

EDUCATORS' GUIDE

Fossil Hall: Evolution of Life and Land
at the 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



Florida Museum of Natural History

2

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For more information about the variety of educational programming 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



Florida Museum of Natural History

5

Part One: Northwest Florida: Waterways and Wildlife Exhibition

Exhibit Introduction.....	06
Content Discussion: Evolution and Paleontology	07
Section One: Geology Florida.....	09
Section Two: Florida Under Water	19
Section Three: By Land or Sea: A Changing Environment.....	29
Section Four: Terrestrial Florida.....	43

Part Two: Teacher and Student Resources

Section One: Books.....	54
Section Two: Web Sources	56
Section Three: Videos, Music	57
Section Four: Current Research at the Florida Museum	58

Part Three: Related Exhibitions and Programs

Section One: Permanent Exhibitions.....	60
Section Two: School and Outreach Programs	61
Section Three: General Visitor Programs and Special Events	63

Part Four: Exhibit Map.....	64
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PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND

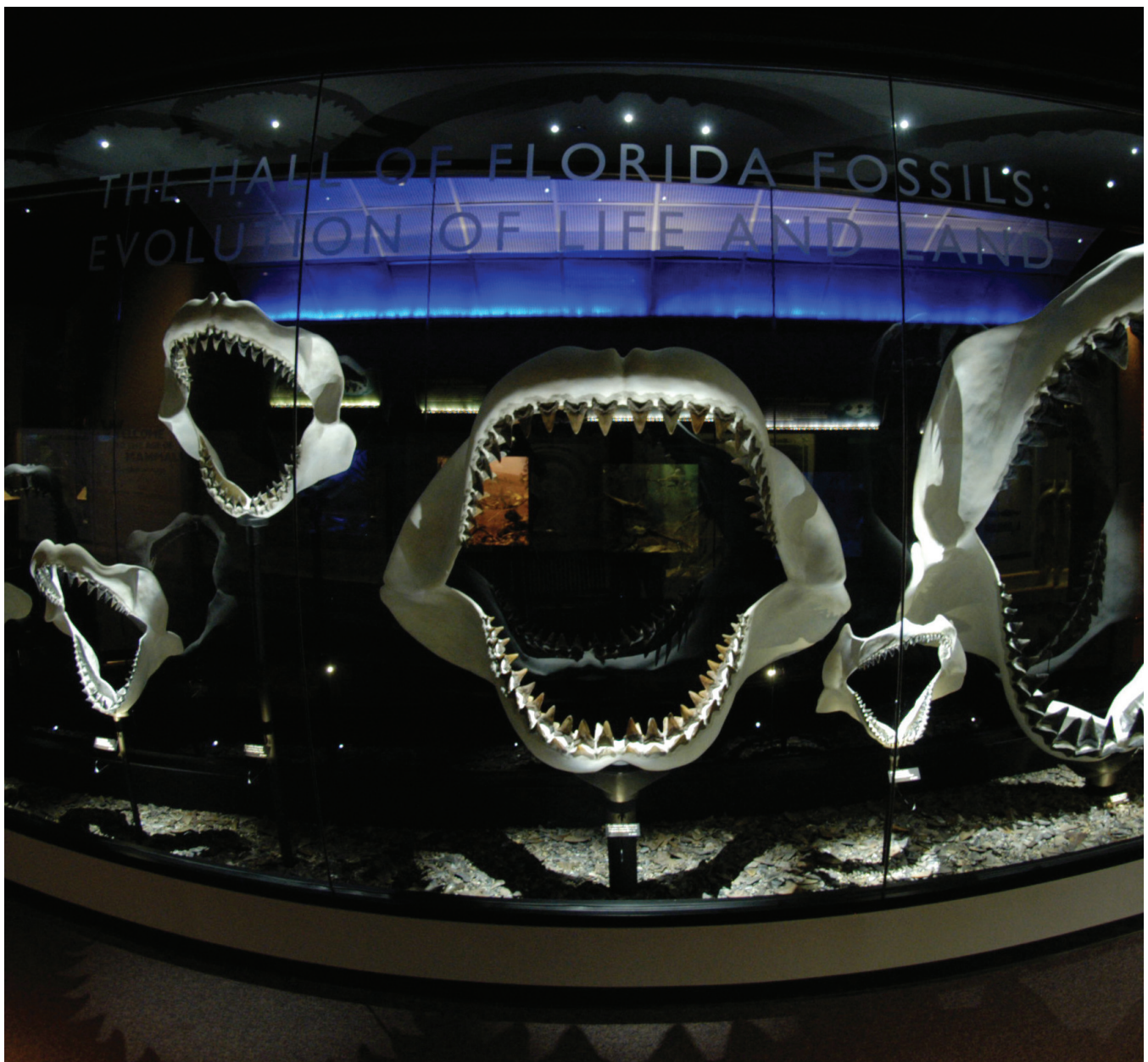


Florida Museum of Natural History

Exhibit Introduction

6

Drawing upon the Florida Museum's internationally acclaimed fossil collections, this award-winning exhibit describes the last 65 million years of Florida's history. Walk through time beginning with the Eocene, when Florida was underwater, to the Pleistocene when the first humans arrived 14,000 years ago. More than 90 percent of the 500 fossils in this exhibition are real and many were found within 100 miles of Gainesville.



Entrance to the Hall of Florida Fossils: Evolution of Life and Land

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Content Discussion: Evolution and Paleontology

7

Evolution is the idea that all organisms have changed through time due to the inheritance of specific characteristics. Evolution occurs due to a process called natural selection. Natural selection is when some individual organisms have the ability to survive in a particular environment better than others because they have characteristics that help them do so. For example, if one species of moth has a variation in color so that some are brown with white spots and others are white with brown spots, the brown ones will blend in with trees and leaves better than the white ones. The white moths will be easily spotted against the brown bark and therefore easier for predators to catch. Therefore, mostly brown moths will survive to reproduce and pass the color characteristic on to their offspring, eventually altering the color variation for the entire moth population.

One must, however, make the distinction between inherited characteristics and acquired characteristics. Inherited characteristics are those that are chemically encoded in an organism's genes. For example flexibility is a characteristic that is inherited. For instance if a person stretches daily and are flexible this does not mean that their children will also be flexible.

Some early evolutionists believed that giraffes' necks grew long due to generations of stretching to reach the leaves in treetops. They believed that due to this behavior over generations, over time, giraffe's necks became longer in each subsequent generation. This obviously was a misconception since we now know that giraffes that were born with slightly longer necks were able to get to the food and therefore survive, reproduce, and pass the trait on to their offspring.

The theory of evolution is known and studied by a wide range of scientists, for example paleontologists. There are four major ways that paleontologists find fossils in Florida: surface collecting, diving, screen washing and excavation. Surface collecting or prospecting involves searching for fossils in previously exposed areas. Scientists that dive find fossils in underwater locations such as rivers, springs and submerged caves. Screen washing is when scientists use a sieve to separate fossils from sediment found in or near a body of water, such as a river. Excavation is a more methodical way of uncovering fossils. It involves carefully removing and documenting layers of sediment to reveal buried fossils.

Paleontologists study fossils by comparing them to other specimens, both modern and ancient. These comparisons show scientists the similarities and differences between and within different groupings of animals and how these animals have changed over time. Often, they must repair fossil specimens so that they can be studied more accurately. If a specimen is rare or delicate, scientists create molds and casts of the fossil that can be studied more easily.

Fossils can give scientists information about when an animal lived, how an animal lived (e.g. diet, life cycle, locomotion) and how the animal died. This information, combined with information from the surrounding area where a fossil is found, can help scientists interpret the paleoenvironment or ancient habitat of the animal. Studying the fossils and paleoenvironments of Florida shows scientists how Florida has changed over time.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Content Discussion: Evolution and Paleontology continued

8

The understanding of scientists about the history of life on Earth contradicts the beliefs of some religious groups that the age of the Earth can be measured in thousands, not billions of years and that species do not change or go extinct. There is no way to change such deeply held beliefs in one trip to the museum, nor is the intent of this exhibit to do so, but questions about the science of the exhibit from such populations should be answered respectfully and accurately. It is often useful to address such issues by explaining that this lesson is specifically about the scientific process. The scientific process gathers evidence through observation of the natural world. In paleontology, observations of the natural world include the fossils excavated and dates recovered from potassium-argon dating. It is not the intent of science to refute a person's religious beliefs, but to find answers to questions using scientific investigation, and form theories based on sound scientific evidence. Science does not deal with the supernatural or with questions or issues for which no falsifiable evidence exists.

Classification System

The classification system used by scientists today is designed to place all organisms into hierarchical categories. Categorization starts out very general in Kingdom and becomes more specific as one moves down the list. A way to help your students remember the classification categories is to give them a saying of words where each word begins with the same letter of the category. For example:

K ings	K ingdom
P lay	P hylum
C hess	C lass
O n	O rders
F ridays	F amily
G enerally	G enus
S peaking	S pecies

These categories are artificial, human inventions that are constructed for our convenience. Humans like to classify things into manageable units (think neighborhood, town, county, state, country, continents etc.) However, the concept of species is more concrete. Often times a “species” cannot interbreed with members of a different species. And, it is sometimes the case that organisms can recognize whether another individual is a member of their species. Birds can do it by coloration or by vocalizations in chirps and songs and some marine organisms can do it using chemical cues. Among scientists, however, deciding the boundaries of species is a difficult task.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section One: Florida Geology

9

Introduction

The oldest rocks underlying Florida's surface are about 500 million years old. Studies of the ancient magnetic field preserved in these rocks indicate that ancient Florida was next to Northwestern Africa approximately 300 million years ago. Pangea was formed 290-250 million years ago when ancient continents collided. This collision welded ancient Florida to what is now Southeastern North America. When Pangea broke apart 250 to 220 million years ago, Florida remained attached to North America and drifted to its present position on the globe. Throughout most of its history, Florida has been underwater, explaining why marine fossils can be found throughout the state, while dinosaur fossils are absent.



Fun Fact: The oldest vertebrate fossil known from Florida is a sea turtle shell fragment from Okeechobee County at a depth of 2,807 meters (~9,122 ft). This shell fragment dates from 100 million years, into the “Age of Dinosaurs” (Mesozoic).

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Part One: Florida Geology continued

10

Vocabulary Words

Carbonization: The conversion of organic material into carbon.

Dissolution: The process of dissolving a solid substance into a solvent or liquid.

Formation: Formally defined layers of rock.

Organic: Of, relating to, or derived from living organisms.

Pangea: A supercontinent that existed during the Paleozoic and Mesozoic periods about 250 million years ago. It was comprised of modern Eurasia, North America, South America, Africa, Antarctica, Australia, and India.

Permineralization: A process of fossil petrification in which minerals replace bones, shells, or woody tissue without changing the original shape of the fossil.

Petrified: A term used to describe organic material that has been fossilized without decaying.

Recrystallization: A fossil formation process where the crystal structure of shells is replaced with alternate, more stable crystal shapes.

Strata: Layers of rock or soil with specific characteristics to distinguish it from surrounding layers.

Trace Fossils: Impressions made by organisms; for example burrows and footprints.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Part One: Florida Geology *continued*

11

Guiding Questions and Answers

1) What is Florida made of? How does limestone form? How does limestone help scientists understand the past?

Florida is formed of thousands of feet of limestone that stretches down to bedrock when Florida was initially part of Africa over 250 million years ago. Extensive limestone deposits like those in Florida are called carbonate banks or platforms. Formed in shallow marine environments, these banks are comprised of skeletal remains of organisms such as corals, calcareous algae, mollusks, and foraminifera (forams). The process of carbonate bank formation requires the accumulation of organic matter in addition to calcium. Carbonate deposition probably began in the Mesozoic (175 million years ago). During the late Jurassic and Cretaceous over ~8,125 feet of carbonates were deposited in southern Florida. Deposition occurred almost continuously on different parts of the Florida platform for the next 100 million years.

