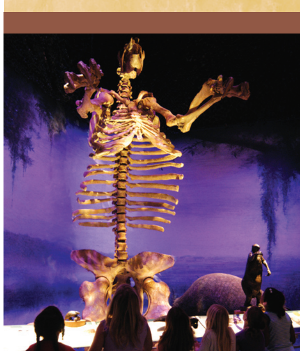
EDUCATORS' GUIDE

Butterfly Rainforest
at the Florida Museum *of* Natural History



FLORIDA MUSEUM OF NATURAL HISTORY®

The Florida Museum of Natural History *is Florida's state museum of natural history. The Museum is dedicated to understanding, preserving and interpreting biological diversity and cultural heritage.*

Acknowledgements

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offered by the Florida Museum, please visit our website:
www.flmnh.ufl.edu/education

The Florida Museum of Natural History's Educators' Guides, in combination with ongoing teacher workshops and field trips to its permanent and temporary exhibitions, will help you structure learning experiences that correspond to the following Florida Sunshine State Standards. All guides contain materials and online resources to supplement and enhance student learning in the classroom and during in-gallery experiences, tying Museum exhibits to the state standards and enhancing school fieldtrips.

Language Arts

Reading Standard 1:
The student uses the reading process effectively

Reading Standard 2:
The student constructs meaning from a wide range of texts.

Writing Standard 1:
The student uses writing processes effectively.

Writing Standard 2:
The student writes to communicate ideas and information effectively.

Listening, Viewing and Speaking Standard 1:
The student uses listening strategies effectively

Listening, Viewing and Speaking Standard 2:
The student uses viewing strategies effectively.

Math

Measurement Standard 1:
The student measures quantities in the real world and uses the measures to solve problems.

Data Analysis and Probability Standard 3:
The student uses statistical methods to make inferences and valid arguments about real-world situations.

Science

Processes that Shape the Earth Standard 1:
The student recognizes that processes in the lithosphere, atmosphere, hydrosphere, and biosphere interact to shape the Earth.

Processes that Shape the Earth Standard 2:
The student understands the need for protection of the natural systems on Earth.

Processes of Life Standard 1:
The student describes patterns of structure and function in living things

How Living Things Interact with Their Environment Standard 1:
The student understands the competitive, interdependent, cyclic nature of living things in the environment.

How Living Things Interact with Their Environment Standard 2:
The student understands the consequences of using limited natural resources.

The Nature of Science Standard 3:
The student understands that science, technology, and society are interwoven and interdependent.

Social Studies

Time, Continuity and Change Standard 1:
The student understands historical chronology and the historical perspective.

Time, Continuity and Change Standard 6:
The student understands the history of Florida and its people.

People, Places and Environments (Geography) Standard 1:
The student understands the world in spatial terms.

People, Places and Environments (Geography) Standard 2:
The student understands the interactions of people and the physical environment.

The Arts: Visual Arts

Cultural and Historical Connections Standard 1: | The student understands the visual arts in relation to history and culture.

Applications to Life Standard 1: | The student makes connections between the visual arts, other disciplines, and the real world.

Table of Contents

The McGuire Center for Lepidoptera and Biodiversity serves both research and education functions. Visitors can explore the "Wall of Wings", which reaches nearly three stories high and 200 feet long, containing thousands of images and actual Lepidoptera specimens, information panels, videos and maps.

Come face-to-face with exotic, vibrant butterflies fluttering atop a lush tropical canvas of foliage and flowers as you experience the Butterfly Rainforest. The screened vivarium houses subtropical and tropical plants and trees to support 55 to 65 different species and hundreds of free-flying butterflies.

The McGuire Center houses many millions of specimens in one of the most comprehensive collections devoted to Lepidoptera, comparable to those of the top museums in the world.

The research space includes laboratories focusing on molecular genetics, scanning electron microscopy, image analysis, conservation and captive propagation of endangered species, optical microscopy and specimen preparation.

The McGuire Center for Lepidoptera and Biodiversity

Butterfly Habitat

Butterflies and moths can be found all over the world. However, the world's greatest diversity of butterflies and moths can be found in tropical rainforests. This means that there are a great number of different species in areas close to the equator.

Tropical rainforests are home to such diversity for several reasons. The first is that over the past 100 million years, lands near the equator remained fairly undisturbed by sea level change, climate change, or glaciations. This allowed many different animals and plants to evolve over long periods of time. Diverse plants provide highly varied resources for animal life, and have evolved into thousands of species.

Butterfly and moth species live at specific heights in the rainforest. In a typical rainforest there are at least 4 layers or strata:

1) The ground layer or forest floor usually contains herbs, ferns, and low shrubs.
2) The under story layer has shade-tolerant small trees, mosses, lichens, and ferns.
3) The canopy layer includes the tops of tall trees and as many as 400 species of trees per square mile.
4) The emergent layer includes extraordinarily tall species that rise above the canopy layer.

Most Lepidoptera species rarely leave a familiar environment. Some species live hundreds of feet high in the rainforest canopy, while others fly close to the ground or rest in leaf litter. Each is adapted to a certain temperature, humidity, and light range, and stays in its favorite strata.

Fun Fact: *There are 125 Lepidoptera families and about 12 times as many moths as butterflies: approximately 240,000 moths and 20,000 butterflies.*

Introduction

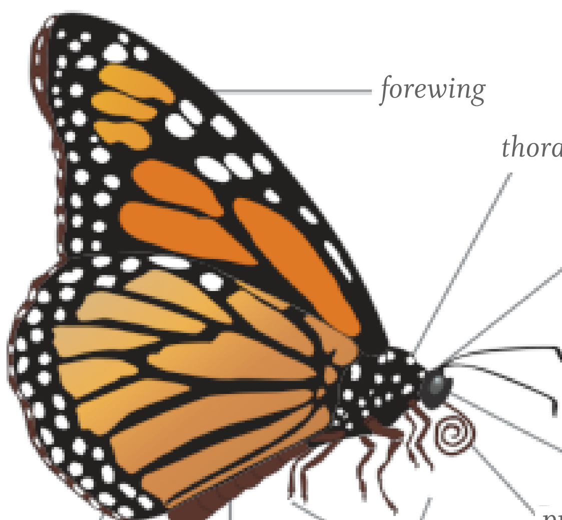
Butterflies and moths are insects that scientists call Lepidoptera, meaning, "scale winged" in Greek. They get this name from the tiny scales covering their wings and body. Like all insects, Lepidoptera have a hard outer covering called an exoskeleton, which is divided into sections and has joints so the animal can move. Also like other insects, moths and butterflies have six legs, a head, a thorax, and an abdomen.

On the head are two compound eyes, a proboscis, and the points of attachment for two antennae.

The thorax is divided into three segments, each with a pair of legs. The four wings of a butterfly or moth are also attached to the thorax which houses the muscles needed for making wings and legs move. The wings are composed of two membrane layers that are supported by tubular veins and are covered in thousands of colorful scales. Wing color and pattern serve a variety of purposes, from attracting mates to warning predators or providing camouflage.

The abdomen is composed of ten segments and contains the majority of the insect's organs such as the heart, breathing pores or spiracles, most of the digestive system, and reproductive organs.

Fun Fact: *Butterflies and other insects see a much wider range of color than we do, including shades revealed through ultraviolet (UV) and enhanced infrared. UV patterns can help members of the same species communicate, but can also endanger the butterfly when birds use UV-reflected light to search for prey.*



Vocabulary Words

Abdomen: In insects, crustaceans, and other arthropods, the last, most posterior segment of the body.

Compound Eye: An organ in insects made up of many light-sensitive elements each forming a portion of an image.

Eyespot: A round marking that resembles an eye, such as those on a peacock's tail, or on the wings of an owl butterfly.

Exoskeleton: A hard covering on the outside of insects that provides support for muscles and protection of the body.

Host Plant: The plant which a female butterfly or moth chooses to lay her eggs on. These are often specific species, which meet the food needs and adaptations of the caterpillar.

Larvae: The newly hatched, wingless, wormlike form of many insects before metamorphosis.

Lepidoptera: The order of insects, including butterflies and moths with four wings covered with microscopic scales.

Membrane: A thin flexible sheet of tissue connecting, covering, lining, or separating various parts or organs in animal and plant bodies.

Pheromone: A chemical secreted by an animal that influences the behavior of members of the same species. Reproductive pheromones are used to attract mates, for example.

Proboscis: In butterflies and moths, a long straw-like mouthpart that unrolls to feed on liquids.

Setae: A stiff, hair-like projection on insects, used as a sensory organ.

Spermatophore: In insects, a pouch or capsule used to transfer reproductive material (spermatozoa) from a male to a female.

Spiracle: In butterflies and moths, a respiratory opening in the exoskeleton.

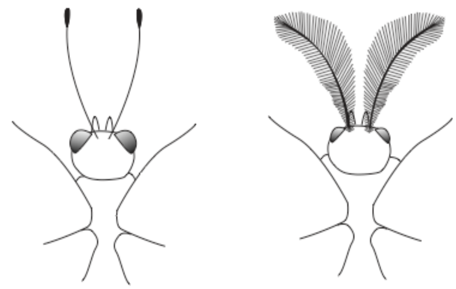
Thermoregulation: The maintenance of body temperature regardless of changes in the environment.

Thorax: The middle section of an insect's body that bears the legs and wings.

Tympanum: A vibrating membrane in some insects that serves as a hearing organ.

Veins: Vessels that carry blood or other fluids around the body.

Guiding Questions and Answers



1) What is the difference between a butterfly and a moth?

There are three major differences between butterflies and moths.

a. Butterflies are often more colorful than moths because butterflies are active during the day. Moths, active at night, have earthy colors to camouflage them against trees and plants while they sleep during the day.

b. Most butterflies have club-shaped antennae. Moth antennae are feather-like or taper to a point. Male moth antennae can be larger and more elaborate than female moth antennae. The increased surface area allows males to pick up scents of potential mates from a longer distance. Male butterflies rely less on scent and more on vision in the search for mates.

c. Moths have a thicker coating of scales than butterflies, giving them a furry appearance. Why? Moths fly at night and do not have the sun to warm their bodies. Instead, moths generate heat internally, and the heavy scales insulate them against heat loss.

2) What do a butterfly's colors and patterns mean?

