting our essential pollinators:

The Great Pollinator Project
http://greatpollinatorproject.org/

Xerces Society for Invertebrate Conservation
https://xerces.org/

Other useful information with links to resources:

Acorn Naturalist
http://www.acornnaturalists.com/

New York Entomological Society, Inc.
http://www.nyentsoc.org/

Scholastic Insects and Bugs
https://www.scholastic.com/teachers/collections/teaching-content/insects-and-bugs/

Understanding Evolution
http://evolution.berkeley.edu/evolibrary/home.php