

Teacher's Guide

The O. Orkin Insect Zoo



“Insects won’t inherit the Earth—they own it now.”

—Thomas Eisner, entomologist

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Overview

The O. Orkin Insect Zoo is a special exhibit hall located on the second floor of the National Museum of Natural History (NMNH) where visitors can observe live insects and other arthropods. Volunteers conduct tarantula feeding demonstrations, show live insects that visitors may touch and hold, and answer questions about the many-legged creatures that live in the Insect Zoo.

Insects and their relatives (collectively called arthropods) are ancient members of the animal kingdom. Arthropods first appear in the fossil record 500 million years ago. Since then, arthropods began cycling nutrients, pollinating plants, eating other arthropods, providing food for fish, mammals, birds and other vertebrates, and even farming. Arthropods now account for up to 90 percent of all animal species. Life as we know it would not exist without these indispensable animals.

The Insect Zoo focuses on a few major concepts:

Definition—What is an arthropod? *The uniquely shared characteristics of arthropods—jointed legs and exoskeletons—define the group.*

Diversity—How many animal groups are found within the arthropod group? *All insects are arthropods, but not all arthropods are insects. Arachnids, centipedes, crustaceans, insects, and millipedes are all arthropods and inhabit the Insect Zoo.*

Ecosystem inhabitants—What part do arthropods play in the environment? *Insects and their relatives cycle nutrients, pollinate plants, and provide food for most other animals on the planet. Five habitat areas (desert, house, mangrove, pond, and rain forest) show how arthropods fit in.*

Research—How do scientists learn more? *The National Museum of Natural History is known for its extensive collections and research. Insect Zoo exhibits, such as 300 Million Years Ago, Spiders, Entomologists at Work, the Mangrove Ecosystem, and the Rain Forest are based on research being conducted at NMNH.*

Within these major themes there are sub themes, such as adaptation, behavior, comparative anatomy and functional morphology, classification, natural selection,

All age groups will find the Insect Zoo appealing. Over 65 species of live arthropods, in addition to many preserved specimens, capture the imagination of visitors. Non-traditional exhibit components such as interactive displays, touch-it carts, videos, and live tarantula feeding demonstrations address a variety of learning styles.

Messages throughout the Insect Zoo reflect many components of the National Science Education Standards and Benchmarks for Life Science (Standard C). A table in this guide correlates areas of the exhibit with standards for grade levels K-4 and 5-8. In addition, the following pages include brief interpretations for each main area of the exhibit, an online list of resources, and a few suggestions for your visit. The exhibit descriptions, areas on the map, and standards are color coded to indicate their relationships.

Taxonomic Groupings

Centipedes
Crustaceans
Insects
Millipedes
Arachnids

Tarantula Demo Times

Tues–Fri
10:30, 11:30 & 1:30

Sat & Sun
11:30, 12:30 & 1:30

1 THE AMAZING ARTHROPODS

First in diversity! Arthropods are the most diverse animal life form on the planet. There are more species of beetles than all other forms of animal life combined. The circular acrylic display cases exemplify arthropod diversity.

Arthropods (arthro = joint; pod = foot) are the jointed-legged invertebrates. Their skeletons are on the outside of their bodies unlike ours which are on the inside. In order to grow, all arthropods **molt**, or shed, their exoskeleton in order to grow.

Representative arachnids, centipedes, crustaceans, insects, and millipedes reside in displays describing each group's characteristics.

2 300 MILLION YEARS AGO

Three hundred million years ago, during the Carboniferous period, insects first developed wings and took to the air. This diorama depicts life in a swamp-like habitat with a giant prehistoric dragonfly with a 60-centimeter (24 inch) wingspan, scorpions, spiders, centipedes, millipedes, primitive cockroaches, and katydid-like insects.

A metalmark butterfly trapped in amber, fossilized tree sap, 30 million years ago is nicely illuminated in the information rail.

3 THRIVING THROUGH CHANGE

Three dimensional models of the mouthparts of a grasshopper (grinding), mosquitoes (piercing and sucking), houseflies (lapping), and butterflies (sipping) are displayed comparing them to pliers, hypodermic needle, sponge, and straw respectively. Eyes vary in size and shape. Dragonflies and other aerial hunters use their large eyes to see prey. Katydids, on the other hand, have small eyes, and rely on their antennae to sense the plants they eat. Wings allow insects to escape danger, search for food and mates, and communicate. Damselflies, blowflies and katydids are featured in diagrams, photographs and pinned specimens.