Bright coloration, especially yellow and black, orange, or red, warns birds and other predators that such insects may bite, sting, or taste bad. A wasp's sting teaches us to associate danger with the animal's colors. Some butterflies and moths, such as the zebra longwing use these colors to warn predators that they are dangerous or distasteful.

Zebra longwing

Moths and many butterflies, particularly females, have earth-tone colors or patterns that resemble tree bark, lichens, or leaves. This coloration allows them to avoid predators by blending into their surroundings.

Bright coloration also attracts attention and is important in mating rituals. Males are often much brighter than females because they use their colors to attract and compete for female attention. You may see brightly colored male butterflies perch in sunny spots and chase away other males that intrude on their territory. Bright colors attract females and also signal rival males that the spot is taken.

Dark areas on butterfly wings absorb the sun's heat and help butterflies keep warm. This method of warming is called thermoregulation. The dark areas are usually close to the body, as only those small wing areas can transfer heat to the body muscles.

3) How do butterflies and moths avoid predators?

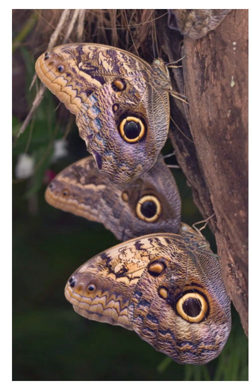
Some animals (for example, birds, bats, spiders, dragonflies, and mice) rely heavily on Lepidoptera for food. Butterflies and moths have evolved several ways to avoid being eaten:

Warning coloration such as a bold pattern and bright contrasting colors warn birds and other predators that such insects may bite, sting, or taste bad.

Moths and many butterflies, particularly females, have earth-tone colors or patterns that resemble tree bark, lichens, or leaves. This allows them to avoid predators by blending into their surroundings.

Eyespots on wings intimidate predators, especially small birds, who think they see the eye of a larger bird that might harm them.





Eyespots

Some butterflies and moths deter predators by mimicking the color pattern of other less edible species or other insects, plants, and animals. There are two types of mimicry:

a) Batesian Mimicry: Some harmless Lepidoptera species mimic the appearance of other species that are poisonous or distasteful. They pretend to be poisonous so predators will avoid them.

b) Mullerian Mimicry: Sometimes two species look alike and both are poisonous or distasteful. When a predator attacks one of the two, it remembers the color pattern and is unlikely to attack either, avoiding all insects with that color pattern.

Many species of hairstreak butterflies have hind wings that resemble a false head. This entices a predator to attack the back edge of the wing instead of the true (and easily injured) head at the front of the body. Thus the insect escapes, losing only part of its wing.

Southern hairstreak

Many species of butterflies and moths have genetic traits that allow them to produce different forms or colors that blend in better at different seasons or in different environments. For example, a light-colored or green butterfly is more likely to survive against green leaves, but brown is better camouflage when leaves dry up and fall.

JD Banded hairstreak

Gray hairstreak

Red-banded hairstreak

Olive hairstreak

4) How do Lepidoptera see, taste and hear?

Lepidoptera, like many other insects, use a compound eye for vision. Human eyes focus with a single lens. Butterfly eyes have hundreds of lenses, each focusing on a narrow area of the surrounding environment. hey see from ultraviolet light through all “visible” colors to infrared wavelengths, a much wider range than people can see.

Caterpillars have six pairs of eyes that are much simpler than the adult’s compound eye. Caterpillars can distinguish light from dark, movement, and the difference between vertical and horizontal lines (which helps them locate leaves and branches of food plants). Caterpillars also have tiny sensory structures called setae all over their bodies. Setae send information to the caterpillar’s brain about the position of its head, legs, and body segments. These stubby hairs also defend against predators by causing skin irritation and sometimes serious hemorrhaging.

Butterflies and moths feed on a wide variety of liquids for energy and reproduction. Though famous for their affinity to flower nectar, butterflies and moths often feed on less appetizing items, such as feces, sap, rotten fruit and decomposing animals. All butterflies drink water, but male butterflies also drink liquids to obtain minerals vital to reproduction.

Butterflies and moths rely on different senses to help them find food. Because butterflies are active during the day, color plays an important role. Brightly colored flowers advertise food sources. However, moths are usually only active at night and cannot rely on visible color to help them find food. Instead, moths rely on smell. Moths' feather-like antennae have greater surface area than the club-shaped antennae of butterflies. This better enables them to detect scents in the dark. Moths are often attracted to night-blooming flowers with strong smells.

Butterflies and moths have receptors on their feet, which allow them to taste when they land. They fly between plants and land briefly on each potential food plant. They taste the plants with their feet to find a specific food plant. Butterflies may also taste by using sensors in their antennae and proboscis.

Butterflies and moths hear sounds through a tympanum, an organ on the animal's body. The exact location varies by species, ranging from the abdomen to the wings. This thin membrane vibrates from sound waves, and receptors behind the membrane carry messages to the brain.

5) How do butterflies and moths find a mate? What is the mating process?

Day-flying butterflies and moths use visual clues to find mates: colors, wing patterns, and wing movements. Since finding a mate at night or in dimly lit forests can be troublesome, female moths and some species of butterflies produce large amounts of pheromones, a kind of chemical perfume. Using their antennae, males can detect the pheromones of potential mates from great distances.

Males of some species look for mates by visiting host plants where a newly emerged female may be found. Other males head for a high place: a hill, tall tree, or forest clearing to wait for females.

Mating rites can be complex. Both males and females perform ritual dances in the air or on leaves. A female may judge a male's strength and vigor by how well he follows her complicated aerial dance. Some males touch the female's sensitive antennae with pheromone-scented wings or with "brushes" of scales on the abdomen. When two butterflies are ready to mate, the male clasps the female's abdomen and locks them together. Over an hour or more, he transfers a packet of sperm, called a spermatophore that also contains proteins, carbohydrates, fats, and sometimes alkaloids. The female stores this mixture in a chamber, later releasing it to fertilize each egg during egg lying. The nutrients also help females live longer, make eggs, and protect eggs against predators.

After mating, a female carefully searches for the correct food plant for eggs and future larvae. Because each species of butterfly or moth is adapted to eat specific species of plants, females are very selective about where they lay their eggs. These plants are called host plants. The female butterfly instinctively recognizes the correct leaf shape, color, odor, taste, and appearance of this host plant. Once satisfied, she lays her eggs, coating them with an adhesive that fastens them to the leaf.

Almost all females mate at least once, and many mate with several males to gain nutrients for a longer life. Some males never mate, but others are still fertile after 7 or 8 mating sessions occurring over a week or more.

Pre Activities

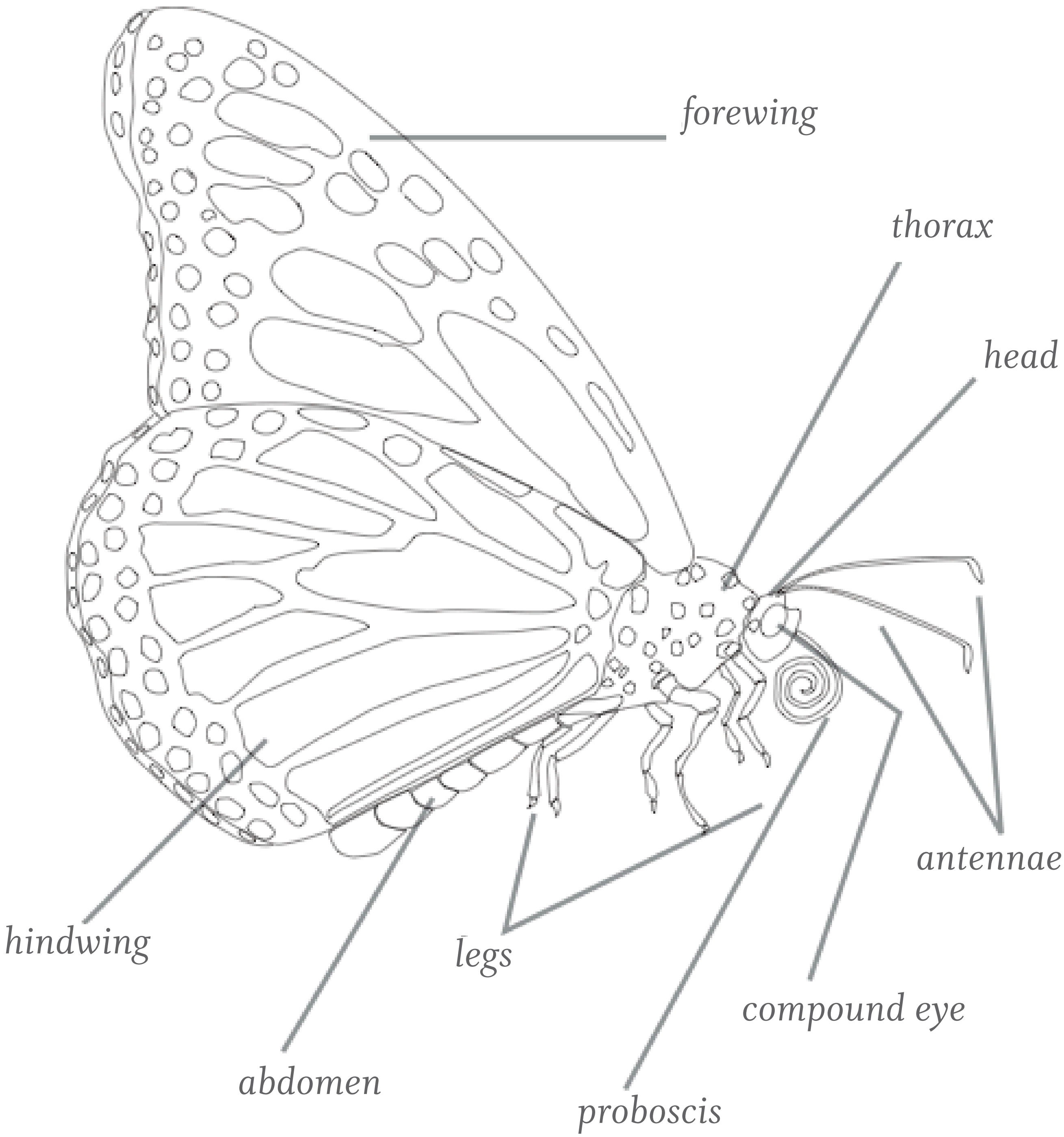
Butterflies and Us: Students can understand and describe Lepidoptera anatomy by relating it to their own.