During the Eocene (55 to 34 million years ago) two formations (different types of rock) were deposited on the Florida Platform. The two formations can be distinguished by the animals and minerals encased inside. The Avon Park Formation, the oldest rock exposed at the surface in Florida, was deposited first and represents habitats further offshore than the later Ocala Limestone. Both rock units are commonly encountered in mining operations, particularly in Central Florida. Limestone quarries are important to paleontologists because they provide access to buried rock and sediments and the fossils trapped inside.

2) What are fossils? How do they form? Why types of materials are preserved?

Fossils are preserved remains or evidence of ancient life and can be thousands, millions, or even billions of years old. Once remains are buried, fossils form in several distinct ways:

- a. Permineralization is a chemical alteration process. For example, wood and bone have many pores. Groundwater seeping through these remains carries dissolved compounds such as calcium carbonate or silica. These compounds fill the pores, eventually turning the wood or bone into rock.
- b. Recrystallization is another alteration process that is common for shells where the shell remains a solid through the entire fossilization process. Shells are made of calcium carbonate, which has a specific crystal shape. Over time, these crystals are transformed into other types of crystals that have a more stable form.
- c. Buried shells and bones can dissolve as water seeps through them. If this occurs, a cavity is created, preserving the shape of the remains in the surrounding rock. The cavity may fill with sediment to form a natural cast of the original preserving the external surface and texture as well as the shape and size of the remains.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section One: Florida Geology *continued*

12

Some remains may undergo dissolution and replacement without leaving a cavity. The original mineral, such as aragonite, calcite, or phosphate, dissolves, but another, like pyrite or silica, rapidly replaces it. Some corals from the Oligocene era are beautiful examples of silica replacing original aragonite.



Oligocene corals

d. Some remains, particularly plant fossils, are preserved as thin residues of carbon in sandstones and shale in a process known as carbonization. The black film may preserve an organism's outline and structure in remarkable detail. Insert image of carbonized fossils

e. The fossil record usually includes only durable remains like teeth, bones, and shells. Occasionally, however, like a woolly mammoth entombed in a glacier, original soft tissues are preserved. These unaltered remains can be extremely useful to paleontologists as a source of ancient biochemicals, such as DNA. DNA can be used to trace ancestry to modern animals.

f. Sometimes no actual remains of an organism are preserved, only evidence of past biological activity. Examples of these trace fossils include dinosaur footprints or petrified burrows of marine worms.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section One: Florida Geology *continued*

13

3) How do scientists determine the age of a fossil?

The age of a fossil can be determined in two very different ways, known as relative and absolute dating:

Relative: Think of a fossil as an old photograph. If the photo has a date on it, we know exactly when it was taken. But what if the photo has no date? We can only examine the content of the photo to determine when it was taken. We note the models of automobiles, dress and hair-styles, or the age of a known person to estimate the photo's age. In much the same way, the relative dating method estimates the age of the fossil in question by its relationship to surrounding rock strata (layers) and other fossils of known age.

Absolute: Absolute age of fossils is determined by using the decay rate (half-life) of a radioactive isotope. Newly formed mineral crystals in rocks sometimes contain radioactive isotopes that break down (decay) at constant rates. In the decay process they change into other elements. For example, the radioactive isotope, potassium-40 breaks down into argon-40 at a fixed rate. By measuring the amount of argon-40 in a mineral crystal, scientists can calculate its age.



The Miocene marine fossil beds of northwestern Florida are known for high diversity and remarkable preservation. Most of the specimens displayed here were collected from the 18-million-year-old Chipola Formation in the Florida panhandle. This marine marl outcrops along the Chipola River and its tributaries.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section One: Florida Geology *continued*

14

Pre Activity

Geologic Time: Students will have a better understanding of geologic time by comparing the last 500 million years of Florida history to a 24 hour time period.

Materials:

- Paper
- Pencil

Actions:

- Give each student a piece of paper and have them do the following:
- Draw a line across the length of the paper. This line represents 24 hours.
- The very edge of the left side of the paper represents 12:01am or 500 million years ago (MYA). Have students label the edge accordingly.
- Midway down the line label it 12:00pm (noon) or 250 MYA.
- Now label midway on either side of noon as 6:00am (375 MYA) and 6:00pm (125 MYA). Ask students to fill in the rest of the hours of the day.
- Ask students to label their timeline with the following events. You can either give them the year and they have to figure out the time, or you can give them the time and they have to figure out the year.

500 MYA the earliest fishes evolved (12:01am)

500 MYA the oldest rocks under Florida formed. (12:01am)

375 MYA bony fishes appear (6:00am)

Shortly after this amphibians, insects and ferns emerge on land (Florida is underwater)

250 MYA the Triassic period begins and dinosaurs appear on Earth. Florida is under water. (12:00pm)

250 MYA the super continent, Pangaea breaks apart and Florida moves away from North Africa and remains attached to North America.

125 MYA dinosaurs are the dominant creatures throughout the world (6:00pm)

Florida is still under water, which is why no dinosaur fossils are found here.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section One: Florida Geology *continued*

15

65 MYA dinosaurs become extinct (8:50pm).

21 MYA Giant sharks, primitive toothed whales and four-legged sea cows (ancestors of manatees) live in Florida's shallow seas and small islands (11:00pm).

10.5 MYA Florida is just emerging as a peninsula as Earth's temperatures cool and sea levels drop. Large mammals such as mammoths, bear-dogs, and giant sloths will soon migrate to Florida (11:30pm)

2.5 MYA the first humans evolve (11:53pm)

6,000 years ago the first humans (Paleo-Indian) migrate to Florida (11:59pm within the last second of the last minute of the day).

- Review the answers to make sure all students had the correct time or year for each occurrence.
- Ask students:
 - What part of the clock does the _ number of years you have been alive represent? (fill in the blank based on how old the class is)
 - What about that last 100 years?
 - Since the beginning of the United States?
 - Hint: 1 minute= 347,222 years; 1 second= 5,787 years

Field Trip Activity

- As you enter the Fossil Hall, point out to your students that the sharks' teeth in the entrance are some of Florida's oldest fossils.
- Ask students why they think sharks teeth are so abundant in Florida? (Florida was underwater for most of its history).
- Look at Megalodon's jaw. Will people see a shark this big in the ocean today? Why not? What does extinction mean?
- Do students think they will see any dinosaurs in the exhibit? Why not?

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section One: Florida Geology *continued*

16

Post Activity

Pangea and Evolution: The super-continent Pangea was made of several of the continents we see today.

Materials:

- Map of the continents. (Activity Sheet 1)
- Scissors
- Evolution Image (Activity Sheet 2)

Actions:

Part One: Pangea

- Distribute one map to each student. Ask students to cut out the continents and piece them together as a puzzle. They should be able to match the continents together into a super continent, much as Pangea looked. Notice how Florida fits near North Africa.
- What do students think the fossils found on continents that were next to each other but are now separate will look like? Are the fossils going to be the same or different?
- What about the type of rocks that make up a continent? Are they going to be the same or different?
- Explain to students that since Florida was attached to North Africa 250 million years ago, the same types of rocks and fossils are found in both places

Part Two: Evolution

- Distribute the Evolution handout or display a transparency so that all students can view the image.
- Ask students to describe what is happening in images 1-3. Is the population of mice different in image 3 than in image 1? Why do students think this is happening? What does this mean for future mice populations? Explain that this is how evolution occurs. Those animals that are best adapted to their environment are the ones that will survive to reproduce.
- Discuss additional situations for evolution:
 - Giraffe neck length- those with long necks are able to reach more leaves and food
 - An owl's eyes- larger eyes allow more light in, enabling the owl to see better at night
- Going back to Pangea, ask students what they think happened to the animals that lived on separate continents once Pangea broke apart? Look at Antarctica. Do students think that a larger number of animals used to live on Antarctica? Explain that when Antarctica was part of Pangea, it was not as cold. What do students think happened to the animals on Antarctica as it drifted into a colder and colder environment?

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section One: Florida Geology *continued*