Two major types of metamorphosis are displayed: gradual and complete. An insect undergoing **gradual metamorphosis** begins life as an egg, hatches into a nymph, and molts its exoskeleton each time the nymph grows larger. The house cricket (*Acheta domestica*) undergoes gradual metamorphosis. Nymphal house crickets resemble adults, except that the nymph is incapable of reproducing and does not have fully developed wings. An insect undergoing **complete metamorphosis** begins its life as an egg and hatches into a larva. The larva grows by molting its exoskeleton several times, and on the last molt progresses from the larval to the pupal stage. Unless it is overwintering, the pupal stage is anything but resting. Tissue must be broken down and reorganized into a totally different form. The adult emerges from the pupa sexually mature. In many instances the larva and adult do not consume the same food resource. The Carolina Sphinx Moth (*Manduca sexta*) is a good example where the larva feeds on leaf tissue and the adult feeds on nectar with its long, straw-like mouthpart called a **proboscis**.

4 DEALING WITH DANGER

Camouflage, protective (aposematic) coloration, and mimicry are presented using live walking stick species (*Extatosoma tiaratum*, *Heteropteryx dilatata*, and *Phyllium bioculatum*), leaf-footed bugs (*Leptoglossus oppositus*) and milkweed bugs (*Oncopeltus fasciatus*), pinned specimens, and a video showing a naive blue jay eating a monarch butterfly. An interactive push button display illustrates just how cryptic insects can be.

5 SPIDER STRATEGIES

A series of six web silhouettes shows how different sit-and-wait hunters solve the problem of finding food. Four live spiders are on display showing different examples of active hunters that rely on eyes and/or **pedipalps**, the sensory appendages on cephalothorax, for finding food. Look for the following tarantulas: *Avicularia avicularia*, *Brachypelma smithi*, and *Theraphosa blondi* as well as wolf spiders.

6 INSECT SOCIETIES

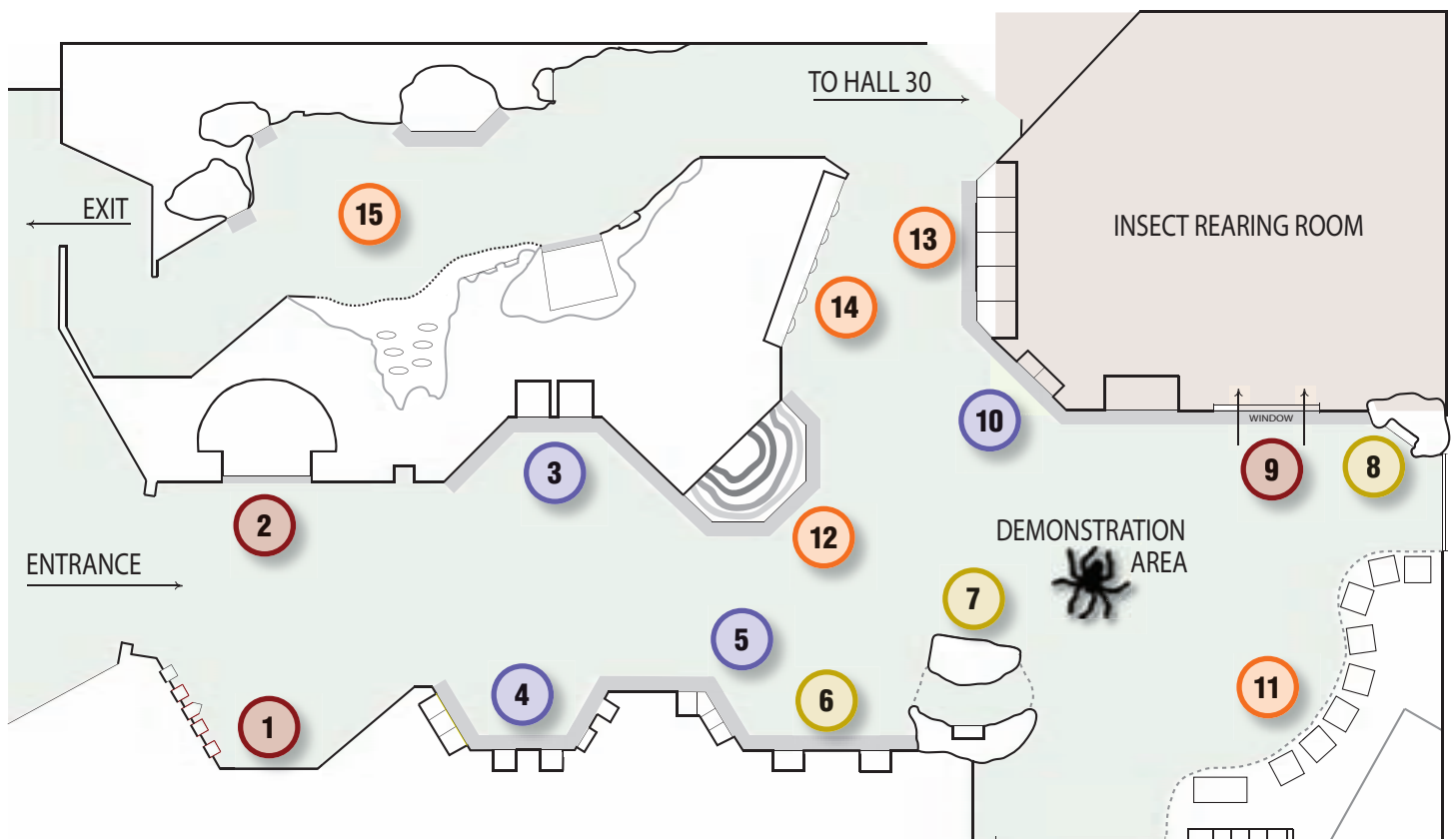
Colonies of honeypot ants (*Myrmecocystus mimicus*) and acacia ants (*Pseudomyrmex ferrugineus*) demonstrate how these social insects' colonies are analogous to the human body. Reproductive castes (queens and kings) are like the reproductive organs; worker castes are like the muscles, and individuals that carry food and messages are like the circulatory and nervous systems of a large animal such as a cat or dog.