Materials:

- Kaleidoscopes
- Labeled Butterfly Illustration
- Activity Sheet 1

Actions:

- Begin by discussing butterflies and moths. Can students give examples of insects? Butterflies and moths are both insects that belong to the same group or order of insects. This order is called Lepidoptera. Like other insects, butterflies and moths have three major body sections: head, thorax, and abdomen.
- Ask students if they believe they have the same three body sections. All humans have these three sections, just like Lepidoptera.
- Have students put their hands on their heads. What do we have on our heads?
- What do butterflies and moths have on their heads? Show students a picture of a labeled butterfly.
- How many eyes do we have? How many eyes do butterflies have? While both humans and butterflies have two eyes, we only have one lens in each eye. Butterflies have hundreds of lenses in each eye. This means that butterflies see lots of little images. This kind of eye is called a compound eye.
- Pass around the kaleidoscopes and have the children look through them. Tell students this is how a butterfly sees the world.
- Butterflies have two antennae between their eyes. Point to the antennae on the picture. They use their antennae to feel and smell. What do we use to feel and smell? Insects do not have hands and noses like we do, so they use their antennae.
- How do humans eat? Butterflies and moths have a different kind of mouth called a proboscis. The proboscis is like a straw that unrolls from the head when the butterfly needs food or water. What do students eat with a straw? Butterflies have an all-liquid diet.
- Where do students think their thorax is? Have students put their hands on their chest. This is the thorax. What is inside our chest? These same things are inside a butterfly or moth's thorax. What is attached to a butterfly's thorax? Point to the legs. Butterflies and moths have six legs.
- Where do students think their abdomen is? Have students feel their bellies below their belly button. This is the abdomen. An insect's abdomen is usually long. What is inside the abdomen?
- Have students read and fill out the diagram of a butterfly's anatomy.


forewing
thorax
head
antennae
hindwing
legs
compound eye
abdomen
proboscis

Activity Sheet 1

Read the definitions and label the diagram below.

Abdomen - The abdomen is the segmented tail area of an insect that contains the heart, trachea (breathing tubes), reproductive organs, and most of the digestive system.

Antenna - An antenna is a sensory appendage that is attached to the head of adult insects. Antennae are used for the sense of smell and balance. Butterflies have two antennae with clubs at the end.

Compound Eye - Insect compound eyes are made up of many hexagonal lenses.

Forewing - The fore wings are the two upper wings.

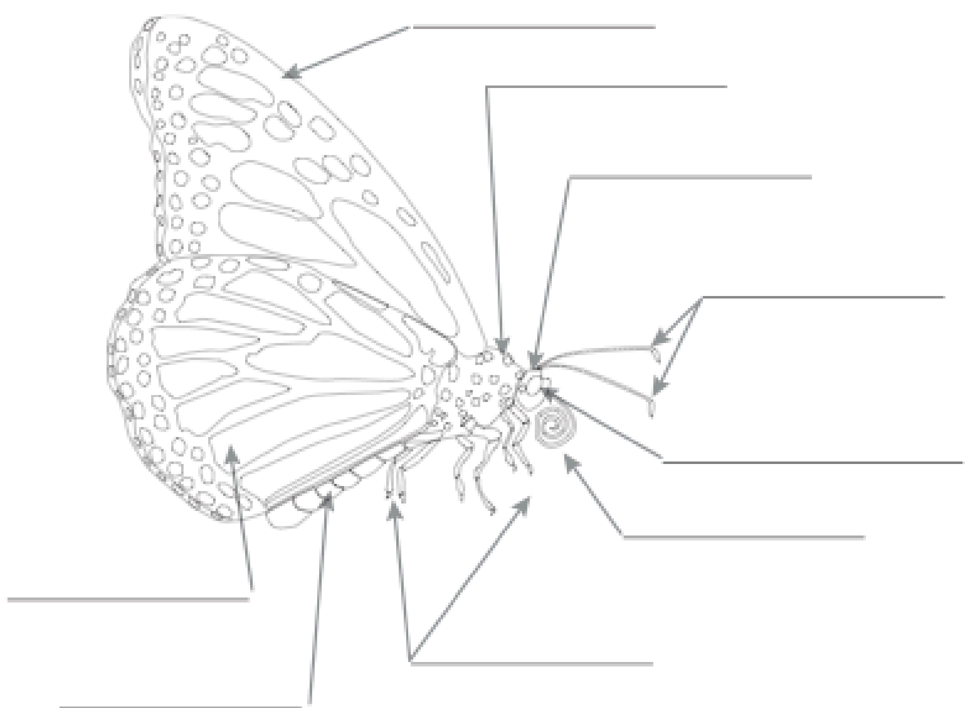
Hindwing - The hind wings are the two lower wings.

Head - The head is the part of the insect that contains the brain, two compound eyes, the proboscis, and the pharynx (the start of the digestive system). The two antennae are attached to the head.

Leg - Adult Lepidoptera (butterflies and moths) have six legs. The two forelegs of some butterfly species are tiny.

Proboscis - Adult butterflies sip nectar and other liquids using a spiral, straw-like proboscis located on their head.

Thorax - The thorax is the body section between the head and the abdomen. The legs and wings attach to the thorax.



Butterfly vs. Moth: Do you see the difference?
There are key physical differences between a butterfly and a moth.

Materials:

- Picture of a butterfly and a moth
- Activity Sheet 2

Actions:

- Show students a picture of a butterfly and a moth.
  What differences can students see between the two?
- Allow students to make observations and conjectures until they have uncovered the three differences:
  - a. Butterflies are more colorful
  - b. Antennae shape
  - c. Moths have a thicker coating of scales (they look furry)
- Why do students think these differences exist?
  - a. Butterflies are often more colorful than moths because butterflies are active during the day. Moths are active at night and have earthy colors to camouflage them while they sleep during the day.
  - b. Most butterflies have club-shaped antennae or antennae with knobs on the end while a moth's antennae are feather-like or taper to a point.
  - c. Moths have a thicker coating of scales than butterflies, giving them a furry appearance. These heavy scales help keep them from losing heat during the night when they are most active.
- Have students complete activity sheet 2. Discuss reasons for their answers after completion.

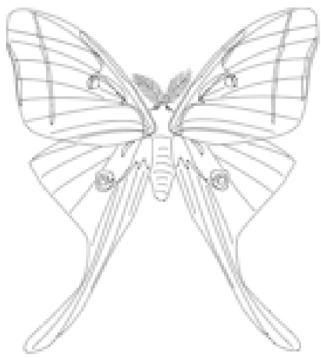
Field Trip Activity

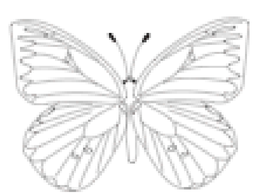
- Look at the different specimens on this wall.
- Which specimens are butterflies and which ones are moths? How can students tell?
- Which specimens would be camouflaged against a leaf during the spring? A leaf during the fall or winter? The bark of a tree? A flower?
- Can students find two specimens that are utilizing mimicry?
- Can students find a specimen with eyespots?


moth
butterfly

Activity Sheet 2

Identify each insect by writing butterfly or moth under each picture.





Post Activity

Camouflage: Color Camouflage is one of the ways that butterflies and moths avoid predators.

Materials:

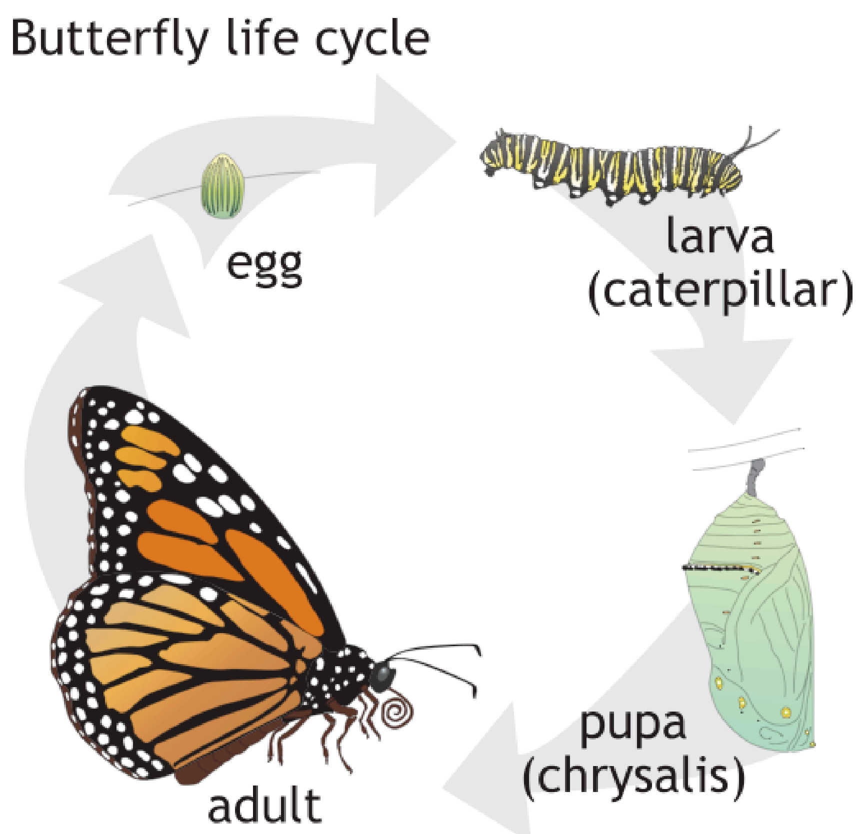
- Drawing paper
- Scissors
- Crayons, markers or colored pencils
- Tape
- Pictures of various flowers and plants

Actions:

- Have each student color a butterfly that would be camouflaged in some part of the classroom.
- Cut out the butterflies.
- Divide the class into groups of 5-8 students.
- Have everyone except one group close their eyes.
- The remaining group should tape their butterflies around the room in places where their butterflies would be difficult to see.
- The rest of the class should now go search for the butterflies.
- When all the butterflies have been found, allow the next group of 5-8 to hide their butterflies. Continue until all students have had a chance to hide their butterfly.
- Discuss which butterflies were the easiest to find? Which were the hardest to find? Why? What do students think this means for butterflies outside?
- Show students pictures of various flowers and plants. What color butterfly or moth would be best camouflaged?