17

Activity Sheet 1

Pangea Puzzle



PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND

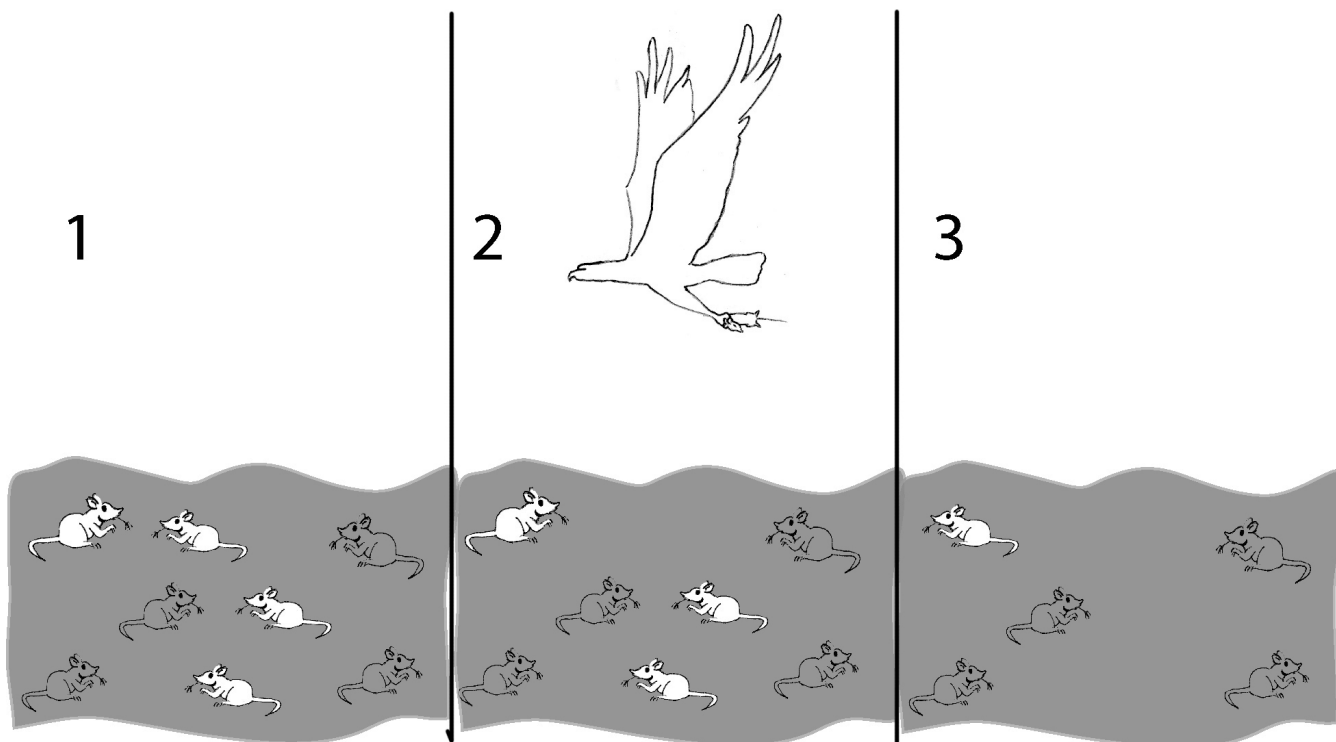


Florida Museum of Natural History

Section One: Florida Geology continued

18

Activity Sheet 2



PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Two: Florida Under Water

19

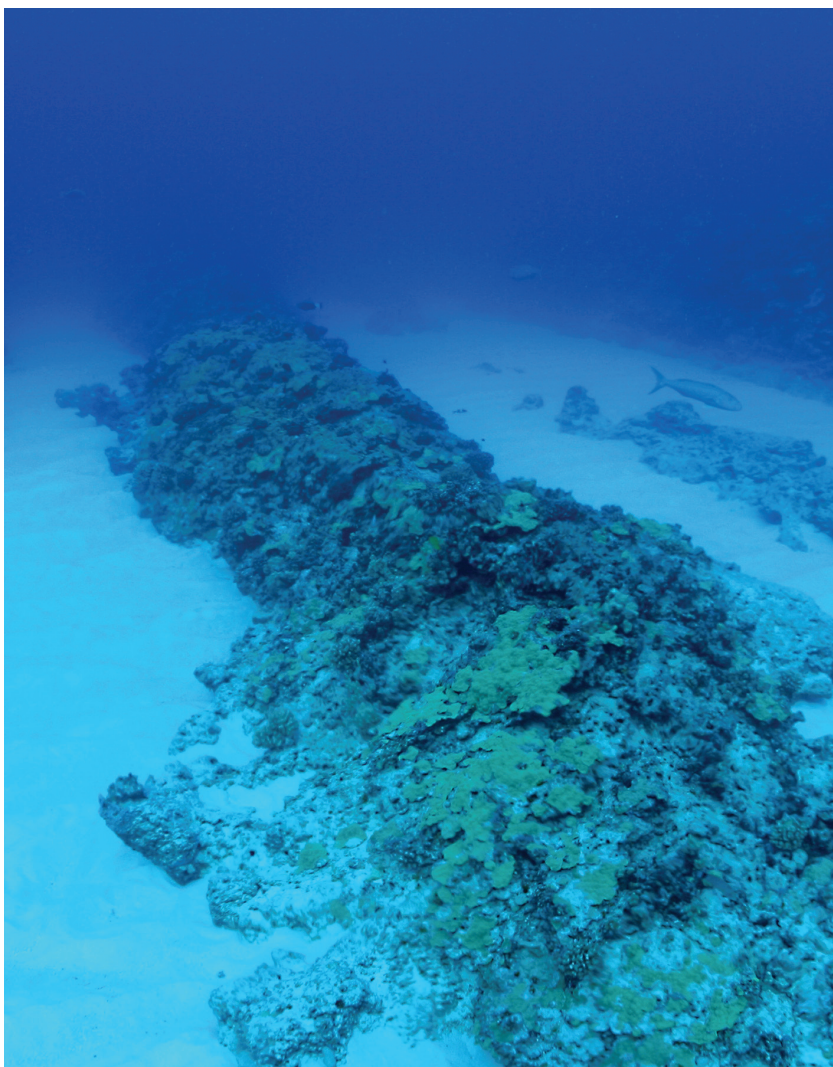
Introduction

Eocene: 55 to 34 million years ago

Lush tropical forests covered much of the world's landmasses during the Eocene and oceans were warmer than today. The Florida Platform was probably similar to the Bahama Banks today. Florida was under water as a region of shallow marine habitats, warmed by a tropical sun, and filled with a diverse array of marine life. This pristine carbonate bank was isolated from land by deeper water, even to the north.

The coastlines of southeastern North America were patrolled by large predators, including sharks, crocodilians, and primitive toothed whales called archaeocetes, while four-legged, primitive sea cows (ancestors of modern manatees) waded and swam in the shallows. Tropical ocean currents and the Tethys Sea provided throughways for the dispersal of sea creatures and plants from far and wide.

Fossils from the Eocene are not common in Florida, but the remains of archaic toothed whales, early sea cows, giant sea snakes, sea turtles, and various fish, such as sawfish, sharks, and rays, have been collected. In fact, shark and stingray teeth are common finds in Gainesville creek beds. Hundreds of vertebrate species must have lived in this shallow marine setting and many exciting finds await discovery.



Ancient Florida was covered by a warm, shallow sea; similar to the Bahama Banks today.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Two: Florida Under Water *continued*

20

Vocabulary Words

Archaeocetes: Ancient whales.

Biota: The plant and animal life of a region.

Extant: A term used to describe a species that is still living today.

Herbivore: An animal that only eats plants.

Sirenian: A taxonomic order of fully aquatic, herbivorous mammals that inhabit rivers, estuaries, coastal marine waters, swamps, and marine wetlands. Examples include the manatee and dugong.

Proboscidian: A term used to refer to the mammals of the order Proboscidea. They are characterized by a flexible trunk formed of the nostrils and upper lip, large tusks, a massive body, and columnar legs. The elephant and extinct mammoth and mastodon are members of this category.

Tetrapod: A term used to describe animals that walk on four legs or feet.

Cetacean: Mammals that are adapted to aquatic life with flippers as forelimbs.

Mesonychid: An extinct order of medium to large-sized carnivorous mammals that were closely related to even-toed ungulates, dolphins, and whales.

Ungulate: Several groups of mammals that walk on the hoofed tips of their toes.

Artiodactyl: a hoofed, even-toed mammal of the order Artiodactyla, comprising the pigs, hippopotamuses, camels, deer, giraffes, pronghorns, sheep, goats, antelope, and cattle.

Pectoral: Located on the chest.

Rostrum: A beak-like extension.

Vestigial: Something that remains after nearly all the rest has disappeared. The remains have become functionless over the course of time.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Two: Florida Under Water *continued*

21

Guiding Questions and Answers

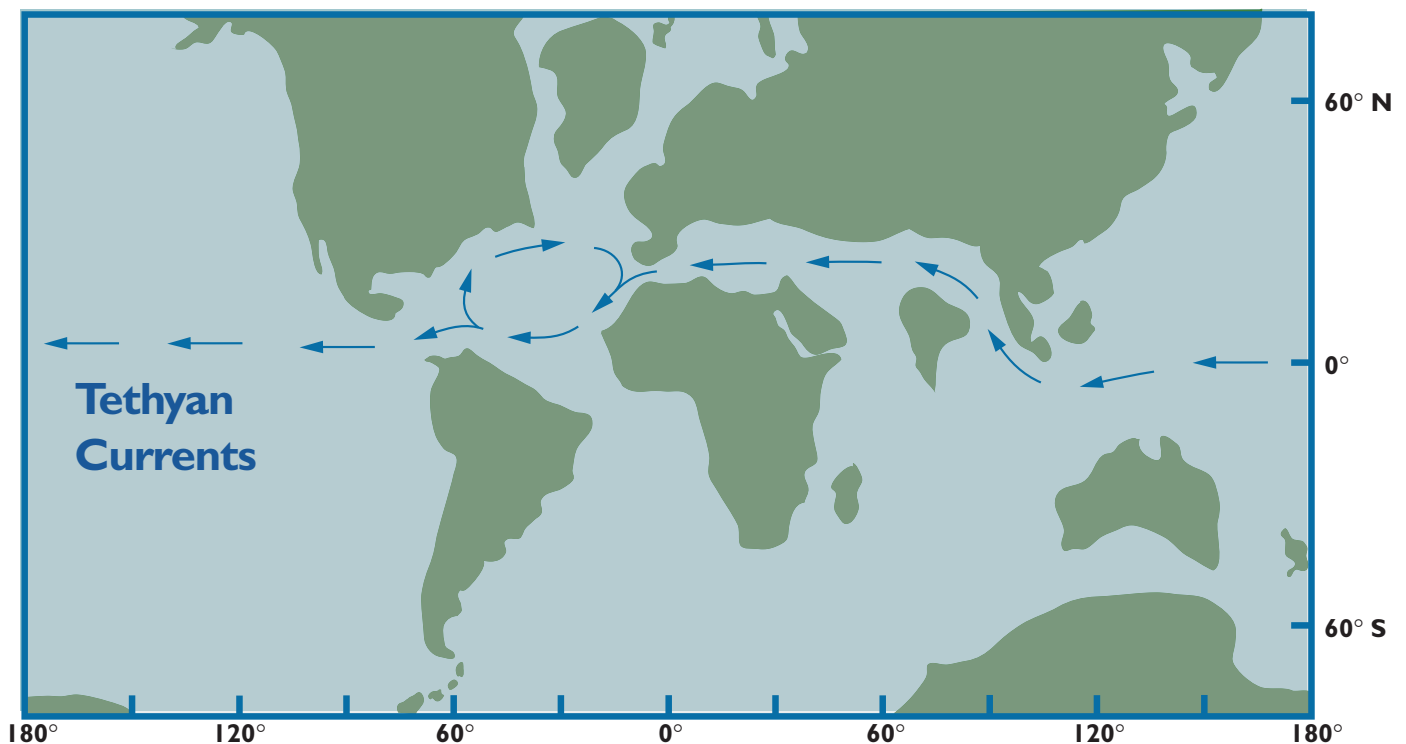
1) What is the Tethys Sea? When did it exist? Why is it important?

The Tethys Sea was an ancient waterway encircling the globe between the northern and southern continents. During the Eocene, the Tethys extended from the western Pacific Ocean, through the Arabian and Mediterranean seas, and across the Atlantic Ocean. Since North and South America were not yet connected, Tethyan currents passed between the two continents before entering the eastern Pacific Ocean.

The westerly Tethyan currents promoted dispersal of marine plants and animals to and from distant shallow-water environments. Similar biotas are known from Eocene sediments in the Caribbean Basin, western and southern Europe, Egypt, Pakistan, and other widely separated sites.

Tethyan currents influenced ancient Florida during much of the Eocene. Several modern groups of mammals, including sirenians and proboscideans (elephants and their relatives), originated in or near the Tethys Sea and are called “tethytheres,” (theres–beasts). Both these groups have continuous tooth replacement during an individual’s lifetime, suggesting a close relationship and origin from a common ancestor.

Over millions of years, wandering continents closed the Tethys. Remnants of this once great seaway exist today as the Mediterranean, Black, and Caspian seas. The disappearance of the Tethys Sea affected marine communities throughout the world. Animal groups became extinct, while others rose to replace them. Some Tethyan groups, however, survived and still exist today.



PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Two: *Florida Under Water* continued

22

2) What animals lived during the Eocene?

Echinoids (class Echinoidea)

At least 40 species of sea urchins, sea biscuits, and sand dollars are known from Florida's Eocene sediments. A wide range in size and shape indicates different life habits. Echinoids belong to the phylum Echinodermata, meaning spiny skin, which also includes feather stars, sea lilies, sea stars, brittle stars, and sea cucumbers. These creatures first appear in the fossil record ~450 million years ago during the late Ordovician Period.

Marine Vertebrates

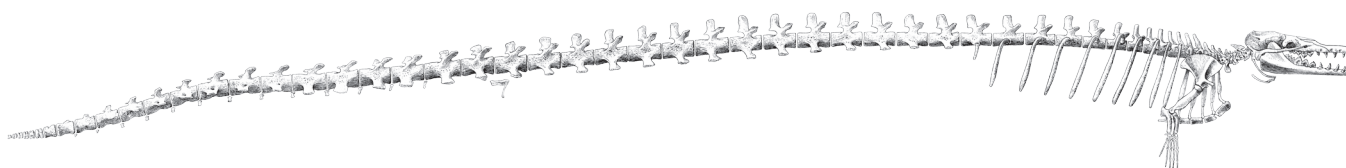
Marine vertebrate fossils are uncommon in Eocene sediments of Florida, but include fishes such as the porcupine fish, sea bass, barracuda, sharks, and sawfish. Crocodilians and early sea cows are also present in the Eocene record, but are poorly known and understood.

During the Eocene, sharks and primitive whales ruled the seas. Some of these animals may have lived at moderate depths, but their fossils were found in shallow water sediments. How? Bodies of dead marine animals are commonly transported into shallow water by ocean currents.

Florida's Eocene sediments preserve three species of primitive toothed whales, or archaeocetes. Their large size (up to 65 feet) and serrated teeth clearly place them in the top predator category. Their more common occurrence in the Eocene of Alabama, Georgia and South Carolina (where the approximate shoreline was at that time) may indicate that these whales kept relatively close to shore.