Honeypot ants forage for sweet nectar or honeydew during moist weather. The workers return to the underground nest to regurgitate their load to other honeypot workers called **repletes**. The repletes act as living storage jars from which other honeypot ants draw during the long dry period.

Acacia ants fiercely attack leaf-eating insects and keep the base of the acacia tree clear of competing vegetation, in exchange for food and shelter from the bull's horn acacia. Acacia ants feed on the tree's protein-rich leaf tips called Beltian bodies and the nectar found in the leaf stem secretory glands called nectaries.

7 AFRICAN TERMITE MOUND

African termite mounds can reach 14 feet in height. The Insect Zoo's is a replica of an actual mound found in Kenya. The African Mound Termite (*Macrotermes natalensis*) uses sand, soil, and termite saliva to build these towering castles. You can find scratch marks at the base of the mound where pangolins, African relatives of the anteater, clawed away the exterior to get at the live termites. As soon as the outer wall is broken termites rush to seal the holes, as high humidity inside the mound is crucial. Text and color video footage describe and show termite behavior inside and outside of the mound. Don't forget to crawl through the mound and hear the amplified sounds of what is happening inside a real termite mound.



The numbers and color codes on the map correspond to the numbered sections of text. The color coding of the numbers correspond to the National Science Standards printed on the back page of this teacher's guide: habitats—orange; survival strategies—purple; societies—yellow; diversity—brown.

The African Mound Termite (*Macrotermes natalensis*), as all termite species, is more closely related to cockroaches than it is to other social insects such as ants and bees. Termites have a caste system of queen, king, workers and soldiers similar to that of ants and also use pheromones with which to communicate. **Pheromones** are chemicals released from the body of the termite to communicate alarm, the presence of food, and when it's time to swarm. Termites, however, have gradual metamorphosis not complete metamorphosis as do ants and bees (see section 3, *Thriving Through Change*).

8 OBSERVATION BEEHIVE

Like ants and termites, honey bees are social insects relying on a division of labor to allow the hive to survive and grow. **Workers** (sterile females) provide the necessary nectar, pollen, and labor to keep the hive going. The **queen** is tended by the workers and produces large numbers of eggs, as she is the only fertile female in the colony. **Drones** (fertile male bees) are produced solely for the purpose of mating with the virgin queens produced by the hive.

9 ENTOMOLOGISTS AT WORK

A great deal of research on arthropods is conducted behind the scenes at the National Museum of Natural History. Entomologists collect insects, identify new species, and study their relationships with the rest of the natural world by collecting data in the field and studying one of the world's largest insect collections—the national collection of insects. An observation window provides a look into the rearing room behind-the-scenes.

10 HOW DANGEROUS ARE THEY?

Mosquitoes, fleas and ticks are just some of the arthropods that can transmit diseases from one human to another. Malaria, caused by protozoans and carried by the *Anopheles* mosquito, kills thousands of people each year. The Bubonic Plague was the worst disease epidemic in human history. The plague is spread from rats to humans via the Oriental rat flea (*Xenopsylla cheopis*). Lyme disease and Rocky Mountain spotted fever are carried by the deer tick (*Ixodes scapularis*) and the dog tick (*Dermacentor variabilis*) respectively.