Introduction

Lepidoptera undergo a wonderful transformation from caterpillar to fantastic winged adult. There are 4 life-cycle stages for all butterflies and moths: egg, larva (or caterpillar), pupa, and adult. This cycle is called complete metamorphosis



The first stage of an insect's life is an egg. When the egg hatches the young butterfly or moth is called a caterpillar or larva. A caterpillar spends most of its time feeding on plants and growing very quickly. When it has reached its full size, the caterpillar stops feeding and becomes a pupa. A moth pupa transforms inside a cocoon and a butterfly pupa transforms inside a chrysalis. During this immobile stage, the butterfly or moth makes its transformation from wingless larva to winged adult.

Fun Fact: *All insects undergo a metamorphosis, but not all have a pupae stage. Lepidoptera, beetles, ants, flies, and wasps pupate. But cockroaches, grasshoppers, and many other insects emerge from the egg as nymphs, miniature versions of the adult insects that grow and shed skin several times before reaching maturity.*

Vocabulary Words

Chrysalis: The hard encasing that protects a butterfly during its change from larva to adult.

Cocoon: A protective case of silky material spun by the larvae of moths and some other insects during the pupa stage.

Instar: A stage between two skin sheddings of caterpillars

Metamorphosis: A cycle of change of physical form and structure.

Pupa: An insect at the stage between larva and adult in complete metamorphosis. At this stage the insect is in a cocoon or chrysalis, stops feeding, and undergoes physical changes.

Guiding Questions and Answers

1) How does a butterfly or moth know where to lay an egg? How many eggs does a butterfly lay?

After mating, a female carefully searches for the correct food plant for eggs and future larvae. She instinctively recognizes the right leaf shape, colors, odor, and appearance of the host plant. She may even scratch it with claws on her forelegs to release chemical cues. Once satisfied, she lays an egg, fertilizing it as it is laid, and coats it with an adhesive that fastens the egg to the leaf.

Some species lay single eggs, while others lay clusters. Cluster-layers may lay up to 1,400 eggs in just a few days. Single-layers may take several weeks to six months to lay all the eggs. Some butterflies (especially grass-eaters), and many moths, scatter their eggs while flying.

2) What happens after an egg hatches?

When the eggs hatch, tiny caterpillars begin feeding and growing. As they eat and their bodies expand, their skin (an exoskeleton with a limited stretching capacity) becomes tight. Special hormones trigger production of a new skin, and the old skin splits and is shed. This occurs several times as the larva grows. Each molt leads to another, larger instar (stage). Most caterpillars go through 5 instars, each time approximately doubling in length.

3) What is a pupa? How long is a butterfly or moth in the pupa stage?

When the caterpillar has grown enough, it finds a protected spot, sheds its skin for the last time, and hangs upside down in a protective pupae case. A butterfly's pupae case is called a chrysalis while moths spin a silken cocoon for more protection. The pupa undergoes tremendous change while inside. It develops four wings, new legs, new eyes, new mouthparts, and genitalia. Some species spend a week or less as pupae, while others require an entire season or winter before they emerge as winged adults.

4) How does an adult Lepidoptera emerge from its chrysalis or cocoon? What does an adult Lepidoptera do? How long do adult Lepidoptera live?

When the time is right, the pupae case splits. The adult pulls itself out and pumps fluids through its veins, expanding its wings within an hour. After the wings dry, the adult spends the rest of its life searching for a mate and reproducing. The average adult lifespan is 2 weeks, but ranges from several days (giant skippers and silkmoths, which do not feed as adults) to as long as eleven months (some monarchs and their relatives, and a Costa Rican ithomiine butterfly).

Pre Activity

Metamorphosis: Insects go through a cycle of changes called metamorphosis throughout their lives.

Materials:

- Activity Sheet 3
- Scissors
- Crayons and/or markers

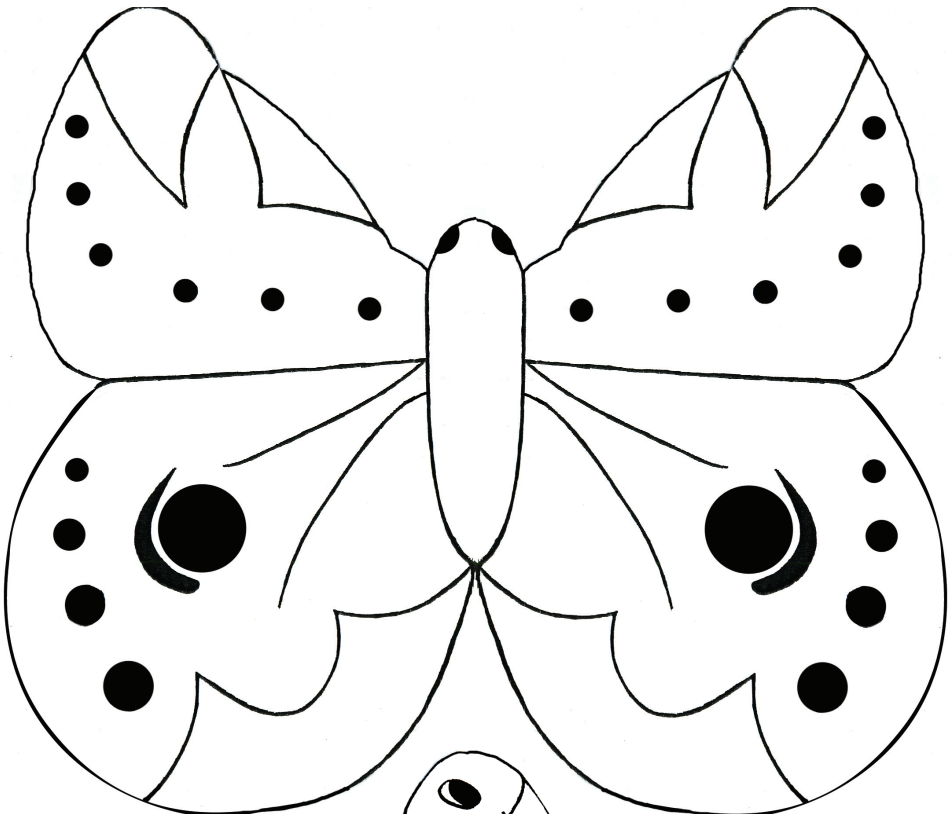
Actions:

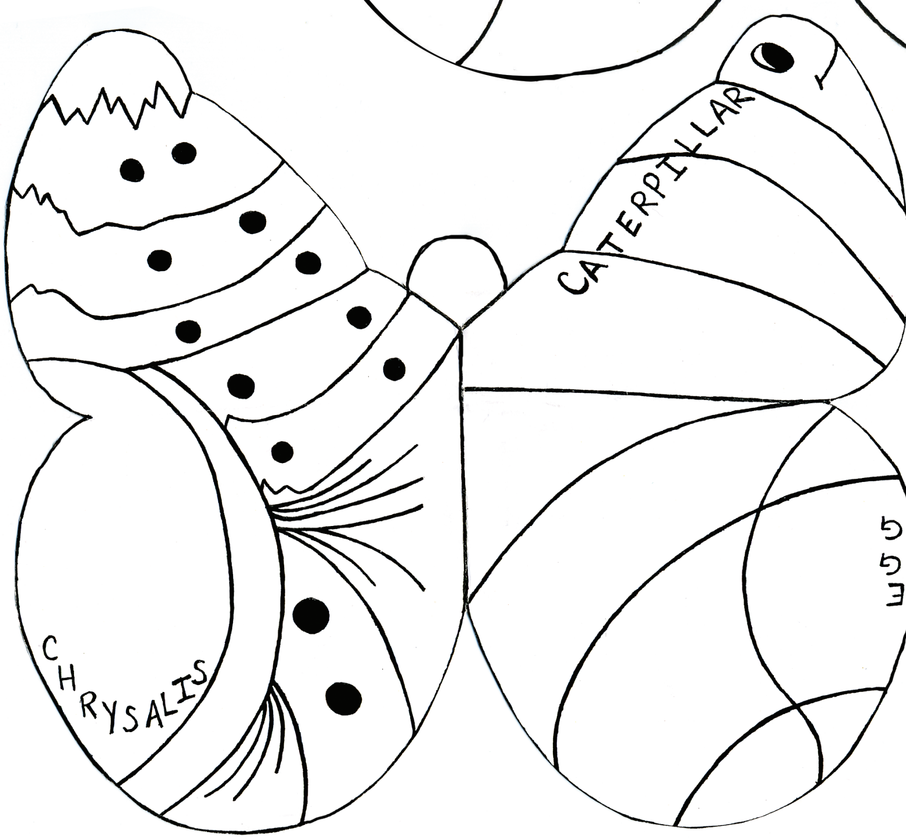
- Each student should have a set of materials
- Fold a piece of drawing paper in half.
- Trace the figure from activity sheet 3 along the folded edge.
- Cut out the figure.
- Unfold the figure, draw, and color a butterfly on one side of the paper.
- Fold the paper in half again with the blank sides facing out. Draw and color a caterpillar on one side.
- Flip the folded paper over to the other blank side. Draw and color a pupa on this side.
- Fold the paper in half again.
- All folded up, the paper starts as an egg. Unfold it once and it is a pupa. Flip the paper over and it is a caterpillar. Unfold the paper again and it becomes a butterfly.

Field Trip Activity

- Have students look at the rearing lab window.
- What are the different life stages that they can see?
- Do all the pupas look the same? Why do students think some look different?
- Do all the caterpillars look the same? Can they find two caterpillars of the same species that are different sizes? Why do student think they all look different? Why are particular caterpillars only on one kind of plant?

Activity Sheet 3





Post Activity

Locating a Host Plant: Butterflies use observational skills such as color, odor, taste and appearance to find the right host plant.

Materials:

- 6 jams of the same color. These 6 can have different textures as long as they are all the same color or roughly so. Some can even be the same flavor as long as the texture is different and the colors are the same.
- 2 small paper plates for each child
- 1 index card for each child
- Lots of paper towels

Set Up:

- Set out two small paper plates and an index card for every child in the class.
- Assign a number to each of the six jams.
- Write the numbers for each of the six jams on one of the child's plates.
- Place a small amount of each jam next to its number on the plate.
- Write the name of one of the jams on the second plate and place a small amount of that jam on it.

