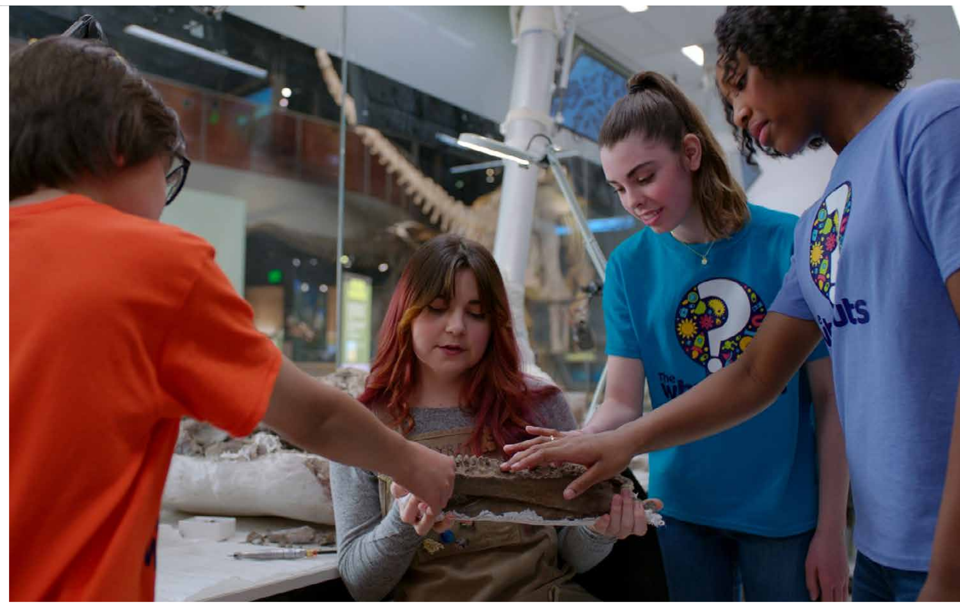
THE WHYNAUTS:

Episode 1: Paleontology

EDUCATOR GUIDE SUGGESTED GRADE LEVELS 3RD-5TH

The Whynauts

Perot Museum of Nature and Science

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INTRODUCTION

HOW TO USE THIS GUIDE

The Whynuats **"Paleontology"** Video explores how paleontologists study fossils to learn about past living organisms and their environments. This guide is designed to help you incorporate the video into a complete learning experience for your students. It is composed of three main sections:

The **Viewing Strategies and Tools** section includes suggestions for engaging students with the video, a student viewing journal to encourage active participation, and a pre- and post-assessment to track student learning. These materials can be printed out or completed digitally.

The **Supplemental Activities** section includes options for both hands-on and virtual learning. The "pre-video" activities are recommended to help students engage with and explore the content, while the "post-video" activities are recommended to extend and evaluate learning. You can choose to use the activities in any order or combination that works best for you.

The **Additional Resources** section includes a 'Meet the Team' feature that introduces members of the Perot Museum's Paleontology and Collections departments. There is also a glossary, reading list, and links to continue learning.

LEARNING OBJECTIVES

Students will be able to:

- Identify fossils as the remains or traces of prehistoric life.
- Describe how paleontologists study fossils to learn about past living organisms and their environments.

TEKS ALIGNMENT

SCIENCE CONCEPTS

3.12D. Identify fossils as evidence of past living organisms and environments, including common Texas fossils.

4.12C. Identify and describe past environments based on fossil evidence, including common Texas fossils.

SCIENTIFIC AND ENGINEERING PRACTICES

3-5.4. The student knows the contributions of scientists and recognizes the importance of scientific research and innovation for society.

NGSS ALIGNMENT

SCIENCE CONCEPTS

3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.

BACKGROUND INFORMATION

FOSSILS

Fossils are the remains or recorded traces of something that was once alive. Fossils can be classified into two main categories – body fossils and trace fossils. **Body fossils**, such as bones, teeth, wood, and leaves, are preserved remains of dead organisms. **Trace fossils** are preserved evidence of an organism's activity, like footprints or skin impressions. The word "fossil" literally means "dug up" in reference to how fossils are usually found buried in ancient rock formations.

There are a few ways fossils could form. One of the most common ways for vertebrate bones and wood to be preserved is through **permineralization**. If an organism is buried soon after death, it slows down the decomposition process enough to allow for the pores in the hard elements, like bones or teeth, to be slowly filled in or replaced by minerals. This process takes place slowly over thousands or millions of years. Bone fossilized in this way is "mineralized" and very much like a rock. However, fossilized bone retains traces of its biological structure (such as tiny lines on the surface, a dense outer layer, and an inner spongy structure that resembles honeycomb) which paleontologists use to differentiate it from inorganic rocks.