Live black widow (*Latrodectus* sp.) and brown recluse (*Loxosceles* sp.) spiders, though no bigger than a nickel, have venom which is far more potent than that of the large hairy tarantulas. The black widow's venom attacks the nervous system, causing nausea, intense pain and respiratory problems. The brown recluse's venom attacks cell tissue, resulting in a wound which spreads slowly and can take months to heal.

11 OUR HOUSE, THEIR HOUSE

Our homes and backyards make excellent insect habitats. Carpenter ants, mosquitoes, fireflies, clothes moths, adult fleas, silverfish, German cockroaches and flour beetles are just some of the arthropods that are commonly found in and around buildings. Encourage students to use the nine interactive stations.

12 FRESHWATER POND HABITAT

Whirligig beetles, water striders, water scavenging and **predacious** diving beetles, and other aquatic insects swim throughout the five sided aquarium, while sounds common to freshwater ponds are heard. Aquatic insects provide food for birds, fish, frogs and other denizens of ponds. Katydid, water boatmen, field crickets, red-winged blackbirds, kingfishers, cicadas, coneheaded grasshoppers, and spring peeper frogs are commonly heard in or near a pond.

13 SONORAN DESERT DWELLERS HABITAT

Desert arthropods must deal with extremes. *Lack of water*—these arthropods have a thick, waxy body-covering that acts like a Thermos liner. They also remove water from solid foods and efficiently reabsorb water from their

feces. *Starvation*—many desert arthropods are active only when the plants on which they feed are plentiful. Others subsist year-round on seeds and grasses blown across the sand. *Hot desert sun*—many desert arthropods go out only at night, concealing themselves underground or beneath plants and rocks during the day. This display includes a scorpion, which stings its prey only when the prey is unmanageable; a tarantula, which comes out at night from its daytime burrow; darkling beetles, which have hard waxy forewings to protect them from the intense dry heat; a vinegaroon, which squirts acetic acid (vinegar) from its abdomen in defense; and a large desert centipede, which hides during the day.

14 MANGROVE SWAMP HABITAT

Mangroves provide a real challenge for arthropods which live above and below the surface of the water. The tides bring daily changes and challenges to the animals and plants in these forests that dominate the world's tropical and subtropical coasts. Water level, salinity, and temperature changes present the biggest challenges.

Wood-boring beetle and moth larvae carve galleries in the mangrove branches, escaping the extreme conditions on the outside of the plant (altering patterns in prop roots and tree limbs). Termites build huge nests and covered walkways between branches. The nests and walkways protect the soft-bodied termites from **desiccation**. Leaf mines of beetles and moth larvae can be seen winding a yellow path through the green mangrove leaves. Land crabs dig burrows that reach the cooling water table. They can plug the openings, which block out enemies and reduce extreme temperature. Mangrove tree crabs travel between the intertidal areas and the uppermost branches of red mangrove trees, seeking shelter and leaves to eat. Fiddler crabs, which live in burrows and mud flats, slow their breathing to protect themselves as the temperature rises. Below the tides, shrimp and crabs regulate the concentration of seawater inside their bodies, allowing them to withstand changes in the salinity of the seawater around them.

15 TROPICAL RAIN FOREST HABITAT

Rain forests cover about seven percent of the earth's surface. Africa, Asia, Australia, Central and South America house these shrinking biologically rich areas. The diversity of life reaches its zenith in the canopy of the rainforest.

Passionflower vines and Heliconian butterflies and caterpillars illustrate a fascinating relationship between a plant and an insect. Heliconian butterflies lay their eggs on upward curling tendrils of the passionflower vine. Some of these tendrils are inherently weak and under the weight of the butterfly's egg break and fall to the ground. This is one way the plant defends itself from hungry caterpillars. Some of the leaves on the passionflower vine have butterfly egg-like structures on them. Female Heliconian butterflies will not lay their eggs on these leaves, as Heliconian caterpillars are cannibalistic. Ants on the passionflower vine defend the plant by carrying off foliage eating caterpillars. The vine rewards the ants with nectar from extra floral **nectaries**, structures not located in the flower.

Giant cockroaches (*Blaberus giganteus*) are found in Central and South America. These giant cockroaches will sometimes make a sound similar to what a hissing cockroach makes when disturbed.