Actions:

- Butterflies are very picky about where they lay their eggs because each species of butterfly caterpillar is adapted to eat only specific kinds of plants. These plants are called host plants. The female butterfly instinctively recognizes the leaf shape, color, odor, taste, texture, and appearance of her species' host plant in order to lay her eggs.
- The labeled jams are students' host jams. Students need to use their observational skills to determine which of the unknown jams is their host jam.
- They should look, feel, taste and smell the jams. Have them record their observations on the index card.
- When they think they have figured out which of the six mystery jams is their host jam, they should write down the number on their index card.
- When everyone is finished, read out the numbers with their corresponding jam.
- Go around the room and ask what senses the students used to determine their host jam. What were the determining factors that gave away their host jam?

Introduction

Tropical rainforests support the World's greatest variety of plants and animals, including a stunning diversity of butterflies and moths. Rainforest life, however, is currently experiencing the greatest extinction in the history of Earth. This is caused by land development for growing populations, agriculture, timbering, and mining.

Fun Fact: *One square mile of forest in Rondonia, Brazil, has 1,863 butterfly species. The entire United States has only about 700 species.*

A butterfly's view of the Rainforest

Guiding Questions and Answers

1) Why are Lepidoptera so diverse?

Over the past 100 million years, lands near the equator remained fairly undisturbed by sea level change, climate change, or glaciations. New species developed uninterrupted over long periods of time.

Lepidoptera thrive in rainforests because they have the world's best climate for plant and animal growth. Rainforests have constant high temperatures, humidity, rainfall, and intense sunlight. Thousands of plant species provide highly varied resources for animal life. To lesson competition for food and resources, animals adapt to new and different resources.

2) Why do butterflies fly? How do they fly? Where do they fly? How fast do they fly?

Butterflies fly to find mates, locate food, find plants on which to lay eggs, avoid predators, and migrate long distances to avoid winters or dry seasons. Some Lepidoptera fly over 2,000 miles in their adult lifetime while others fly less than 25 feet from where they hatched.

There are many different flight styles: hovering, soaring, gliding, and darting. Different species of butterflies are built in unique ways to enable these types of flight. Broad wings are for soaring. Narrow pointed forewings and tails are for darting about and changing direction quickly.

Slow-flying butterflies have thin elegant bodies. Fast flyers have a bulky thorax with powerful flight muscles. Skipper butterflies and Sphinx moths can fly 35 mph! Slower ithomiine butterflies may fly only several feet per minute.

3) How do butterflies regulate body temperature?

For best performance, butterflies must keep their body temperature around 100o F and avoid overheating (or freezing) at any cost. Thermoregulation, controlling body temperature, has allowed butterflies to survive extreme climates and adapt to many habitats, from the Sahara Desert to the Alaska Arctic.

Butterflies control body temperature in several ways:

a) In warm regions, a butterfly opens its wings wide to bask in the sun until its body temperature is high enough to fly.
b) In cold regions, some butterflies warm up by holding wings together and turning sideways to the sun, trapping body heat between their wings.
c) Hairs and scales insulate the body and prevent rapid heat loss.
d) Darker wing scales near the body help butterflies absorb heat.

4) What happens to the rainforest at night?

When night falls, a whole new world wakes up in the rainforest. While butterflies rest, moths become active.

At dusk, butterflies crawl under logs, hang off leaves, and hide under bark to avoid nighttime predators. Moths take flight and feed on sap, plants, rotting or ripe fruit, and nocturnal flowers. They search for mates, using their feathery antennae to sense pheromone trails wafting on the air through the forest.

Night-blooming flowers often rely on moths for pollination. Many flowers cater exclusively to moths, sometimes co-evolving special floral tubes, petals, and colors to make access easier. They even make fake pheromones to attract their pollinators.

4. Do Butterflies Reproduce in the Butterfly Rainforest?

Reproduction does not occur in the FLMNH Butterfly Rainforest because there are no host plants provided. Plants inside the rainforest are feeding plants for the adult moths and butterflies.

Pre Activity

Following a Scent: Butterflies find food and mates by smelling scents called pheromones.

Materials:

- Cotton balls
- Blindfolds
- Essential oils (mint, orange, sage, lavender etc.)

Actions:

- Begin with a discussion about how students think moths find mates. Guiding questions include: When are body part do butterflies and moths use to smell? How do they think moths that fly at night and butterflies that live in dimly lit forests find mates? It is too dark to see colors well so how do students think they find each other? Female moths and some species of butterflies produce large amounts of pheromones, a kind of chemical perfume. Males use their antennae to detect the pheromones of potential mates from great distances.
- Clear a large space in the classroom.
- Break the class into groups of five.
- Have one group form a line at one edge of the clearing.
- Place a blindfold on each student.
- Tell them that you are going to put down a trail of scented cotton balls and that they will need to follow the scent to the end of the trail.
- Place the cotton balls down about a foot or two apart in a winding trail to the other side of the room. Make sure to spray each cotton ball with the scented spray.
- Each student will go one at a time. When they believe they have reached the end of the trail they should stop and take off their blindfold.
- When the first group is done, place blindfolds on the next group.
- Once the second group is blindfolded, rearrange the trail so that they will not know what the trail looks like.
- Repeat until all students have had a turn.

Field Trip Activity

- Before entering, remind students that they need to walk at all times, do not yell, and do not try to touch or pick up the butterflies.
- What types of flight do students see?
- What different wing shapes do students see?
- Can students find a butterfly with eyespots?
- Can students find a moth that is hiding and sleeping?

Post Activity: **Candy Butterflies:** Review butterfly anatomy with this tasty treat.

Materials for each student:

- 1 paper plate
- 4 toothpicks
- 2 unbroken pretzels
- 2 mini M&Ms
- 1 two-inch piece red shoelace licorice
- 6 half inch pieces black shoelace licorice
- 3 Tbs. vanilla frosting
- 1 candy fruit slices
- 1 gumdrop
- 1 large marshmallow
- Paper towels
- Paper plates

Set up:

- Place one set of candies on a paper plate. Make one for each student.
- Place one half of a container of vanilla frosting at each workstation. The frosting will serve as "glue."
- Place paper towels at each workstation.
- Write a key on the board or place a printout (Activity Sheet 4) of it at each desk to tell students what piece of candy represents what body part.

Actions:

- Have students wash their hands or use antibacterial gel.
- Review an image of a butterfly, pointing out the three main body sections (head, thorax, abdomen) and their components.
- Everyone is going to build their own butterfly out of candy, do not eat the pieces until everyone is finished.
- Put the head (gumdrop) on the end of one of the toothpicks.
- Slide the thorax (large marshmallow) on the tooth pick just below the head.
- Slide the abdomen (candy fruit slice) behind the thorax.
- Attach the two wings (pretzels) by pushing the bottom of the pretzel into the topsides of the thorax (large marshmallow).
- Attach the legs (black shoelace licorice) by pushing them into the bottom sides of the thorax.
- Insert two antennae (toothpicks) close together into the very top of the head.
- Take the proboscis (red shoelace licorice) and coil it.
- Stick the end of the proboscis into the bottom front of the head.
- Dip the eyes (mini M&Ms) in the frosting and attach them to the head right beside the antennae.

Note: Make sure to buy a little extra in case pieces get dropped on the ground or broken.

Activity Sheet 4- Review Sheet and Key

The **head** (gumdrop) is has two compound eyes, a proboscis, and two antennae.

Eyes: (mini M&Ms) Each eye of a butterfly has hundreds of lenses. This is known as a compound eye

Proboscis: (red shoestring licorice) The proboscis is a long straw-like tube that unrolls from the head when the butterfly needs to take either food or water for its liquid diet.

Antennae: (toothpicks) The antennae extend out of the top of the head, from between the eyes and end in a thickened or club like structure. These organs act as the insect's nose and aid in finding food, mating, and balancing during flight.

The **thorax** (large marshmallow) is divided into three segments, each with a pair of legs. The four wings of a butterfly or moth are also attached to the thorax which houses the muscles needed for making the wings and legs move.

Legs: (black shoestring licorice) Butterflies and moths have six segmented legs.

Wings: (pretzels) Butterflies and moths have two sets of wings. The front two are called forewings while the rear two are called hind wings. The wings are covered in thousands of colorful scales.

The **abdomen** (candy fruit slices) is long and contains the majority of the butterfly's organs such as the heart, breathing pores or spiracles, most of the digestive system, and reproductive organs.