The environmental conditions have to be just right for permineralization to occur. In general, organisms are buried and can form fossils in areas where sediment is accumulating, such as river deltas, along curves in steams, or at the bottom of ponds or bogs. Soft tissue is decayed by oxygen-loving microorganisms, so for them to have a chance at fossilization, they must be buried in an environment without oxygen (anaerobic). Commonly, this occurs when organisms are buried in a body of water. If an organism dies on dry land, chances are high that it would be scavenged by predators or destroyed by decomposers before having a chance to fossilize.

There are some other common ways for plant fossils to form. **Molds** and **casts** form when a 3D plant part, such as a trunk or seed, is buried in sediment that hardens without crushing the plant. The plant later decays, leaving a mold of the outside of the plant that can later fill with sediment to form a cast of the original plant. **Compressions** and **impressions**, on the other hand, are relatively two-dimensional fossils that happen when plant remains, like leaves, are buried in sediment that compacts and crushes the plant before it turns to rock.

No matter how it happens, fossilization is a rare process when one considers the number of fossilized species so far discovered in comparison to the biodiversity of life on Earth. And just because a fossil forms, does not mean that it will last for us to be able to find thousands or millions of years later. Even so, there is much more of the fossil record yet to discover!

Left: *Convolosaurus marri*, a small, plant-eating dinosaur from the Early Cretaceous rocks of north Texas, on exhibit in the Perot Museum.

Right: Fossil leaf from Jose Creek Formation, New Mexico. About 75 million years old.

PALEONTOLOGY

Paleontologists are scientists who study the history of life on Earth. Because life on Earth is so vast and diverse (from vertebrates, to invertebrates, to plants, and even microorganisms), there are many different subdisciplines of paleontology. Vertebrate paleontologists and paleobotanists, like those at the Perot Museum, study past life by analyzing fossilized remains to gain clues about what past environments and organisms living in those environments were like.

One way they do this is to compare what we know of life now to life then. For example, paleontologists compare the preserved, or fossilized, teeth of an extinct animal to the teeth of animals living today. The teeth can give clues to not only whether that animal ate meat (a **carnivore**) or plants (an **herbivore**), but also what kinds of prey or plants might have been available to eat in that animal's environment. Paleontologists can also determine if an animal was walking, jogging, or running using information gathered from its footprints, stride length, and some useful equations based on observations of living animals. Paleobotanists compare the fossil plant communities to living plant communities to learn what the ancient environment was like.

Finding fossils is a combination of knowing where to look, what to look for, and chance. Most fossils are found in sedimentary rocks exposed at the surface of the Earth, or at the edges of lakes or rivers, where water is continually eroding away the surface to expose the rock strata below.

Steps From Discovery to Display:

1. Discovery: The fossil is found in the field.
2. Recovery: The fossil is removed from the ground and transported to the lab.
3. Preparation: The fossil is carefully cleaned and restored.
4. Curation: The fossil is catalogued and enters the scientific record.
5. Research: The fossil is examined and researched in detail, and may be studied by scientists for many years.
6. Display: The fossil may become part of an exhibit to be enjoyed by, inspire, and educate the public.

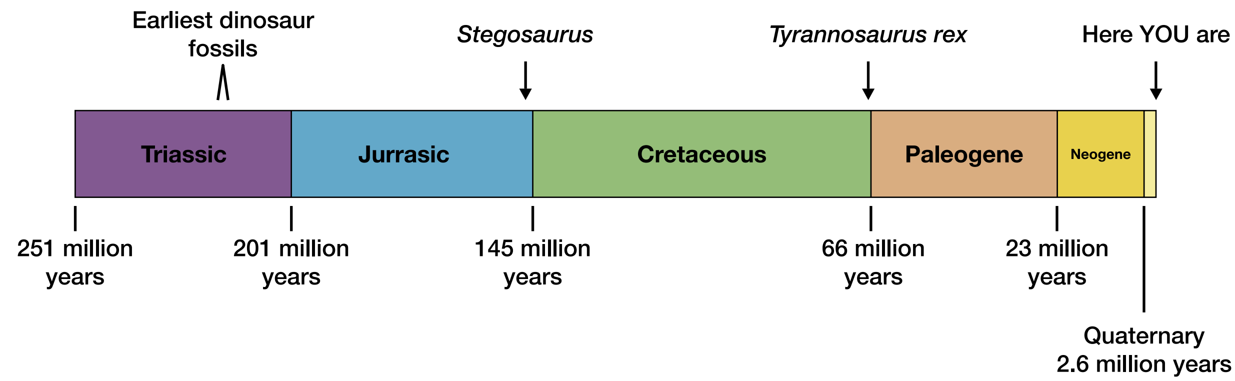
It is important to note that the specimens on display at a museum often represent only a tiny fraction of what is in the Museum's collections – just like seeing only the tip of an iceberg!