Marine mammals have a terrestrial, four-legged (tetrapod) ancestor. Evidence for this comes from the presence of small "hind limbs" attached to the pelvic bone of marine mammals. These hind limbs are no longer functional, but tell a story of adaptation to a new environment. Also, paleontologists originally believed that cetaceans (extant whales, dolphins and porpoises) were closely related to mesonychids, an extinct group of land-dwelling carnivores because of a similarity in their teeth.

Some paleontologists now think that whales are closely related to even-toed ungulates like the modern hippopotamus. This is based on molecular evidence, as well as the similarity between the unique anklebone of primitive archaeocetes, and those seen in all artiodactyls (hippopotamus, pigs, camels, etc).



Basilosaurus cetoides

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Two: *Florida Under Water* continued

23

Cartilaginous Fish

Cartilaginous fishes, including rays, skates, and sharks, are among the oldest vertebrates. Their fossil record spans 400 million years. These fish have skeletons composed mostly of cartilage, like your nose and ears. Cartilage does not usually fossilize, so only teeth, stingray barbs (tail spines), and the calcified discs of the backbone are found.

Shark teeth are durable and commonly found as fossils. They are also abundant because sharks continually replace their teeth. An individual may have up to 3,000 teeth over its lifetime.

Eagle and bat rays (family Myliobatidae), first appear in Florida in 55-million-year-old limestone and still live along the coast today. They have plate-like, crushing teeth and long, whip-like tails with one or multiple spines. Their large pectoral fins allow them to gracefully “fly” through the water. These warm water fishes are usually found near shore where they feed on mollusks and other invertebrates. Their durable dental plates and tail spines are abundant as fossils.

Sawfishes (family Pristidae), inhabited Eocene seas 55 million years ago. Sawfish appear shark-like, but are actually more closely related to rays. Living sawfish can be more than 18 feet long. Some extinct species were even larger. Today they inhabit warm, shallow seas and tropical estuaries. The sawfish rostrum is a flat blade armed with ever-growing “teeth.” This structure has receptors that sense electro-magnetic fields of burrowing shrimp and crabs, and acts as a rake to expose them. These receptors also detect fish that are then killed with rapid slashing movements of the rostrum.



Bat ray



Shark teeth



Sawfish

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Two: Florida Under Water *continued*

24

Turtles and Tortoises

The order Testudines (turtles and tortoises) is a highly successful group of reptiles with origins dating back 200 million years during the early “Age of Dinosaurs” (Mesozoic). They are common as fossils because of their durable bony shell and other skeletal elements that preserve well. Today turtles and tortoises live in terrestrial, freshwater, and marine habitats. Sea turtles represent an invasion of the sea from a freshwater or terrestrial ancestor.

Eosphargis is the earliest sea turtle known from Florida, although its fossils are rare and fragmentary. Sea turtles have a fossil record that extends back into the Cretaceous, about 75 million years ago. Some sea turtles were gigantic, such as the North American Archelon that was 13 feet in length in comparison to modern leatherback sea turtles that grow to about 8 feet in length.

Living sea turtles are found throughout the world in tropical to arctic waters. All are officially protected by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Snakes

Snakes are first recognizable as fossils about 100 million years ago (Cretaceous) during the “Age of Dinosaurs.” Snakes probably arose from early ancestors of monitor lizards. Snakes are distinctive due to the lack of functional limbs, greatly increased number of vertebrae, and remarkable lower jaw flexibility. Some modern pythons, however, have vestigial hind limbs as spurs used during mating and combat. Ninety-five-million-year-old Middle Eastern snake fossils also have small hind limbs.

The giant snake *Pterosphenus* was completely aquatic during the Eocene. *Pterosphenus* fossils are only found in sediments deposited in marine environments. The shape of its vertebrae also suggests that it was adapted to aquatic life. *Pterosphenus* was probably unable to move between terrestrial and marine environments.



Green Turtle



Different kinds of snakes from egg eaters to vipers

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



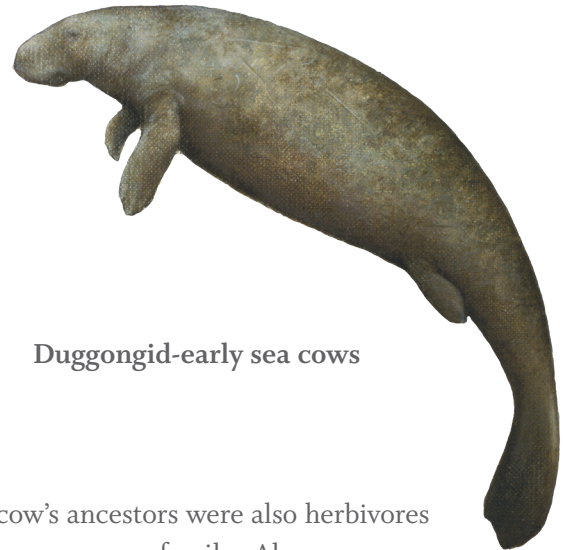
Florida Museum of Natural History

Section Two: Florida Under Water *continued*

25

Sea Cow

The order Sirenia (sea cows) includes the manatees and dugongs. Paleontologists do not know in which extinct family the mid-Eocene dugonid belongs because so few fossils have been found. Modern dugongs replaced these early sea cows ecologically about 15 million years ago (Miocene). Manatees appear in the fossil record about 2 million years ago (Pliocene). Small hind limbs are visible on early sea cows but not on modern sea cows, suggesting evolution from a terrestrial habitat to a marine environment. Also, many modern manatees have elephant-like toenails, and vestigial pelvic bones. Insert image of manatee nails vs. elephant nails



Duggongid-early sea cows

Modern sea cows graze on sea grasses. It is believed that the sea cow's ancestors were also herbivores because dugongid fossils have been collected from the same rocks as sea grass fossils. Also, sea grasses have a unique carbon component. This distinctive carbon signature is incorporated into the tooth enamel of mammals that feed on these sea grasses. Through chemical analyses of dugongid teeth, UF paleontologists confirmed that early sea cows fed on sea grasses 44 million years ago.

3) What plants existed during the Eocene?

Few plant fossils are known from Eocene sediments of Florida. Since a shallow sea covered the carbonate bank that now underlies Florida's peninsula, Eocene plant life was restricted to sea grasses. Nevertheless, other plant fossils of seed and wood have been discovered in Florida's Eocene limestone. The existence of the plant fossils in marine sediments suggests that land may have been nearby.

Sea grass beds act as nurseries for many marine invertebrates and fish. Dense stands of sea grass protect young from predators, serve as egg deposition sites, and provide many types of food. Florida's sea grass fossils contain the remains of juvenile marine invertebrates, indicating that sea grass habitats have provided safe haven for young marine organisms for at least 38 million years.



Seagrass

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Two: Florida Under Water *continued*

26

Pre Activity

Classification: Students will understand how scientists classify objects and specimens by creating their own system of classification.

Materials:

- A variety of objects for each group such as buttons, writing utensils, and wrapped candy
- Paper
- Pencil

Actions:

- Divide the class into groups of 2-3 students.
- Give each group a bag full of objects. Ask them to divide the objects by the type of object that they are (buttons, writing utensils, candy). These large groups represent Kingdoms in the classification system since they are very general.
- Ask students to divide their groups further. For example, by type of candy, button color etc. Allow students to choose their divisions on their own.
- Can students divide these new groups even further? For example color of candy within the type of candy. Or size of button within button color. Once again, allow students to choose their divisions on their own.
- Students should divide their groups of objects as far as they can. Did all the groups end up with the same divisions? How did students choose how to divide their objects?
- Discuss how the divisions and groupings they created are like the classification system. They started with general groupings with a wide variety and kept separating and dividing to more specific groups. If they were given a new object, how would they figure out what group it belongs in?
- Give each student a piece of paper and a pencil. Ask them to draw a dichotomous key to help guide an outsider to identify their object. For example:

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Two: Florida Under Water *continued*

27

Is the object made of wood?

yes

The object is a pencil

yes

Can you write with the object?

Is the object made of wax?

no

Are there holes in your object?

no

The object is a button

yes

Field Trip Activity

- Discuss with students the vestigial leg on the ancient sea cow, and the giant sea snake.
- Ask them to explain how the legs likely became reduced over generations.

Post Activity

Jell-O Strata: Students will understand how different strata are deposited and how paleontologists know relative dates of fossils based on the strata in which they are discovered.

Materials:

- 4 different colors of instant Jell-O
- Large clear bowl or Tupperware
- 4 different kinds of sprinkles, fruit pieces etc.
- Large bowl
- Mixing spoon
- Refrigerator
- Bowls
- Spoons

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Two: *Florida Under Water* continued

28

Actions:

- Mix up one color of Jell-O. Add one kind of sprinkles or fruit pieces. Allow the Jell-O to set and cool.
- Repeat the process 3 more times, pouring each additional color on top of the previous.
- Look at the different layers with students. Explain that when paleontologists dig into the ground, they see layers of rock like the different colors of Jell-O. These layers, called strata, represent different time periods.
- Ask students if the top layer or the bottom layer is older? How do we know? If they struggle with answering this, lead them with questions about which color Jell-O did you pour first? What day/time did you do that? What day/time did you pour that top color? Which day/time is further in the past? Something that happened further in the past means that it is older.
- Ask students what they think it means for the fossils (sprinkles and fruit) inside the strata. Are the fossils in the bottom layer older or younger than the fossils in the top layer? How do we know?
- Divide the Jell-O up and allow students to have a tasty snack.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment

29

Introduction

Oligocene: 34 to 24 million years ago

Global climates became cooler during the Oligocene. Colder temperature world-wide caused more water to be stored in the polar ice caps causing sea levels to drop. The northern portion of the Florida platform, once abundant with tropical, marine habitats was exposed above sea level and became a small area of land.

The earliest Florida Oligocene terrestrial fossils (~30 million years old) were found near Gainesville during construction of Interstate 75. Early immigrants to the Florida peninsula included amphibians, reptiles, bats, shrews, and rabbits. Also, predators tracked dwarf horses and the strange, hoofed mammals, oreodonts and chalicotheres, onto this new land. In the ocean, huge sharks plied the depths, while several kinds of sea cows were abundant near shore. Marine invertebrate communities consisted of more modern groups.

Miocene: 24 to 5 million years ago

Great changes took place during the Miocene Epoch. Colliding continental plates and rising mountain ranges altered global climatic conditions, especially rainfall patterns. Drier conditions affected vegetation types and many dense, wet forests were lost. Grasses, once a small plant group, began to flourish.

Life on land was becoming increasingly more abundant. The spread of grassland savannas with mixed woodlands offered a wide range of plant foods for grazing and browsing mammals. Florida had giant tortoises, giant sloths, elephant-like proboscideans, tapirs, camels, horses, rhinos, and predators like bear-dogs and saber-toothed false cats. The Miocene savanna provided the setting for different survival strategies to evolve.

Pliocene: 5 to 2 million years ago

The Pliocene witnessed wildly fluctuating climatic extremes resulting in higher (transgressions) and lower (regressions) sea levels. These shifts greatly altered coastline geography of eastern North America, as well as much of the rest of the world. Coastal lowlands were flooded with sea water during high sea level stands (warmer temperatures), while vast tracts of the sea floor were exposed during periods of low sea level (cooler temperatures).

The formation of a land bridge across Panama in Central America about three million years ago was a major biotic event. Both North and South America had been previously isolated for millions of years. Each had evolved its own unique flora and fauna.

Contact between North and South America allowed for the overland dispersal of organisms between the two continents. Mammals living in North America invaded South America. South American mammals moved north. The closure of the seaway between North and South America apparently resulted in extinctions of many marine organisms. However, newly formed habitats also promoted the evolution of many new species as well.

Fun Fact: Fossilized Oligocene coral has been named as the official rock of the State of Florida.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

30

Vocabulary Words

Carapace: A bony shell covering part or the entire back of an animal.