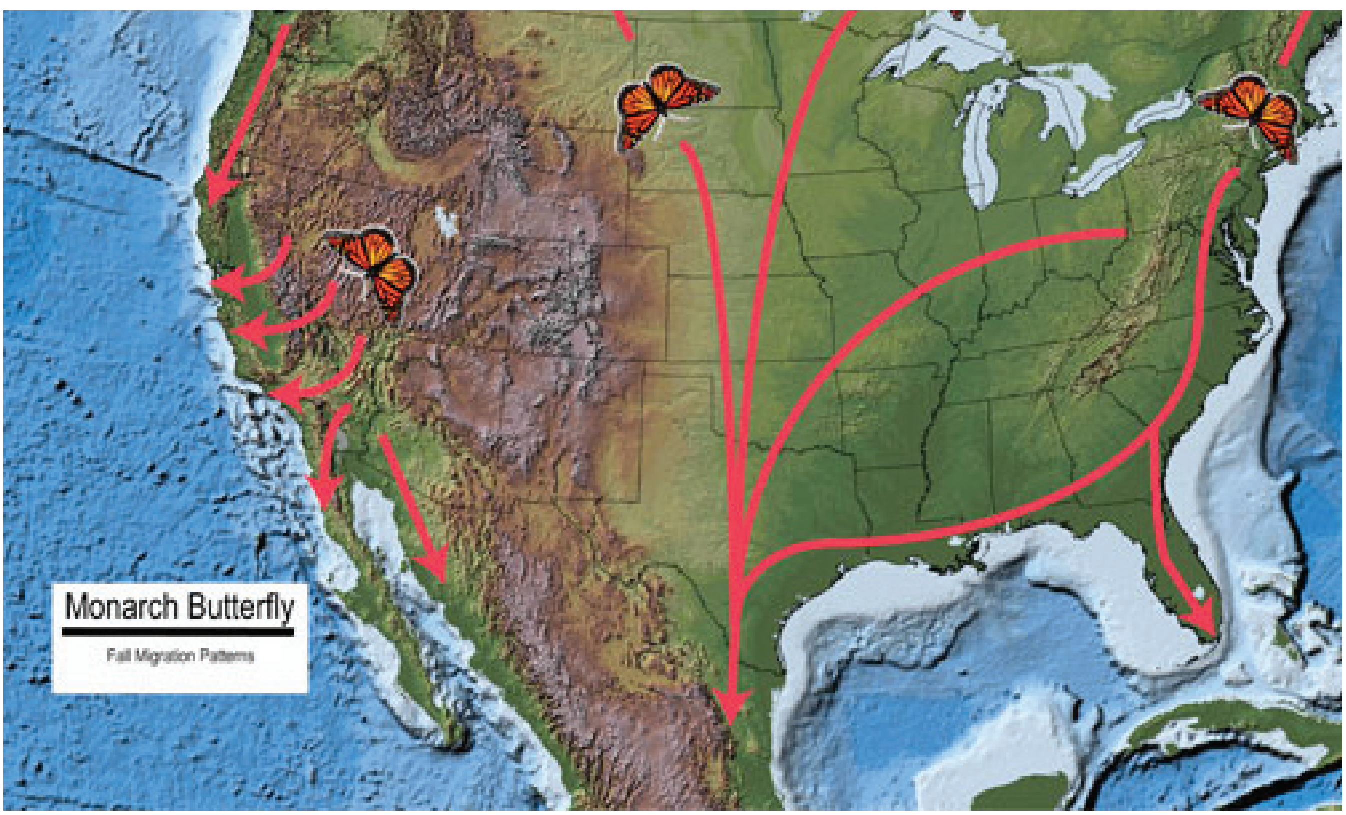
Introduction

Butterflies and moths are second only to beetles as the largest group of animals in the world. Even with the 165,000 species of butterflies and moths that scientists have described, there are still an estimated 100,000 species that have not. There are about 12 times as many moths as butterflies: approximately 240,000 species of moths and 20,000 species of butterflies.

In Florida, we have 2,932 Lepidoptera species: 189 butterflies and 2,743 moths. North America has over 12,500 species: only 765 species are butterflies and the rest are moths. Most Lepidoptera occur in more tropical regions.

In fall, monarch butterflies (Danaus plexippus) across North America begin moving south to avoid cold winter temperatures.

Fun Fact: *In fall, eastern U.S. Monarchs fly over 2,500 miles to their Mexican wintering sites. In spring they return north, but it takes several generations to complete the journey.*



Monarch Butterfly fall migration pattern. Photo from USGS, Science for a changing world.

Vocabulary Words

Genetically Engineered: An organism who's DNA has been altered by techniques of genetics used to cut up and join together genetic material (DNA) from one or more species of organism in order to change its characteristics.

Herbicides: A chemical substance used to destroy, or inhibit the growth of plants.

Guiding Questions and Answers

1) Where do monarch butterflies migrate? How far do they fly? When do they leave? When do they return? What do they do in Mexico?

Monarchs west of the Rocky Mountains migrate to the coast of California, where they cluster in colonies of several hundred to tens of thousands. They spend the winter in specific groves along the coast. Other winter sites have recently been discovered in eastern California desert canyons. Monarch movement through Nevada and Arizona also suggests there are undiscovered sites in northern Mexico.

East of the Rocky Mountains, monarchs migrate south towards the Gulf of Mexico. This is a larger migration. Monarchs enter Mexico across the Texas border, flying by the hundreds of millions. Their flight ends at the states of Mexico and Michoacan, where they overwinter in a dozen mountain retreats. Some monarchs fly across the Gulf of Mexico, an over-water flight of 400 miles or more. In addition, some monarchs fly from Florida to Cuba.

Monarchs begin the journey south in September, arriving at the Mexican wintering sites in late October. One monarch generation makes this amazingly long trip. They fly without a map over territory they have never seen and arrive perfectly on target at the wintering sites used by their ancestors. There they remain inactive for the next 4_ months. They may leave the colony to drink water or nectar, but return almost immediately to their trees.

In late March warmer longer days arrive, and monarchs become more active. They mate and begin to fly north. In the southern U.S. they lay eggs and die. The next generation emerges in late April and continues north, laying eggs along the way. The second generation emerges by June and continues north. A third and fourth generation may emerge by the end of August. Now the great-grandchildren of monarchs that wintered in Mexico migrate south, over a path they have never followed themselves.


The monarch migration

At over 2,500 miles, the monarch migration is the longest of any butterfly. During migration, monarchs can fly non-stop for 11-12 hours and cover 200-400 miles a day. They may fly as high as 11,000 feet above land. Thanks to frequent tail winds and body fat accumulated before migration, monarchs can fly 750 miles without "refueling." Usually they feed heavily during migration and arrive at the wintering sites with more fat than when they started.

2) How do butterflies learn to migrate? How do they know where to go?

Butterflies do not learn to migrate. They inherit the behavior that takes them to their wintering sites and brings them back north the following spring. Scientists are just beginning to understand the ability of monarchs to travel so far and arrive at a specific place where they have never been:

Experiments show that a remarkably accurate "sun compass" keeps the monarchs on target. Monarch butterflies contain magnetite, which may help orient them like a compass to Earth's magnetic field. The Mexican mountains contain heavy metal deposits, giving a strong magnetic signal for monarchs to cue on.

Scent may also help locate the exact trees that their ancestors used the year before. An odor remains on the evergreen firs from billions of their ancestors' wing scales.

3) What human caused phenomena and activities threaten Lepidoptera populations and actions?

Monarchs as a species are not endangered, as there are still many populations in Central and South America that do not migrate. But the phenomenon of migration is in grave danger. The greatest threat is destruction of wintering sites. In California, development has destroyed many sites. In Mexico, sites are disappearing because of logging, firewood gathering, fires, and agricultural clearing.

Monarch wintering sites suffer a double-whammy: forests thinned by human actions combined with more severe weather associated with global warming. Thick forests once protected the colonies from winter winds. But thinner forests do not protect the colonies from severe winter storms, and millions of monarchs can freeze to death. The Mexican government has legislated reserves, parks, and protection for monarchs. Local communities now recognize the economics of monarch tourism, which attracts hundreds of thousands of visitors annually. But tourism also brings problems. Permanent concrete trails and hundreds of shops and small restaurants all affect the monarch's winter environment.

Studies show that genetically engineered crops also threaten monarchs. Pollen from pest-resistant corn (Bt corn) contains toxic chemicals from the genes of the bacterium Bacillus thuringiensis. The pollen falls on milkweeds, and monarch caterpillars eat the milkweeds and die.

In recent years there has been a sharp decline in the number of butterflies migrating into Florida. This may reflect fewer available food plants. Some food plants die from herbicides used in lawns, roadsides, and agricultural fields. Also, a recent decline in soybean farms affects butterflies that rely on bean-family plants for food such as cloudless sulphurs and long-tailed skippers.

4) What other Lepidoptera besides the monarch migrate?

Scientists have recorded 13 butterfly species that migrate into the Florida peninsula to avoid cold winter temperatures. Four of the most common species are the cloudless sulphur (Phoebis sennae), gulf fritillary (Agraulis vanillae), long-tailed skipper (Urbanus proteus), and buckeye (Junonia coenia). None of these butterflies migrate as far as Monarchs do. In summer they live throughout the southeastern to northeastern U.S., but in fall they head south into Florida.

5) What is Florida's state butterfly?

In 1996, Florida claimed the graceful zebra longwing (Heliconius charitonius) as its official state butterfly. This slow-flying black-and-yellow striped butterfly favors tropical hammocks in South Florida and moist woods and pine forest edges further north. Unusually social, the adults often roost in large groups and return to the roost each night. Also long-lived, they may survive several months.

Zebra longwing - Florida State Butterfly

Pre Activity

Monarch migrations connect North America with Mexico. With a symbolic migration, students can communicate with students from Mexico and learn about butterfly conservation.

Participate in the Symbolic Migration from the Journey North program.
http://www.learner.org/jnorth/sm/index.html

Field Trip Activity

- Have the students find Gainesville on the Florida satellite image.
- What other areas do students know?
- Discuss the monarch migration from the Florida Panhandle to Mexico. Did you know if you follow the trail of flying butterflies overhead, you will end up in the Northwest Florida exhibit, where the monarch trans-Gulf migration begins?

Post Activity

Monarch Conservation: Students can help with monarch conservation by planting milkweed plants for monarchs to lay eggs along their migration.

Materials:

- Milkweed seeds (www.livemonarch.com)
- Cups
- Potting soil

Actions:

- Talk about butterfly conservation concerns. One of the reasons butterflies have become endangered is the destruction of their natural habitats including host plants to lay eggs and for larva to eat.
- Plant milkweed seeds in the cups.
- Students can either bring their plants home to plant in their home garden or the teacher can ask for permission from the school to plant seedlings in a school garden.
- Check on plants later in the year to see if there are any eggs or caterpillars on them.

Introduction

The McGuire Center for Lepidoptera and Biodiversity, at the Florida Museum of Natural History, is devoted to the study of butterflies and moths worldwide. The McGuire Center houses many millions of specimens in one of the most comprehensive collections devoted to this insect order of Lepidoptera. Its huge butterfly collection holdings contain more than 95% of the butterfly genera and approximately 75% of the described species. It is particularly strong for Central and South America, the world's richest and most complex biological region. Recent intensive collections from southwestern Brazil, Ecuador, Central America, and especially Mexico contain many species and geographic races that are either unnamed by scientists, or represented in only a handful of collections worldwide.

Fun Fact: *The Florida Museum vivarium gets shipments of 1000 pupae every week from places such as Kenya, Suriname, El Salvador, Costa Rica, Ecuador, Malaysia, the Philippines, and throughout Florida. Only about 80-85% of these pupae are released into the FLMNH rainforest, however. The remainders are either deformed, diseased or have some type of parasite.*

McGuire Center Wall of Wings

Vocabulary Words

Urbanization: The removal of rural characteristics such as plants and trees in order to develop towns or cities for human occupation.

Guiding Questions and Answers

1) How did Schaus' swallowtail become endangered? What is unique about Schaus' swallowtail? How did this butterfly recover from endangerment?

The Schaus' swallowtail, native to South Florida and once seriously endangered by development and pesticides, has returned from the brink of extinction. Insert image of Schaus' Swallowtail.