Fossils have been discovered on every continent – including Antarctica! But that does NOT mean that all fossilized species are found everywhere or in every time period.

NORTH TEXAS IN THE CRETACEOUS PERIOD

Much like we divide time into units (days < weeks < years) to understand the chronological order of events, geologists and paleontologists divide layers of the Earth (strata) in time to understand the relationship of past geologic events. For the most part, older rock layers are on the bottom (deeper underground) and the younger are on top nearer the surface. We then classify these divisions of geological time of Earth's history into eons > eras > periods > and epochs.

Dinosaurs (the non-bird kinds) have only been found in the rock layers of the Mesozoic Era (252 million to 66 million years ago). The Mesozoic is further divided into three periods: the Triassic, the Jurassic, and the **Cretaceous**.



We have a lot of Cretaceous-age rock in the North Texas area. This means that we would not expect to find Jurassic dinosaurs like *Brachiosaurus* or *Allosaurus* here. Instead, the Museum's paleontologists discover many fossils of organisms that lived during the Cretaceous Period.

During the early part of the Cretaceous Period, around 110-115 million years ago, in what is now Texas, giant long-necked sauropods like *Sauroposeidon* munched on the tops of conifer trees, while smaller dinosaurs like *Tenontosaurus* and *Convolosaurus* ate the plants in their reach, including some of the earliest flowers. And stalking them were meat-eaters, like wolf-sized, bird-like *Deinonychus* and the multi-ton *Acrocanthosaurus*. Of course, not every animal that lived here then was a huge dinosaur. Fossils show us there were plenty of crocodiles, turtles, lizards, frogs, salamanders and fish that lived here too.

Artwork by Karen Carr

The late part of the Cretaceous Period lasted from 100 to 66 million years ago. Although dinosaurs roamed much of North America at this time, there weren't many in Dallas. That is because Dallas was usually covered by the **Western Interior Seaway** – large expanses of shallow, warm, Caribbean-like water, with big fish, little fish, ammonites, plesiosaurs, giant sea turtles, and mosasaur lizards swimming around in it. There were some seabirds too, which technically means some dinosaurs. Because we now know that birds are modern-day dinosaurs!

VIEWING STRATEGIES AND TOOLS

SUGGESTED DISCUSSION QUESTIONS

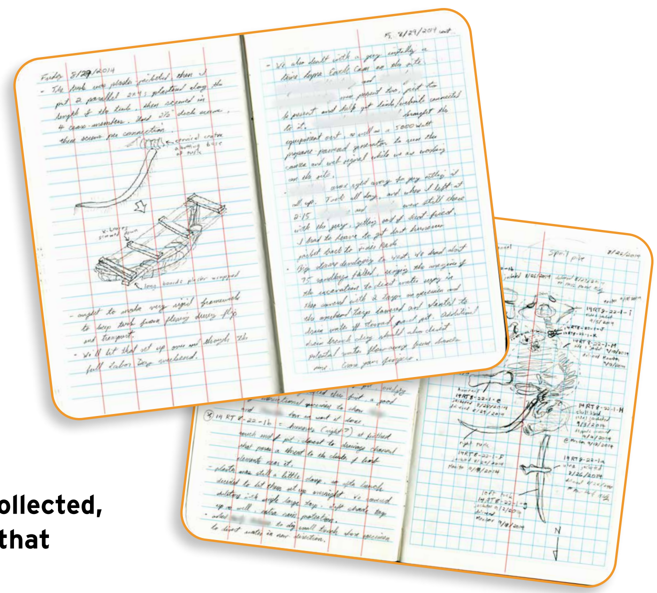
You can choose to have students watch the Whynauts "Paleontology" video in one sitting, or break it up into sections. We recommend pausing the video to check for understanding, using the suggested discussion questions.