Carnivore: An animal that only eats meat.

Chalicotheres: Any of various extinct ungulate mammals of the Eocene to Pleistocene epochs, having distinctive three-clawed, three-toed feet.

Convergent evolution: The appearance of similar characteristics in organisms that evolved from different ancestors.

Cormorants: A group of diving birds with characteristics such as dark plumage, webbed feet, a slender hooked bill, and a pouch that can stretch and expand.

Dead-fall trap: A way of capturing animals that involves the collapse of the land they are standing on to the point that the animals cannot climb out and eventually expire due to starvation.

Dermal: A term used to describe things that relate to the skin.

Dinoflagellate: Any species of single-celled marine plankton from the order dinoflagellata with two flagella. They are one of the most common plankton organisms. They have both plant and animal characteristics. Some species are responsible for “red tide.”

Estuary: An ecosystem that occurs where rivers empty in to sea or ocean.

Karst: An area of limestone characterized by sinkholes, ravines, and underground streams.

Oreodonts: Sheep-like animals that lived during the Eocene and Miocene epochs.

Proboscis: Any of various elongated feeding, defensive, or sensory organs of the oral region, as seen in elephants or tapirs.

Red Tide: A brownish-red discoloration of marine waters caused by the presence of enormous numbers of certain microscopic flagellates, especially dinoflagellates. Flagellates produce a potent neurotoxin that accumulates in the tissues of shellfish, making them poisonous when eaten by humans and other animals.

Regression: The act of going back to a previous state.

Topography: The features of an area of land, including mountains, valleys, lakes, rivers, streams, etc.

Transgression: Relative rise in sea level resulting in deposition of marine strata over terrestrial strata.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

31

Guiding Questions and Answers

1. What is a karst? What does it mean for Florida's ancient animal life?

The German word karst refers to landscapes formed of eroded limestone with sinkholes, disappearing rivers, underground streams, and caverns. Karst regions occur in many parts of the world, including Florida.

When sea levels retreated millions of years ago, large portions of limestone in northern Florida were exposed. Limestone is a porous rock, easily dissolved or eroded when exposed to rainfall. Limestone dissolves as weak acids in rainwater slowly percolate through tiny cracks and crevices, creating larger and larger passageways. This process ultimately weakens the structural integrity of our limestone platform.

The never-ending passage of water eventually forms fissures and caverns in the porous limestone. When cavern ceilings are weakened to the point of collapse, sinkholes form at the surface.

Florida's rich fossil record reveals that rugged karst topography proved deadly to now extinct animals. Hidden cracks and sinkholes in forests and grasslands acted as dead-fall traps for animals on the surface.

Sinkholes often served as watering holes and homes for many species. Land mammals such as sloths, rhinos, and horses fell while visiting these dangerous, rocky places. Others became trapped in muck and mud.



As caverns in the limestone expand over time, their ceilings may collapse, forming sinkholes. Image: U.S. Geological Survey

Terrestrial Environment

2) What terrestrial animals moved into Florida during the Oligocene?

Florida's earliest immigrants were frogs, tortoises, snakes, lizards, shrews, bear-dogs, peccaries, horses, and others. Many mammals made debuts in Florida during the Oligocene. Fossil bats are well known and indicate that in Florida bat diversity was higher than today. Primitive camels and oreodonts also arrived in the early Oligocene. The tiny three-toed horse, *Archaeohippus*, made its first appearance in Florida during the late Oligocene, as did the peccary, *Cynorca*, our first rabbit, *Palaeolagus*, and opossums.

Dwarf camels (*Genticamelus*), mouse deer (*Nanotragulus*), false cats, hedgehogs, and a large, pig-like entelodont also made their first appearances during the transitional period between the Oligocene and Miocene.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

32

The first fossil record of terrestrial invertebrates in Florida occurs during the latest Oligocene. Fossils indicate that land snails were widespread in Florida by about 24 million years ago (Oligocene/Miocene boundary). These rare fossils were deposited in shallow water marine sediments via run-off from freshwater and estuarine waterways.

3) What is Thomas Farm? Why is it an important paleontological site?

Thomas Farm, located 50 miles northwest of Gainesville, is one of the richest deposits of Miocene fossils in eastern North America.

Approximately 250 feet in diameter and more than 100 feet deep, the Thomas Farm deposit is believed to be an ancient sinkhole. The arrangement of fossilized bones suggests that the slopes of the sinkhole were very steep and that the animals either accidentally fell in or were unable to climb out after descending in search of water.

Since its discovery in 1931 by state geologist Clarence Simpson, more than 50 species and thousands of individuals have been identified. Thomas Farm has been excavated by paleontologists from Harvard University and the University of Florida.

Extant (living today) relatives of some of the fossil frogs and lizards found at Thomas Farm occur only in tropical settings today. This suggests that the climate 18 million years ago in North Central Florida was probably warmer than it is now.



Thomas Farm dig site

The presence of birds, small rodents, rhinos, horses, camels, peccaries, dogs, bears, and bear-dogs suggest that the sinkhole pond was a popular watering hole for many terrestrial animals. The great number of fossil bats recovered also indicates the presence of caves. The remains of aquatic animals, such as turtles, alligators, and fish, are relatively uncommon at Thomas Farm and are restricted to discrete layers. This distribution suggests that a pond inside the sink hole periodically dried up.

Alligators are some of the more recent members of the group called Crocodylia, which also includes crocodiles, caimans, the gavial, and extinct species. This lineage extends back to the beginning of the “Age of Dinosaurs,” more than 215 million years ago. Like the alligators, these other crocodylians have changed little in their evolutionary history.

The earliest fossil crocodylians in Florida (45 million years ago, middle Eocene) are fragmentary and poorly known. The first true crocodile in Florida, *Gavialosuchus americanus*, dates from at least 14 million years ago (Miocene). The American crocodile, *Crocodylus acutus*, occurs today in extreme southern Florida and the Caribbean Basin.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

33

Thomas Farm is one of the earliest known sites that record the arrival of Alligators in North America from South America 20 million years ago. Eighteen-million-year-old Alligator olseni is a member of the same genus as the species living in Florida today (Alligator mississippiensis). This close relationship indicates that alligators have not changed much since their appearance in Florida during the Miocene.

4) What terrestrial animals lived during the Oligocene?

Oreodonts

Oreodonts were small- to medium-sized, pig-like, hoofed mammals, with long tails and stout jaws that fed mostly on leafy vegetation. Native to North America, they were a diverse group, with over 50 species recognized. Oreodont fossils are extremely common from 50- to 20-million-year-old (late Eocene to early Miocene) sediments in the central United States, but are very rare in Florida. By the late Miocene, about 8 million years ago, oreodonts had become extinct.

Even-toed hoofed mammals

The two major living groups of hoofed mammals are the Artiodactyla and Perissodactyla. Artiodactyls include pigs, hippos, camels, giraffes, deer, antelope, bison, sheep, cows, and extinct groups like oreodonts. In the artiodactyl foot, two digits (toes) are generally larger than the others and bear most of the weight. Two, or rarely three, smaller side toes may be present.

What terrestrial animals lived during the Pliocene?

Turtles

The Pliocene freshwater turtle fauna of Florida was very similar to that of today. The flat-edged slider and snapping turtle lived in rivers, lakes, and ponds. The Florida soft shelled, *Apalone ferox*, is still common throughout much of the state.

Glyptodonts

Glyptodonts have carapaces (shells) composed of thick, fused dermal plates with no movable sections. Armadillos are similar in appearance, but have a carapace with flexible sections or bands. The hexagonal dermal plates of glyptodonts are commonly fossilized.

Glyptodonts (Family Glyptodontidae) were one of the groups of animals that dispersed from South America across the Isthmus of Panama and into North America as part of the Great American Interchange 2.5 million years ago. They became extinct about 10,000 years ago.

Glyptodonts were probably slow, shuffling creatures considering their heavily armored carapace, large size, and estimated weight of more than a ton. The armored carapace may have evolved to provide protection from predators or thorny plants in the arid regions of South America. Glyptodonts must have presented quite a challenge to carnivores looking for an easy meal.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

34

Sloths

Eremotherium eomigrans (Family Megatheriidae) is the largest ground sloth to disperse from South America into North America during the Great American Interchange. It stood 4.5 meters (15 feet) tall. Males are estimated to have weighed more than three tons (females were smaller). These plodding giants were surpassed in size in ancient Florida only by the mammoth and mastodon.

In life, the claw (ungual phalanx) consisted of bone covered with a nail-like substance. Tracks on the surface were for blood vessels. Like modern tree sloths, extinct ground sloths used their claws for food gathering (tree leaves) and protection against predators.



Eremotherium- giant sloth

Tapirs

Tapirs (family Tapiridae) are odd-toed ungulates (hoofed mammals) related to horses and rhinos. Tapir-like mammals first appear in the fossil record 55 million years ago in North America. The genus *Tapirus* became extinct on this continent at the end of the Ice Age 10,000 years ago.

Tapirs have a proboscis—a short, fleshy structure between the muzzle and eyes. It functions as the tapir's nose, but also is used for food gathering, much like an elephant's trunk. The distinctive indentation on the front of the skull indicates that extinct tapirs also had a proboscis. Insert image of tapir skull with arrow to the indentation



Tapiridae- tapir

Tapir evolution has been relatively conservative, meaning they have changed only a little through time. The skeletons and teeth of extinct tapirs are very similar to those of living species.

Terror Birds

Titanis walleri was one of the largest and perhaps the last member of the terror birds (family Phorusrhacidae). This extinct lineage of large, flightless, carnivorous birds is known mostly from South American sites dating back 60 million years ago. Its large beak and powerful feet armed with sharp talons indicate a powerful predator.

Titanis appears in the North American fossil record along the Gulf Coast at only a few late Pliocene localities. *Titanis* dispersed to North America during the Great American Interchange and became extinct shortly thereafter.

Although *Titanis* was an extremely large bird, very few fossil remains have been found. Despite the lack of *Titanis* fossils, there are enough fragments for comparison with more complete skeletons of other terror birds.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

35

UF paleontologists used scaling (a method that estimates the size of extinct animals) to reconstruct *Titanis* as ~6.5 to 10 feet tall, sporting a ~2.5 feet long skull.

Although fossil remains of other terror birds are known in South America, the evolutionary relationships of terror birds remain unclear. Their skeletons share distinctive characteristics that separate them from most birds. The only birds that have this same suite of characteristics are South American seriemas. Not much is known about seriemas or their relationships to other birds. Two living species inhabit open grasslands, a habitat much like that of Florida during the late Pliocene when existed here.

5) What did dryer conditions during the Miocene mean for animals?

Dryer conditions meant that long-distance travel was necessary between water sources. Seasonal migration for food may have become more essential. Since these mammals were walking further distances, they evolved long limbs, resulting in longer strides with increased efficiency. (Fewer steps to cover a distance results in fewer calories needed.)

6) What terrestrial animals lived during the Miocene?

The Miocene was a period of high land-mammal diversity. Grasslands, intermixed with different forest types, offered varied habitats in which animals lived. Florida was much like modern African savannas, with many kinds of herbivores all under the watchful eyes of predators.

Bear-dogs

The Amphicyonidae was a separate family related to both bears and dogs. Amphicyonids have unique features in the ear regions of the skull and very distinctive molar teeth that clearly separate them from dogs and bears. An evolutionary “dead-end,” bear-dogs became extinct 10 million years ago.

Horses

The horse family (Equidae) includes modern horses, their wild relatives (zebras, asses, and onagers), and more than 150 extinct species. Horses have existed for over 55 million years. Some species were tiny, while others were larger than modern wild horses.