Leaf cutter ants (*Atta cephalotes*) cut pieces of leaves from whole leaves in the canopy and carries these fragments down to underground chambers. Walking along their clearly defined and well maintained paths on the forest floor, worker ants appear to be carrying parasols of leaf fragments giving *Atta* its other common name, parasol ants. Once underground the worker ants incorporate the leaf fragments from the canopy into the ever growing fungal gardens. The ants feed the fruiting bodies of the fungus to the larval ants. Leaf cutter ants along with many other ant species are "tilling" the soil and enriching it by transferring biomass from the canopy back into the soil which, when decomposed, can be used by the tree, creating more biomass in the canopy.

When strangler fig seeds germinate in the branches of their host tree, they send down clasping roots. The strangler fig's leaf-bearing branches grow taller than the host tree. The crisscrossing of the clasping roots provide microhabitats in which a variety of animals, including insects, live.




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Planning a Trip to the National Museum of Natural History

Before making a class visit . . .

-  Visit the Museum and tour the exhibit prior to bringing a group of students. Knowing the layout and contents of the exhibit and the locations of bathrooms, drinking fountains, and the cafeteria goes a long way toward having a smooth trip. If you are unable to make a pre-trip visit look over the Museum map online at <http://www.mnh.si.edu/museum/VirtualTour/floor.maps.html>. All visitors must pass through bag screening and metal detectors, much as you would encounter at an airport. Museum Security will help your group make an efficient entry into the building.
-  Bring one chaperone for every five students.
-  Review the main themes of the Insect Zoo with the students to help increase their interest and understanding of the exhibit.
-  Look over the resource list provided online at <http://www.mnh.si.edu/education>; it will help you put together background reading and provide the students with supplemental materials.
-  Review appropriate museum behavior and remind students that live arthropods cannot tolerate tapping on the exhibit cases.
-  Ask students to make “field notes” of the displays or draw in their journals.

After visiting the Museum . . .

-  Review the visit.
-  Have students share and display their writing or drawing journals.
-  Design a classroom insect resource center based on the online resource guide.

NMNH Exhibit Connections

Connections to the Insect Zoo can be found throughout the Museum. Here are some examples.

Bone Hall

This hall leads to the Insect Zoo and provides a great tool when emphasizing the difference between a vertebrate endoskeleton and an arthropod exoskeleton.

Rotunda

The African Savannah diorama featuring the bull elephant incorporates 15 species of insects. A touchable display demonstrates the importance of the dung beetle in nutrient cycling.

Paleobiology Hall

The Burgess Shale, that dates back 500 million years, has many arthropod fossils. Trilobites, eurypterids (one almost six feet long) and other early arthropods are displayed.

National Science Education Standards

The table cross-references Life Science Standards (C) that are addressed by the Insect Zoo. These standards were developed by the National Academies, approved by the Governing Board of the National Research Council, and published in 1995. They have served as a guide for science standards throughout the states, in both public and private sectors. The science standards are color-coded to the numbered sections of the Insect Zoo map that is found on the inside of this guide.

GRADES K-4	HABITATS	SURVIVAL STRATEGIES	SOCIETIES	DIVERSITY
The Characteristics of Organisms				
Components of survival. Distinct environments support distinct life.	X	X	X	
Different structures serve different functions.	X	X	X	
Influences on the behavior of organisms.			X	
Life Cycle of Organisms				
Life cycles vary between organisms.		X	X	
Organisms in Their Environment				
Patterns of behavior relating to environments.	X	X	X	
Changes in Environment				
Scale and duration of changes in environments.	X	X	X	X
GRADES 5-8	HABITATS	SURVIVAL STRATEGIES	SOCIETIES	DIVERSITY
Structure and Function of Living Systems				
Systems and ecosystems—digestion, locomotion, and reproduction.	X	X	X	
Reproduction and Heredity				
Inheritance, characteristics, and interactions with the environment.	X			
Regulation and Behavior				
Maintaining stable internal conditions in a constantly changing environment.	X			
Behavior as a response stimuli.			X	
Behavior as an evolutionary adaptation.	X		X	
Populations and Ecosystems				
Biodiversity and population density depend on resources available, and on abiotic factors	X			
Diversity and Adaptation of Organisms				
Unity accounted for by uniquely shared characteristics.		X	X	X
Diversity accounted for by biological evolution.		X		
Extinction and fossil record.				X



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Printed copies of this guide are available at no charge from the Office of Education, National Museum of Natural History, PO Box 37012, NHB, MRC 0158, Washington DC 20013-7012.

www.mnh.si.edu/education/teacherresources.htm

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