Schaus swallowtail

The rare Schaus' swallowtail (Heraclides aristodemus ponceanus Schaus) lives on Elliott Key, one of the few places in South Florida where there is no spraying for mosquito control. Once widespread in South Florida, its population size and distribution were reduced by urbanization of Miami and the Keys, and later by mosquito control spraying with pesticides Dibrom and Baytex.

This large, beautiful swallowtail flutters through dense tropical hardwood hammocks, avoiding lethal spider webs. It can even "back up" in flight; a rare move among butterflies. Schaus' larvae feed on wild lime and torchwood, both of which have limited ranges much diminished by urban development.

In 1992, Hurricane Andrew hit South Florida and devastated Schaus' habitat on Elliott Key. This prompted a large-scale captive breeding program. In captivity Schaus' females lay up to 430 eggs. In nature, predators eat most eggs, and wasps parasitize most larvae. But in the laboratory, researchers can raise most eggs to adults. The team bred over 1,500 butterflies in captivity and released them in the Keys and South Florida.

Success of the new populations is monitored every year. In spring, scientists visit Elliott Key to collect, mark, and release the butterflies. Recapture rates of marked butterflies help estimate population size. The number of individuals flying hovers at about one thousand.

2) How did the Miami blue recover from endangerment? What are future plans to help this species recover further?

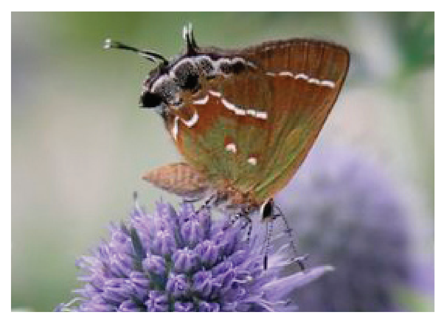
Miami blue

The Miami blue (Cyclargus thomasi bethunebakeri) is a small, brightly colored butterfly that lives only in Florida. Primarily a coastal species, the Miami blue inhabits tropical hammocks, beachside scrub and pine rock lands. Its larvae feed mostly on the native balloon vine (Cardiospermum corindum) and gray nickerbean (Caesalpinia bonduc).

Development in coastal areas eliminated the Miami blue from the South Florida mainland. This alarming decline continued in the Florida Keys. After disappearing for seven years, the species was rediscovered on Bahia Honda Key. Current threats to the remaining tiny population include adult mosquito control spraying, which kills larvae feeding on sprayed host plants.

In 2002, approximately 50 adult butterflies were flying in Bahia Honda State Park. The same year, scientists established a captive breeding population in Gainesville. The first reintroduction of this species occurred in May 2004 in Everglades National Park, and other sites will receive reintroductions after suitable habitats are identified.

3) Why is the St. Augustine hairstreak endangered?



St. Augustine hairstreak

The St. Augustine hairstreak occurs only in northeast and North Central Florida. Colonies are geographically isolated and very small, with only 3-40 adult butterflies normally present. The larvae feed only on southern red cedar trees (Juniperus silicicola). You may see 3-4 males perched on every tree in a colony, waiting for passing females.

Ten years ago, several colonies of the St. Augustine hairstreak (Mitoura grynea sweadneri) were known from Jacksonville, St. Augustine, and Gulf coast areas near Cedar Key. Today, colonies remain only inland west of the St. Johns River. The status of this butterfly east of St. Johns River is in question and the original coastal populations may no longer exist.

Coastal development has eliminated many old cedar trees, which led to the demise of this species and continues to be a threat. Also, landscapers often trim cedar tree branches, removing new growth that hosts both eggs and caterpillars. Mulching around tree bases can kill the underground pupae and suppresses wildflowers vital to adult feeding.

4) What does Global Warming mean for butterfly populations?

When temperatures rise, scientists predict most cold-adapted animals will shift north or into higher mountain areas where it is colder. For example, if temperature rises by five degrees by the year 2050, about 20% of the butterflies of the Rocky Mountains and Sierra Nevada will disappear as their unique forests are greatly reduced.

- Edith's checkerspot (Euphydryas editha) now occurs at higher altitudes than any time in the last century. Also, extinctions occurred in its southern range, while northern populations expanded.
- The ranges of many North American butterflies have expanded northward as much as 150 miles.
- In Ontario, Canada, two butterflies recently expanded north: the Delaware skipper (Anatrytone logan) and the gorgone checkerspot (Chlosyne gorgone). The latter had not been seen in eastern Canada since the late 1800s.
- With warmer temperatures, Ontario's tawny-edged skipper (Polites themistocles) now produces two generations per year instead of one.
- In northern Europe, 65% of studied species extended their ranges northward, and only 2% shifted south. In southern Europe, 5% extended south, and 22% shifted northward.

5) How can individuals help with butterfly conservation?

Butterfly gardening has been around for at least a hundred years. Old English gardening books provide advice on planting caterpillar food plants and nectar sources for butterflies. In the United States, butterfly gardening became fashionable in the 1980s, and live butterfly conservatories such as the one at the Florida Museum of Natural History began to open in the U.S. and Canada.

Butterfly gardens are beautiful and let us observe butterflies up close. But they also help butterflies. Florida natural areas are increasingly destroyed due to population growth. When homeowners swap manicured lawns for native plant landscaping, they save on water and chemicals, and provide food and shelter to animals such as butterflies and moths. So go native! And don't forget to support conservation of remaining natural areas.

6) Are moth populations also in danger? What can individuals do to help?

Artificial lights confuse night-flying moths and are responsible for a dramatic decline in moth populations. Moths navigate using moonlight, and are thus attracted to light. Artificial lights (such as streetlights, security lights, advertising, and building illumination) devastate wild moth populations. They disrupt navigation and prevent moths from feeding and reproducing normally. Moths die before leaving offspring. Light pollution has caused a decline in moth populations worldwide, especially in Western Europe and the United States.

Light pollution can be dramatically reduced by some simple measures:

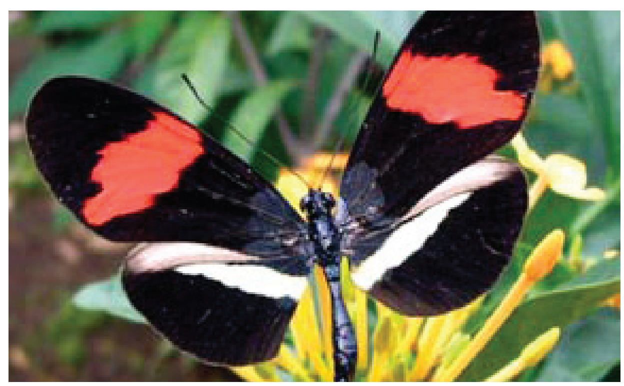
- Design and use light fittings that prevent light from shining upward.
- Position lights properly and direct them downwards.
- Use only a necessary amount of lighting.
- Switch off unnecessary lights late at night and early in the morning, especially decorative floodlights and advertising lights.
- Support community initiatives that reduce light pollution.

7) What do genetic studies at the Florida Museum of Natural History tell us?

Heliconius erato and Heliconius melpomene

Nearly impossible to tell apart, the butterflies Heliconius erato and Heliconius melpomene are extremely accurate mimics of one another. Heliconius mimics are so similar that correct identification requires microscopic examination of anatomical structures or examination of the immatures (eggs, larvae, and pupae). The color of these species may vary in different geographic areas, from red-banded or yellow-striped to iridescent blue, but at each place they mimic each other perfectly.

Heliconius melpomene



Heliconius erato

Brightly colored Heliconius mimics are all distasteful or poisonous. From an evolutionary perspective, this allows species to combine their defenses against predators and find safety in numbers. If a bird discovers that a butterfly with a red stripe tastes bad, it will avoid all like it in the future. Thus distasteful butterflies benefit from being conspicuous and memorable, boldly announcing "Don't mess with us."

The wing patterns of two Heliconius species (H. erato and H. melpomene) often change together across Central and South America. At any given location, the two species have identical patterns, yet they have diversified together, producing more than two-dozen color-pattern "races." Together these butterflies form a complex model for studying butterfly evolution and ecology.

The remarkable color pattern radiation of H. erato and H. melpomene is genetically complex. Biologists believe that 5 or 6 separate genes on different chromosomes control the color, position and shape of wing pattern elements. Mutations at each gene site produce the stunning variation seen among dozens of geographic races of the two species.

Bicyclus anyana

Eyespots are a prominent feature of butterfly wing patterns. Up close, they help scare predators, and from a distance they help butterflies blend into their surroundings. In many species, eyespots are quite variable in size and number. In Bicyclus anyana, a satyrine butterfly from tropical Africa, their presence and prominence changes with the seasons of the year.

Bicyclus anyana

Bicyclus anyana is easy to raise in the laboratory and has been used in many experiments that help us understand Lepidoptera wing pattern formation. Scientists artificially bred the butterflies and found that mutations could eliminate individual eyespots without changing the rest of the wing pattern. This led to the theory that different gene groups regulate wing pattern in different wing cells (compartments in the wing).

The genetic controls for butterfly eyespots offer insights into similar controls for human development. Advances in molecular biology have allowed identification of genes on butterfly DNA that are responsible for specific characteristics. Similar genetic mapping is underway for many human genes, especially those connected to deadly hereditary diseases such as cancer. Experiments on insects, which go through generations much faster than humans do, often help move medical research forward.

African Swallowtail

Research on the African Swallowtail (Papilio dardanus) led to an understanding of the genetics of certain human diseases and contributed to saving thousands of lives. African Swallowtail females mimic a variety of toxic milkweed butterflies, posing as more than 12 different species in different parts of Africa.

English scientist Cyril Clarke and colleagues studied the genetics of African Swallowtail mimicry. They showed that basic mimicry started as a major mutant gene, but then minor genes would accumulate on the same chromosome if they led to an improvement in the mimicry. The genes were so close on the chromosome that they were inherited as a unit and controlled the expression of the mimicry very precisely.

African swallowtail

Clarke's medical background made him realize that the Rhesus (Rh) blood groups in humans are inherited in much the same way as butterfly mimicry patterns. His team discovered a way to prevent Rhesus disease. An injection given to an Rh-negative mother after she delivered an Rh-positive baby destroyed any Rh-positive cells that entered the mother's bloodstream, preventing an immune reaction. This butterfly-generated discovery has enabled countless thousands to survive.