Bear-dog

All horses, both living and extinct, share these defining features: a unique skull anatomy, distinctive enamel patterns on the teeth, and either three toes or one large toe, as in modern equus.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

36

Rhinos

Rhinoceroses (family Rhinocerotidae) originated in North America 55 to 50 million years ago. The oldest rhino fossils in Florida are from 24 million years ago (early Miocene). The Miocene wildlife in North America has been compared to that of the modern African savanna.

Rhinos were common in Florida for millions of years until their extinction throughout North America 5 million years ago. Along with other mammal groups, rhinos dispersed to the Old World across the Bering Land Bridge that is exposed between Siberia and Alaska during times of lower sea levels. Rhinos lived in Europe until 10,000 years ago and are often depicted in Ice Age cave paintings.

Sloths

Ground sloths originated in South America and dispersed into North America about 8 million years ago. At that time, however, the land bridge between North and South America had not yet fully developed. So how did these lumbering animals reach North America? Modern sloths are excellent swimmers and some fossil evidence suggests that extinct sloths were “island hoppers.” Giant sloths probably swam or rafted on floating vegetation between islands that existed between South and Central America before a land bridge at the Isthmus of Panama was complete. Once in Central America, the sloths dispersed northward.

Turtles

Tortoises (family Testudinidae) are principally adapted to life on land. Tortoises were one of the early arrivals to Florida after land was formed (about 30 million years ago). Since then, many tortoise species have lived in Florida. Studies indicate that all North American tortoises, both living and fossil, arose from the same ancestors. Therefore, extinct giant tortoises are related to the modern Florida gopher tortoise.

Cats

Barbourofelis (family Nimravidae) is considered a “false cat.” The nimravids are separated from “true cats” (family Felidae) by structural differences in the ear region of the skull. “True cats” include the extinct saber-toothed Smilodon, lions, tigers, and house cats. Fossil nimravids are known from Eurasia and North America. Ancestors of Barbourofelis originated in Eurasia and dispersed to North America across the Bering Land Bridge (between Siberia and Alaska) about 15 million years ago. Nimravids became extinct about 6 million years ago and represent an evolutionary “dead-end.”

Saber-like canine teeth evolved independently several times in mammals. The “true cat” Smilodon of the North American Ice Age had similarly shaped canines to those of Barbourofelis. Insert image of Smilodon. Even some marsupials, members of the diverse group including opossums, kangaroos, and cuddly koala bears, had long, dagger-shaped teeth. The marsupial Thylacosmilus of the South American Miocene and Pliocene had saber-like, slicing teeth similar to Barbourofelis. This is an example of convergent evolution.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

37

Marine Environment

7) What marine animals lived during the Oligocene?

Florida's Oligocene deposits have not been thoroughly examined. The marine vertebrates inhabiting Florida 34 to 24 million years ago (Oligocene) were undoubtedly more diverse than scientific literature indicates. However, paleontologists have documented sea turtles, sharks, including the 30 to 40 feet long Oligocene megatooth shark, *Carcharodon angustidens*, stingrays, and assorted smaller fish from the Oligocene Epoch.

Sea Cows

Fossil evidence indicates that sirenians (sea cows) have lived almost continuously in Florida for about 45 million years. The rich, yet incompletely studied, fossil record of sea cows in Florida and the Caribbean Basin fascinate paleontologists. Derived from four-legged land mammals, their fossilized remains clearly bear the marks of evolution at work, from the loss of functional rear limbs to changes in their teeth through time.

The primitive sea cow families, Protosirenidae and Prorastomidae, had disappeared by the Oligocene (34 to 24 million years ago) and were replaced by more modern, dugong-like species. Sirenian diversity was high in Florida during the Oligocene and Miocene, particularly during the late Oligocene when three genera coexisted in shallow water habitats.

Megatoothed sharks

With large bodies and huge triangular teeth, megatoothed (mega = giant) sharks were the supreme predators of their time. Early megatoothed sharks like *Otodus obliquus* (50 to 45 million years ago) and *Carcharodon auriculatus* (40 million years ago) were 3 to 6 meters (~10 to 20 feet) long.

Carcharodon angustidens appeared 35 million years ago (Oligocene) with teeth 12 cm (5 inches) long and a body up to 12 meters (~40 feet) long. The largest megatoothed shark, *Carcharodon megalodon*, lived from 15 to 3 million years ago (Miocene and Pliocene). "Megalodon" had teeth up to 18 cm (7 inches) long and a body estimated to be 15 to 18 meters (~50 to 60 feet) long, making it one of the largest animals that ever lived.

Shark teeth are arranged in parallel rows. The front teeth are used to capture and slice prey. Several rows of replacement teeth grow behind the front teeth. When a front tooth is lost, another moves forward from the row behind. New teeth are developed along the inner margin of the shark's jaw. A shark may produce, use, and shed as many as 2,000 to 3,000 teeth each year. Over its lifetime, a shark sheds tens of thousands of teeth onto the sea floor explaining their abundance as fossils.



Megalodon jaw and teeth

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

38

8) What did the marine environment look like during the Miocene?

The Miocene marine fossil beds of northwestern Florida are known for high diversity and remarkable preservation. It is estimated that over 1000 marine invertebrate species occur in the Miocene sites of northwestern Florida. This great diversity indicates a complex array of shallow water marine habitats. Ecological settings were probably similar in appearance to South Florida today, consisting of reef systems, coral rubble, lagoons, sand and mud flats, and sea grass beds.

The Miocene was a time of changing climates, resulting in several high and low sea level stands. When fossils were deposited in the 18 million year old Chipola Formation, sea levels were higher than today. Dramatically cooler climates in the middle Miocene caused a local extinction of many tropical elements of the Chipola fauna while more temperate species prevailed.

9) What marine animals lived during the Miocene?

The varied fossil remains of Miocene aquatic vertebrates indicate that freshwater and shallow-water marine habitats were diverse. The Williams' slider turtle, *Pseudemys williamsi*, lived in rivers, lakes, and ponds like modern freshwater turtles.

The elongate skull of the crocodile, *Gavialosuchus americanus*, suggests that it ate fish, but with lengths of ~ 40 feet, it surely ate whatever it wanted. It probably lived near rivers along the coast.

The Florida fossil record of toothed whales (odontocetes) extends back about 15 million years. Common fossils are teeth, durable ear bones, vertebrae, and jaw and skull fragments. Extinct dolphins, sperm whales, and beaked whales all first appear in Florida about 15 million years ago. Modern dolphins first appear about 5 million years ago.

10) How do paleontologists know what an animal ate?

Paleontologists interpret the diet of extinct mammals from their tooth structure. Herbivores have flat teeth that are used primarily for chewing and mashing up their food. Herbivores are also broken into two types of animals. Browsers (animals that eat soft, leafy vegetation) tend to have short-crowned teeth, while grazers (grass eaters) have high-crowned teeth. Carnivores have sharp teeth used to bite and shred their food.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

39

11) What animals migrated once North and South America were connected?

Over the subsequent millennia animal and plant groups dispersed to new ground. Some went north, some went south. This is a list of larger mammalian groups that dispersed to North and South America during the Great American Interchange. In addition to mammals, many other groups of animals and plants also immigrated after the formation of a land bridge near present-day Panama. Some were early migrants, while others, like the opossum, *Didelphis*, were apparently late-comers (Pleistocene).

Some of these groups originated in North America, while others were derived from Eurasia originally as noted in parentheses. These Eurasian groups dispersed to North America first, then to South America. It is assumed here that South America's mammal groups originated on that continent because the land mass was isolated for many millions of years. However, their earliest origins may have been elsewhere.

South American mammals to North America	North American mammals to South America
Armadillos	Bears (Eurasia)
Capybaras	Camels (North America)
Glyptodonts	Cats (Eurasia)
Ground sloths	Deer (Eurasia)
Manatees	Dogs (North America)
Opossums	Gomphotheres (Eurasia)
Pampatheres	Horses (North America)
Porcupines	Otters (North America)
Vampire bats	Peccaries (North America)
	Racoons (North America)
	Tapirs (North America)

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

40

12) What paleontology sites are important for Pliocene information?

Florida has many important Pliocene fossil sites. Marine mammals and fish are well-represented in the extensive Pliocene sediments of Florida.

Haile 7C: an ancient sinkhole

Freshwater vertebrates (such as turtles, alligators, and ducks) from fossil site Haile 7C indicate that it was an ancient sinkhole pond. Tapirs, which prefer freshwater habitats, also were common. The ground sloths found there visited this waterhole and probably became trapped in the muddy sediments.

The Richardson Road death assemblage is an ideal paleontology site. Cormorants have a fossil record in Florida starting 5 million years ago (latest Miocene). The 2-million-year-old Richardson Road site yielded 137 partial skeletons of *Phalacrocorax filyawii*. This large number of well-preserved skeletons at a single site is very rare in the fossil record. Paleontologists determined that a single catastrophic event killed them. Analysis of the sediments surrounding the cormorant skeletons yielded numerous bones of small fish as well as microscopic fossil remains (dinocysts) of dinoflagellates known to produce toxic red tides. Along the Gulf Coast today, red tides still kill large numbers of fish and the birds that eat them.



Haile 7C dig site, *eremotherium* teeth from the Haile 7C site.

Pre Activity

Potato Contour Map: Rising sea levels reduces the amount of land visible above water.

Materials:

- Half of a potato (cut lengthwise) for each group of students (try to use oddly shaped potatoes)
- One plastic container with a clear lid (Rubbermaid, etc)
- One dry-erase marker and one permanent marker for each group
- Ruler for each group
- Blue (food color- dyed) water

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

41

Actions:

- Have students place their potato into the container, flat side down, and mark an arrow above it, indicating north.
- Ask students what they think would happen to Earth if it became warmer, and much of the ice at the north and south polar regions was to melt. Where would that water go? What would happen to sea level if that happened?
- Explain to them that this has happened before, and at one time Florida was underwater.
- Explain to students what a contour map is. It shows changes in topography, both on land and underwater. Show them an example.
- Using the ruler, have students mark several 1 cm increments on the side of the container with the permanent marker.
- Have them place the lid on the container, and draw a north arrow on the lid to coincide with the one in the container.
- Have students remove the lid and pour blue water in the tub until it reaches the 1 cm. mark.
- Have students replace the lid, and align the north arrow on the lid with the one in the tub. Instruct them to look down on the potato with one eye closed and trace the “shore line” of the potato with the dry-erase marker. Make sure they draw only what is visible above the water.
- Repeat the last two steps until there are several 1 cm increments representing sea level rise.
- Come together as a class for a discussion. What happened to the “shore line” as the water got higher?
- What would rising sea levels mean if the potato were actually Florida? Look at a topographic map of Florida. What elevation do we live at? What elevation are coastal cities such as Miami and Tampa at? Global warming is causing sea level to rise. What does this mean to Florida? What cities will be affected first?

Field Trip Activity

- Point out Florida on the various globes throughout the Fossil Hall. Is it underwater during certain epochs? When did Florida emerge?
- Ask students what they think the diet of the bear-dog was when it lived 18-10 million years ago. What do students think the terror bird ate?
- The West Indian manatee, *Trichechus manatus*, is found in the southeast United States and Caribbean Sea. It first appeared during the Pleistocene 1.5 million years ago, and is still in Florida today, although endangered. What puts this modern, gentle mammal at risk in today’s world? What mammal was the manatee related to that is now extinct? What is it that makes the manatee’s teeth different?

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Three: By Land or Sea: A Changing Environment *continued*

42

Post Activity

Sea Level Rise: Students will learn about the relationship between temperature and the state of water.

Materials:

- Electric hot plate
- Cake pan
- Heat-resistant 12 ounce glass
- Water
- Ice Cubes

Actions:

Part one: Demonstrate that water expands when heated. Correlate this principle with rising temperatures on Earth. What happens to the oceans when heat is trapped in Earth's atmosphere?

- Fill the glass with very cold water. Be sure that the glass is almost overflowing.
- Place the glass in the cake pan.
- Place the pan on the hot plate, with the glass on top.
- Turn the hot plate on to a low setting
- Observe what happens to the water. Does it expand?

Part two: Demonstrate that ice which is already in the oceans (icebergs) does not increase sea level as it melts, however glacial ice (ice on land) does.

- Place a couple of ice cubes in the glass and then fill it with cool water, almost overflowing.
- What happens to the water level as the ice melts? Does the glass overflow?
- After all of the ice has melted, place another piece of ice in the glass. This represents a glacier that is melting on land and falls into the ocean.
- What happens to the glacial ice?
- Why would there be a difference between glacial ice and an iceberg?

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Four: Terrestrial Florida

43

Introduction

Pleistocene: 2 million to 10,000 years ago

The climate during the North American Pleistocene alternated between cold (glacial) and warmer (interglacial) periods. During the coldest times, extensive glaciers extended as far south as Illinois with cooler temperatures reaching well into the Southeast. Although Florida may have been slightly cooler than today, it was buffered by the warm waters of the Gulf of Mexico.

There were never glaciers in Florida, but colder global temperatures affected its environments and inhabitants. Sea level was lowered by about 400 feet because more water was trapped in glaciers. Florida was over twice as large as it is today. This opened a broad corridor of land along the coast by which animals and plants dispersed in and out of Florida. Glaciers melted during warmer periods and sea levels rose, reducing Florida's landmass to about its present size.

Larger animals (megafauna) took a tumble during the late Pleistocene, but scientists are unsure why these extinctions occurred. Changing climates or disease may have caused their demise. Or perhaps the new predator in the region, *Homo sapiens*, hunted these marvelous animals to extinction. Humans dispersed into Florida about 14,000 years ago, near the end of the Pleistocene.

These earliest Native Americans are known as Paleoindians. Excavations by UF researchers at a site along the Aucilla River in Florida's Panhandle yielded stone tools such as spear points, implements carved from ivory and bone, and the fossilized remains of animals, testifying to their existence in Florida until about ten thousand years ago.

Vocabulary Words

Extinct: No longer in existence.

Glacier: An extended mass of ice.

Megafauna: In Florida, a series of extinct animals that were significantly larger than their extant relatives today.

Paleobotany: A branch of paleontology that deals with fossilized plants.

Pathogen: A disease producing agent such as a virus or bacteria.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Four: Terrestrial Florida *continued*

44

Guiding Questions and Answers

Marine Environment

1) What did Pleistocene marine environments look like?

Pleistocene marine habitats were similar to those of today. Many modern species make their first appearance during the early Pleistocene. Large marine animals, such as whales, manatees, and sea turtles did not suffer the mass extinctions near the close of the Pleistocene like their cousins on land.

2) What marine animals lived during the Pleistocene?

Pinnipeds

Seals and walruses (pinnipeds=fin-footed) are placed near bears in the order Carnivora. Known from Pleistocene deposits, the Caribbean monk seal (*Monachus tropicalis*) persisted into modern times. European colonizers and Caribbean residents hunted them to extinction by the mid-20th Century.

Manatees and dugongs

Dugongs were extinct in the Caribbean Basin by the end of the Pliocene, but two species continued into recent times in the Pacific Ocean. The modern dugong lives in dwindling numbers in the Indo-Pacific region. Steller's sea cow was hunted to extinction by the late 1700s.

The now endangered modern West Indian Manatee, *Trichechus manatus*, made its first appearance in the fossil record of Florida about 1.5 million years ago.

West Indian manatees occur in coastal marine and freshwater habitats in the Gulf of Mexico, West Indies, and northern South America. Two more species of *Trichechus* (Family Trichechidae) live in northeastern South America and western Africa. Early manatees from 10-million-year-old Miocene deposits in Colombia suggest that these sirenians evolved in the Caribbean Basin.

Manatees and proboscideans (elephants and their relatives) have an unusual way to replace cheek teeth. Their teeth erupt in the rear of the jaw and wear down as they move forward. Worn teeth are shed from the front. This adaptation insures that manatees have a continual supply of teeth to replace those worn down by their diet, which frequently consists of abrasive sea grass. This shared feature, along with others, leads paleontologists to assert that manatees and proboscideans share a common ancestry.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Four: Terrestrial Florida *continued*

45

3) Why do we find Pleistocene fossils? Where do we find Pleistocene fossils?

Most Pleistocene exposures occur from mining sand and shells for construction. Invertebrate fossils found in the Caloosahatchee Formation (~2 million years ago, Pliocene–Pleistocene boundary) comprise a tropical fauna of nearly 600 species. Slightly more temperate faunas preserved in the Bermont and Ft. Thompson formations indicate deposition during cooler periods.

The Miami, Key Largo, and Anastasia formations were most likely deposited during an interglacial period about 125,000 years ago.

The Anastasia Formation outcrops along Florida's east coast. Rock typically consists of cemented shell fragments, particularly of the coquina clam, *Donax variabilis*. Blocks of these fossils were used for construction of buildings and forts, such as Castillo de San Marcos in St. Augustine. Ghost crabs and sand dollars are often preserved in these sediments.

Pleistocene fossils are everywhere in Florida. They have been found throughout the state in sinkholes, caves, rivers, lakes, beaches, shell pits, limerock quarries, and backyards. Early UF paleontologists pioneered the use of SCUBA to collect Pleistocene fossils, particularly from northern Florida rivers and springs. Tens of thousands of specimens representing almost a thousand Pleistocene localities are housed in the museum's research collections. Collectively, they characterize a broad diversity of ancient habitats and extinct faunas.

Terrestrial Environment

4) What did the Pleistocene terrestrial environment look like?

Fossilized remains of a diverse host of aquatic plants and animals indicate that freshwater habitats were well developed and had been for many millennia. Animals inhabiting lakes, rivers, sinkhole ponds, springs and spring runs occur in Pleistocene sediments throughout the state. Large plant fossils are rare, but lake sediments often contain pollen from which scientists can reconstruct ancient habitats.

Fossil plants are rare in Florida so any paleobotanical evidence provides a valuable glimpse of ancient plant communities. The conifer cones, probably from pine trees and sabal palm seeds indicate that Florida's flora has not changed much since the Pleistocene. Studies of fossil pollen preserved in Florida lakes indicate that local plant communities fluctuated as climate changed. Warmer times tended to support more lowland pine forests whereas deciduous trees (e.g., oaks and hickory) were more common during colder periods.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Four: Terrestrial Florida *continued*

46

5) What terrestrial animals lived during the Pleistocene?

Giant rodents

Rodents (order Rodentia) are usually small mammals such as mice, rats, and pocket gophers. All rodents have enlarged, ever-growing incisor teeth adapted for gnawing. During the Pleistocene, a giant beaver lived in Florida. It lacked the flat tail of the modern beaver, but probably had webbed feet. *Castoroides* was about 8 feet and weighed up to 440 lbs.



Capybara, a semi-aquatic rodent

Birds

Bird fossils are somewhat rare, because the lightness and thinness of their bones are not conducive to fossilization, but some Pleistocene deposits in Florida have many. A single locality in central Florida produced over 10,000 fossil bird bones. A diverse fauna of freshwater birds is known from Florida's Pleistocene, including ospreys, herons, egrets, loons, anhingas, ducks, and many others.

Condors are first found in Florida 8 million years ago during the Miocene. Fossil Florida condors also include the California condor, which lived over much of North America. The California condor became extinct across most of the continent 10,000 years ago (late Pleistocene), probably because of a dwindling food supply resulting from the mass extinction of large mammals. The group is represented in South America today by the Andean condor (*Vultur gryphus*), the world's largest modern flying bird, with a wingspan of about 3.5 meters (~11.5 feet).



Condor

Snails and Clams

Most freshwater mollusk species, like the Florida apple snail, (*Pomacea paludosa*) persist in our area, although many habitats now have been adversely affected by human activity.

The washboard, *Megaloniais nervosa*, a large freshwater clam, lives today only in main channels of big rivers and their larger tributaries in northwestern Florida. Its presence as fossils at the one-million-year-old Leisey Shell Pit suggests that a large river existed in Hillsborough County during the early Pleistocene.



Megladonis, a freshwater clam

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Four: Terrestrial Florida *continued*

47

Scaled and scaleless critters

Almost all the freshwater fishes, reptiles, and amphibians known from Florida's Pleistocene still exist. Freshwater habitats were replete with sunfish, bass, garfish, catfish, snapping turtles, cooters, sliders, along with water snakes, frogs and salamanders. The top predator, Alligator mississippiensis, often exceeded 5 meters (~16 feet) in the Pleistocene.



Florida alligator

Llamas

The family Camelidae includes camels and llamas. Fossil evidence indicates that camelids originated in North America and became extinct on this continent 10,000 years ago.

Ancestral species entered South America via the land bridge formed by the Isthmus of Panama. The llama and its close relatives, (alpaca, guanaco, and vicuna) are now restricted to South America. They are mostly grazers adapted to a variety of habitats ranging from the high Andes to the low grasslands of Patagonia. The modern camels live in desert regions of Asia and northern Africa. Their ancestors first dispersed across the Bering Land Bridge from Alaska to Siberia during the Miocene.



Llama

Cats

True cats (family Felidae) first arrived in Florida about 22 million years ago. They became more diverse after the extinction of false cats (Family Nimravidae) about 9 million years ago.

Several groups of cats are known from Florida's Pleistocene, including Xenosmilus, Smilodon, and an American cheetah, Miracinonyx.

Lions, tigers, and jaguars are called "roaring cats." A giant form of the jaguar, Panthera onca, lived in Florida during the Pleistocene. It was up to 25% larger than the modern jaguar. Otherwise it is identical to the living form and is classified as the same species. After the Pleistocene, the jaguar's range was greatly reduced. Today, it is restricted to Mexico, Central and South America. Several other cats lived in Florida during the Pleistocene, including the saber cat, bobcat, ocelot, American cheetah, Florida panther, and American lion.



Xenosmilus

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Four: Terrestrial Florida *continued*

48

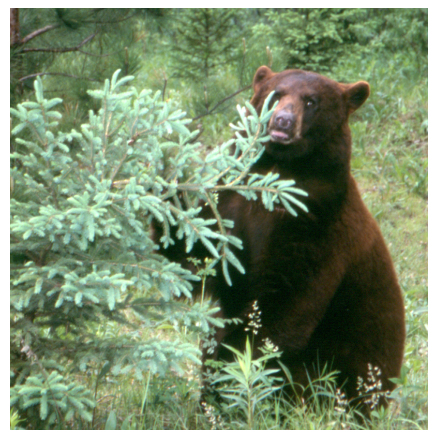
Bears

The family Ursidae includes the modern bears of North America and Eurasia, several south Asian species, the South American spectacled bear, and many extinct species.

The Ursidae is principally an Eurasian group that dispersed several times across the Bering Land Bridge into North America over the past 35 million years.

Even though bears are classified as meat eaters (order Carnivora), their tooth structure and diet indicate that they are omnivores, feeding on both plants and animals.

Tremarctine bears have short muzzles and are called “short-faced bears.” The South American spectacled bear (*Tremarctos ornatus*) is the lone survivor of this group. Its ancestors dispersed into South America during the Great American Interchange, after 2.5 million years ago.



Bear

Peccaries

Peccaries are primitive, even-toed, hoofed mammals. They generally have four hooves on the front limbs and three on the rear.

Two types of peccaries lived in Florida during the Pliocene and Pleistocene. Based on tooth structure, *Mylohyus* probably ate soft vegetation, while *Platygonus* fed on coarser plants. There also were earlier peccaries during the Oligocene and Miocene, but they are rare and poorly known. Peccaries became extinct in Florida by the end of the Ice Age, about 10,000 years ago.

Although peccaries are “pig-like,” they are classified in the New World family Tayassuidae, while true pigs belong to the Old World family Suidae.