Cyril Clarke's work on color dominance in other swallowtail hybrids led him to study dominance among the single-gene differences in human ABO blood groups. He discovered that blood group O people frequently developed duodenal ulcers, which allowed physicians to exercise preventive medicine.

Pre Activity

Anyone can perform experiments. Have students perform an experiment to determine how much a caterpillar eats.

Materials:

- Stiff paper or card stock (for tracing milkweed leaves)
- Data sheets; one per student per day (see Activity Sheet 5)
- Caterpillar container
- Monarch caterpillars and milkweed (www.butterflyskyfarm.com)

Set up:

- Begin with a discussion on how students think they could find out how much a caterpillar eats in a day. Guide them with questions so that they can find the faults in their own ideas (if there are any). If they do not brainstorm the following experiment, talk about the different aspects and why it makes a good experiment (only one variable, knowing the size of the leaf before and after, same caterpillar, making a hypothesis).
- Trace a milkweed leaf onto card stock and cut it out to make a pattern. Make sure to do this right before class and keep the leaf that you traced.

Actions:

- Give each student a data sheet and have him or her trace the cardstock milkweed leaf onto the graph paper.
- Students should count the number of squares the leaf takes up and fill in the numbers on their data sheet.
- Put 1 caterpillar and the milkweed leaf (that was traced) in a container.
- Have students predict how many squares they think the caterpillar will eat. They should record their hypothesis on their data sheet.
- At the end of the day, retrace the eaten leaf on the original pattern and cut out the eaten portions.
- Have students trace the new pattern on the graph paper. Count how many squares the leaf takes up and fill in their data sheet. Subtract the number of squares left at the end of the day from the number of squares at the beginning of the day to find how many squares of leaf were eaten and record this amount on their data sheet.
- Compare the amount of milkweed eaten each day as the caterpillar grows.
- After a week or several days, have students convert their data sheets into a table. Columns should be Day and number of squares eaten. Help students create a bar graph or a line graph from their data.
- Students can also watch the caterpillar form a chrysalis and ultimately emerge as a butterfly. Go outside as a class to release the butterfly once it has emerged and dried its wings.

Activity Sheet 5

Students name ____ date___________

The leaf is ________ number of squares before being eaten. My hypothesis is that they caterpillar will eat _________ number of squares today. The leaf is ________ number of squares after being eaten. The caterpillar ate ________ number of squares today.

Field Trip

- Look into each of the research windows.
- What equipment do students see?
- Do they use any of the same equipment in their own experiments?
- What's important when performing an experiment?
- Why do scientists do experiments?

Post

Butterfly Nectar: Students can help feed and attract butterflies to the school or their home garden with this easy, homemade nectar.

Materials:

- Powdered orange "Gatorade"
- Water
- Shallow dish
- New sponge
- Optional: Very ripe or rotting fruit

Actions:

- Mix 1 scoop powdered "Gatorade" with 2 quarts of water.
- Pour desired amount in a shallow dish.
- Place the sponge in the dish as a place for butterflies to land.
- Add optional pieces of fruit.
- Place the dish outside near flowers.
- Observe the dish to see if butterflies land and drink the nectar. Are there any other creatures that drink from the dish?
- Change the liquid daily. Extra mixture should be kept in the refrigerator in a sealed container.

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Butterfly Conservation
http://www.butterfly-conservation.org/

Butterfly and Moth World
http://members.aol.com/YESbutrfly/home.html

Butterfly Sky Farm
www.butterflyskyfarm.com

FLMNH Butterfly Rainforest: Where Science Takes Flight
http://www.flmnh.ufl.edu/butterflies/

FLMNH Research and Collections: The McGuire Center
http://www.flmnh.ufl.edu/mcguire/

Journey North Program
http://www.learner.org/jnorth/sm/index.html

Magical World of Butterflies
http://www.shuntington.k12.ny.us/curr_resources/butterflies/butterflysites.html

Monarch Watch
http://www.monarchwatch.org/
Project Butterfly Wings
http://www.flmnh.ufl.edu/education/cise/wings.htm

The Live Monarch Foundations
www.livemonarch.com

DK Publishing. Butterfly and Moth. 62 min. DVD: Eyewitness, 2007.

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The collection of over 25,000 Heliconius butterflies and their relatives is one of the most complete and valuable collections of this group of butterflies. Heliconius feature prominently in research on butterfly ecology, distribution, evolution and genetics. This collection is notable for its accurate and reliable specimen locality information, representation of nearly all described names, its "type" specimens (specimens on which scientific names are based), and its exemplary standard curation.

The Lycaenidae (small butterflies such as blues, hairstreaks, coppers) collections are rich in African neotropical (New World tropics), and Asian material.

The colorful robust-bodied Charaxes, Bebearia, and Euphaedra genera are especially significant holdings among the Nymphalidae.

The thousands of large birdwings and other swallowtails represent virtually all of the 573 known species of the Papilionidae (swallowtail family) from every region on the earth.

The incredibly diverse metalmark butterflies of the Riodinidae, often showing brilliant coloration, odd patterns, and endlessly variable wing shapes, and the even more diverse skipper butterflies of the family Hesperiidae are represented by hundreds of thousands of specimens.

Among the moths, the McGuire Center collections include more than half a million hawk moths of virtually all the species of the family Sphingidae; most of the world's species of spectacular silk moths in the family Saturniidae; and huge collections of Microlepidoptera, Noctuidae (especially the underwing moths in the genus Catocala), and Palearctic moths from northern Europe and Asia.

Biodiversity surveys for Lepidoptera are currently underway in North America, especially the western U.S. and south Florida, the West Indies, Mexico, Costa Rica, Ecuador and elsewhere across South America, and Papua New Guinea, and are producing hundreds of new species and races previously unknown to science.
These annual augmentations to the collections at the McGuire Center are also providing a rich genetic library of Lepidoptera biodiversity for future generations of students and specialists to study.

Northwest Florida: Waterways and Wildlife

This exhibit follows water as it flows through the unique environments of northwest Florida, the most biologically diverse region of the state. Explore a hardwood hammock featuring a life-sized limestone cave, a seepage bog with its carnivorous plants, a Native American trading scene and more.

South Florida People and Environments

This exhibit celebrates the story of native people in South Florida and the environments that supported them. Walk along a boardwalk through a mangrove forest, travel underwater to view larger-than-life marine creatures, visit the house of a Calusa leader and much more.

Programs Overview

School groups include home schools and public, private and faith-based PreK-12 schools within a school district.

The Florida Museum of Natural History offers the following field trip opportunities for school groups:

Guided School Programs

Join our museum docents for hands-on classroom activities and interactive walks through our state-of-the-art exhibits and outdoor natural areas. Guided programs are offered Tuesday through Friday mornings, Oct. 7, 2008, through May 22, 2009. Programs fill quickly, especially for the months of October, November, April and May. To avoid disappointment, reserve your date as early in the school year as possible. Reservations must be made a minimum of three weeks in advance of the program date.

http://www.flmnh.ufl.edu/education/guided_programs.htm

Indoor Programming

- 10-60 students per program
- Each program is 60 minutes in length
- $3 student, 1/10 ratio chaperone free, additional chaperones $3/each
- Butterfly-focused programs will have additional entry fee into the Rainforest
- Programs will work with grades pre-school to 12th grade. Each program will be individualized to provide age-appropriate activities

Indoor Program Options:

- Butterfly and Moth Explorations
- Fossils - No Bones About It!
- Trails in Time - Florida's Indian Peoples
- Waterways and Wildlife of Florida

Outdoor Programming

- 10-40 students per program
- Each program is 60 minutes in length
- $3 student, 1/10 ratio chaperone free, additional chaperones $3/each
- Outdoor Programs are available for pre-school through 5th grade students only

Outdoor Program Options:

- Eye on Insects - Fall Only
- Green Machine - Spring Only
- Stayin' Alive

Self-Guided Visits

Suitable for groups that prefer to visit the museum without the benefit of docents or staff. Reservations are required for all self-guided visits of 10 or more students to ensure a positive experience for your group. Self-guided visits must be reserved at least two weeks in advance and are available Monday through Friday during Museum hours. A staff member will greet your group and facilitate the purchase of any tickets before you enter the Museum. After that, your group leaders are entirely responsible for the educational experience of the students.

School Group Self-Guided Tickets (10 or more individuals)
See link - http://www.flmnh.ufl.edu/education/self_guided.htm

Outreach – Inquiry Boxes

The Florida Museum of Natural History currently offers five Inquiry Box outreach programs for use in your classroom. They are also a great way to compliment your docent-led program or self-guided field trip to the Museum. Our Inquiry Boxes are correlated to the Sunshine State Standards and are designed to enhance FCAT preparation.

Each Inquiry Box contains selected natural history objects, games, a video, reference materials and a teacher's guide. Classroom teachers at any grade level may check out the Inquiry Boxes at a cost of $25/box for a two-week period. Teachers will be responsible for the pick-up and return of the Inquiry Boxes to and from museum.
If interested, please contact tours@flmnh.ufl.edu.

- Florida's Butterflies and Moths - grades K-4
- Florida's Reptiles and Amphibians - grades 2-6
- Northern Florida's Early Native People - grades 4-8
- Southern Florida's Early Native People - grades 4-8
- Florida's Seminole People - grades 2-6

Coming Soon!

- Florida's Fossils - grades 5-8
- The Geology of Florida - grades 5-8

http://www.flmnh.ufl.edu/education/inquiry_boxes.htm

Programs for Children and Adults

The Florida Museum offers a wide variety of educational programming for visitors of all ages. These programs include summer and spring break camps, adult workshops and classes, field trips, lectures, weekend and school holiday classes for kids, and a preschool program for tots and parents. Programming for the general public also includes annual and special events such as Collector's Day, Museum Nights, Butterfly Fest, Earth Day and Family Days at each exhibition opening.

Discovery Room

Swim through the shallows of a coral reef, puzzle together a prairie and create creatures from Florida's diverse ecosystems in our self-guided discovery stations. Visit our hands-on Discovery Room filled with activities and join us during scheduled program times for stories, puppets, Museum exploration with Dr. Discovery and more! To utilize the Discovery Room, groups must have one adult chaperone for every 5 students. The Discovery Room attendant reserves the right to limit the number of room participants or ask visitors to leave.

http://www.flmnh.ufl.edu/education/

Part Four: Exhibit Map