Three peccary species occur today in a variety of habitats from the southern borderlands of the United States south into South America. A third species, *Catagonus wagneri*, was thought to be extinct until it was discovered in the 1970s living in Paraguay.



Family of Peccaries

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Four: Terrestrial Florida *continued*

49

6) What happened to Pleistocene animals?

Paleontologists are unsure why most of the North American megafauna became extinct 12,000 to 10,000 years ago. This extinction apparently happened rather quickly, perhaps over a period of just a few thousand years. Large mammals, including ground sloths, glyptodonts, mastodons, mammoths, saber-toothed cats, the American lion, and many others, vanished from the face of the Earth. Why? Scientists have hotly debated the reason(s) for this abrupt and dramatic decrease in mammalian diversity.

Two schools of thought explain these late Pleistocene extinctions:

1. The large mammals did not adapt to climate changes (“chill”); or
2. Humans hunted large mammals to extinction (“kill”).

More recently, it has been suggested that lethal pathogens (“ill”) spread rapidly through large mammal populations, decimating them.

We do not know the answer to this mystery. Probably climate change, hunting, or disease, or some combination of these factors resulted in the demise of these magnificent beasts.

More than 99% of all species that ever lived on Earth are extinct. Millions disappeared during the five greatest mass extinction episodes. Today many of Earth’s animals and plants are again in great peril. There is little debate among biologists that we are facing a biological crisis that rivals the worst mass extinctions of the past. Some biologists estimate that Earth is losing 30,000 species per year—three species every hour—as a direct result of human activity, the “Sixth Mass Extinction.”

Will the endangered species pictured in this Fossil Hall disappear in your lifetime?

Pre Activity

Piecing together the puzzle: Paleontologists make hypotheses based on only a small part of a puzzle.

Materials:

- Small “kiddie” puzzle for each group. If you cannot get puzzles, you can print a picture on cardstock and cut it out to make a puzzle

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Four: Terrestrial Florida *continued*

50

Actions:

- Divide the class into groups of 2-4 students.
- Give each group a puzzle (~15-30 pieces) with several pieces missing. Have them put together the puzzle.
- Have student take the puzzle apart and flip the pieces over. Mix the pieces up.
- Ask students to select 2-3 pieces of the puzzle and flip only those pieces over. What do those pieces alone tell about the whole picture? Is there one particular part that gives away the whole picture?
- Explain that paleontologists learn about animals from the past based on their bones, which are much like the pieces of the puzzle. Sometimes they have an almost complete puzzle, but other times they only have a few pieces.

Field Trip Activity

- Scavenger Hunt (Activity Sheet 3)

Post Activity

Paleo Cookie Dig: Students will understand that how a paleontologist determines what kind of environment a site represents.

Materials:

- Rice Krispies
- Marshmallow
- Margarine
- Knife
- Paper plates
- Raisins
- Nut pieces
- Sunflower seeds (with shell)
- Toothpicks

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Four: Terrestrial Florida *continued*

51

Actions:

- At home, make a batch of Rice Krispies Treats. Mix in raisins, nut pieces, and sunflower seeds or different items but make sure that they will not melt. The raisins represent turtle fossils, the nut pieces represent tapir fossils and the sunflower seeds represent horse fossils.
- In class, cut the tray into pieces. Distribute 1 square to each student on a paper plate with a toothpick.
- Have students “excavate” their square with a toothpick. They should make a pile of each of the different items mixed into the Rice Krispies.
- When finished excavating, ask students to count how many of each item they have on their plate.
- Ask students to raise their hand if they have mostly turtle fossils. Tapir fossils? Horse fossils?
- Based on the types of fossils found in their quadrant and for the whole site, what type of environment do they think this site represents (terrestrial). Why?
- Ask students what they might find if the site represented a marine paleontology site?
- You can easily create a more difficult activity by assigning time period specific organisms as the fossils and asking students to determine what time period the site represents.
- Allow student to eat the excavation remnants or have a second tray that can be cut up to eat.

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Four: Terrestrial Florida *continued*

52

Activity Sheet 3

Fossil Hall Scavenger Hunt

1. I am the oldest Florida fossil ever found. I am over 100 million years old. What am I?
2. We are remnants of a four-legged ancestor. We can be seen on the extinct toothed whale. What are we?
3. I am neither a bear nor a dog. I am an evolutionary “dead end” I lived during the Miocene. Who am I?
4. I am Florida’s first alligator. I lived during the Miocene. Who am I?
5. As the largest mammal to walk the Earth, I lived during the Miocene. I am an Indricotherium.
Where did I live?
6. Fossils of me are found in the Miocene. I am Florida’s “official state tree” today. What am I?
7. I had huge claws, but ate plants. I am referred to as a “gentle giant.” I lived during the Pliocene.
Who am I?
8. I am a large headed llama that once roamed Florida’s grasslands. Where am I found today?
9. I am a top predator that originated in Africa. I first immigrated to Florida about 14,000 years ago.
I may be responsible for the extinction of many large mammal species. Who am I?
10. We are at least four of Florida’s modern endangered species. Who are we?

PART ONE: FOSSIL HALL: EVOLUTION OF LIFE AND LAND



Florida Museum of Natural History

Section Four: Terrestrial Florida *continued*

53

Answers: to be on a separate page for the teacher's reference only

1. Sea turtle shell fragment from Okeechobee area.
2. Small (vestigial) hind limbs
3. Giant Bear-Dog
4. Alligator olseni
5. Central Asia
6. Sabal Palm
7. Giant Ground Sloth
8. South America
9. Humans
10. Right whale, Florida panther, American crocodile, gray bat, West Indian manatee, grass of Parnassus, Atlantic green turtle, Lower Keys marsh rabbit, Schaus swallowtail, wood stork, shortnose sturgeon, Key deer.

PART TWO: TEACHER AND STUDENT RESOURCES



Florida Museum of Natural History

Section One: Books

54

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PART TWO: TEACHER AND STUDENT RESOURCES



Florida Museum of Natural History

Section One: Books continued

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PART TWO: TEACHER AND STUDENT RESOURCES



Florida Museum of Natural History

Section Two: Web Sources

56

Florida Fossil Hunters

http://www.floridafossilhunters.com/About_Us.htm

FLMNH Invertebrate Paleontology

<http://www.flmnh.ufl.edu/invertpaleo/>

FLMNH Paleobotany

<http://www.flmnh.ufl.edu/paleobotany/>

FLMNH Vertebrate Paleontology

<http://www.flmnh.ufl.edu/vertpaleo/>

Field Museum Evolving Planet Online Exhibition

<http://www.fieldmuseum.org/evolvingplanet/>

National Center for Science Education

<http://www.ncseweb.org/default.asp>

Paleontology at the United States Geological Survey

<http://geology.er.usgs.gov/paleo/>

Paleontological Society

<http://www.paleosoc.org/>

Science Daily: Paleontology News

http://www.sciencedaily.com/news/fossils_ruins/paleontology/

University of California Museum of Paleontology

<http://www.ucmp.berkeley.edu/>

PART TWO: TEACHER AND STUDENT RESOURCES



Florida Museum of Natural History

Section Three: Videos, Music

57

Bill Nye the Science Guy “Fossils” Disney Educational Productions. 26 min. video.

National Geographic Society “Fossils, Clues to the Past.” Washington D.C. National Geographic Society, Educational Services, 1983. 23 min. video.

National Geographic Society “Sea Monsters: A Prehistoric Adventure.” National Geographic Video, 2008. 40 min. DVD.

PART TWO: TEACHER AND STUDENT RESOURCES



Florida Museum of Natural History

Section Four: Current Research at the Florida Museum

58

The late Archie F. Carr, Jr. (1909-1987), UF Graduate Research Professor in Zoology and author of popular natural history books, was a leader in the study and conservation of sea turtles.

The Archie Carr Center for Sea Turtle Research, UF Zoology Department, was established in 1986 to celebrate the contributions of this extraordinary naturalist and promote a better understanding of sea turtle biology and conservation.

Invertebrate Paleontology

The strength and significance of the FLMNH Invertebrate Paleontology (IP) Collection resides in the extensive amount of material collected within the last 50 years from over 4000 sites around Florida, the southeastern U.S., and the circum-Caribbean. These collections are unique in that they represent many localities no longer accessible because of rapid regional land development. They are also a significant national research resource that serves as the basis, for an active and productive IP Research Program at the Florida Museum of Natural History, University of Florida.

Paleobotany and Palynology

The FLMNH Paleobotanical Collection includes approximately 300,000 specimens. This is a conservative estimate that does not take into account the fact that an individual hand sample may contain more than one fossil of interest. In addition, the facility houses the John W. Hall paleobotanical collection (approximately 20,000 specimens) currently on a long-term loan from the University of Minnesota.

The collection is international in scope, ranging from the Proterozoic to the Pleistocene, and including collections from 47 countries. Particular strengths of the collection are: Cretaceous of the US western interior, Cretaceous and Eocene of southeastern North America, Eocene and Oligocene of the Pacific northwest, and Pennsylvanian of Indiana and Illinois. Systematically the greatest strength of the collection is in Cretaceous-Tertiary angiosperms, which are represented by large numbers of well-preserved fruits and flowers as well as leaves and wood.

Vertebrate Paleontology

The FLMNH vertebrate fossil collections feature rich samples of all classes, mainly from the Cenozoic Era. More than 90% of the collections come from about 1000 marine and non-marine sites in Florida; other contributing regions are the Caribbean Basin and the South American Andes. Included are about 400,000 specimens, of which more than 240,000 are catalogued and 225,000 are currently on a searchable computer database.

PART TWO: TEACHER AND STUDENT RESOURCES



Florida Museum of Natural History

Section Four: Current Research at the Florida Museum continued

59

Tapir Challenge

The Tapir Challenge pitted fossil collecting teams from the Florida Museum of Natural History and East Tennessee State University to determine whose site would produce the most tapir skeletons. By the spring of 2008, the challenge was about an even draw, although the Tennessee group still has many years of productive work ahead of them. The Florida site was located northeast of the small town of Newberry in western Alachua County. Its technical name is Haile 7G. The fossils found at Haile 7G are about 2 million years old, from the late Pliocene Epoch. A complete list of the species found at the site can be found on the FLMNH Vertebrate Paleontology website.

Over 550 volunteers assisted in the challenge from the fall of 2006 through the spring of 2008. FLMNH collected a total of 79 tapir skeletons. In addition, we found about 100 skeletons of other mammals, about 250 turtle skeletons, 23 alligator skeletons, and three bird skeletons, making this one of the most significant fossil sites ever excavated in Florida. Much of this productivity is due to our volunteers, who contributed over 8,000 hours of work at the site.

PART THREE: RELATED EXHIBITIONS AND PROGRAMS



Florida Museum of Natural History

Section One: Permanent Exhibitions

60

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.

Butterfly Rainforests: Where Science Takes Flight

Stroll through this 6,400-square-foot screened, outdoor enclosure with subtropical and tropical plants and hundreds of living butterflies. View thousands of Lepidoptera species on the “Wall of Wings” and learn about butterfly and moth biology. See scientists working in the Butterfly Rearing Lab and the Research Labs.

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.

PART THREE: RELATED EXHIBITIONS AND PROGRAMS



Florida Museum of Natural History

Section Two: School and Outreach Programs

61

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.flmn.h.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

PART THREE: RELATED EXHIBITIONS AND PROGRAMS



Florida Museum of Natural History

Section Two: School and Outreach Programs continued

62

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

PART THREE: RELATED EXHIBITIONS AND PROGRAMS



Florida Museum of Natural History

Section Three: General Visitor Programs and Special Events

63

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.flmnih.ufl.edu/education/>

PART FOUR: EXHIBIT MAP



Florida Museum of Natural History

64





Florida Museum of Natural History