■ SECTION 1: FORMING FOSSILS [BEGINING-4:25]

- **How do fossils form?**
  - **There are many ways for fossils to form, including permineralization. In this process, the soft parts of the organism deteriorate, leaving only hard parts, like bones. The hollow spaces in the organism's remains are filled with dissolved minerals, which then harden, becoming very much like a rock.**
- **Why do you think some things fossilize and some things don't?**
  - **The remains of an organism will only fossilize if they do not decompose and are not eaten by scavengers. If an organism dies in a location where its remains can be quickly buried by sediment, it is less likely to decay or get eaten. The hard parts of organisms, like bones, teeth, and shells, are more likely to become fossils than the softer parts, like muscles and skin.**

■ SECTION 2: MEET A PALEONTOLOGIST [4:25-10:55]

- **What does a paleontologist do?**
  - **Paleontologists study fossils to learn about past living organisms and their environments, and how life on Earth has changed through time. This includes fieldwork, but also cleaning and preparing fossils, studying specimens, communicating discoveries, and lots and lots of reading!**
- **What kind of information do you think a paleontologist keeps in their journal?**
  - **Field journals are a combination of personal and scientific notes. Paleontologists might record the specimens they collected, drawings and notes of the geology of the site, and events that happened throughout the day.**



■ SECTION 3: CHANGES OVER TIME [10:55-END]

- **Why do we find fossils of ancient marine life in Texas?**
  - **During some parts of its history, Texas was covered by water. Paleontologists often find fossils from marine creatures that lived in the area millions of years ago, when the environment was very different than it is today.**
- **Why might a species go extinct if its environment changes?**
  - **Plants and animals are adapted to survive in their environments. If the environment changes rapidly, their adaptations may not be as helpful for survival as they once were.**
- **Imagine you could go back in time and observe an extinct species. What do you want to know about its life?**
  - **Answers will vary. What did it eat? How did it move? How big could it grow? Did it take care of its young? What were its defense mechanisms? How did it sleep? What was the color(s) of its skin? Did it have hair, scales, and/or feathers? What predators lived in the same area?**

Student Viewing Journal

BEFORE YOU WATCH THE VIDEO:

Use the KWL chart to record what you **know** and what you **wonder** about paleontologists and the fossils they study.

KWL Chart

WHAT I KNOW	WHAT I WONDER	WHAT I LEARNED

AFTER YOU WATCH THE VIDEO:

Record what you **learned** in the KWL chart.

COMPLETE THESE SENTENCES:

This reminds me of

I was surprised by

The most interesting thing I learned was

Pre- and Post-Video Assessment

1. What is a fossil?

____

____

2. How could you use fossils to determine the diet of an extinct species?

____

____

3. A paleobotanist finds the plant fossils shown.

Which question can the paleobotanist most likely answer by examining these fossils?

A. What was the average monthly rainfall in the area?

B. How much water was absorbed by the roots of the plants?

C. How much oxygen was in the atmosphere surrounding these plants?

D. What was the environment like in the area when the plants were alive?

4. Imagine you are a paleontologist. What is your favorite part of your job?

____

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PRE- AND POST-VIDEO ASSESSMENT

1. What is a fossil?

Fossils are remains or traces of prehistoric life. Body fossils, like bones or leaves, are preserved remains of dead organisms. Trace fossils, like footprints or skin impressions, are preserved evidence of an organism's activity.

2. How could you use fossils to determine the diet of an extinct species?

The shape of fossilized teeth can tell us what type of food the animal ate. If the animal had sharp, pointed teeth that could cut through or tear meat off bone, it was likely a carnivore, or meat-eater. If the animal had flatter teeth that could mash and grind up tough plants, it was likely an herbivore, or plant-eater.

3. A paleobotanist finds the plant fossils shown.

Which question can the paleobotanist most likely answer by examining these fossils?

A. What was the average monthly rainfall in the area?

B. How much water was absorbed by the roots of the plants?

C. How much oxygen was in the atmosphere surrounding these plants?

D. What was the environment like in the area when the plants were alive?

4. Imagine you are a paleontologist. What is your favorite part of your job?

Answers will vary. Answers could include collecting fossils in the field, studying fossils in the lab, learning new things about prehistoric creatures or environments, discovering a new species, or creating exhibit displays for a museum.

PRE-VIDEO ACTIVITIES

Let's Talk About Teeth

Let's Talk About Tracks

Let's Talk about Teeth

HOW DO PALEONTOLOGISTS KNOW WHAT PREHISTORIC ANIMALS ATE?

Additional Materials:

- Mirror (optional)

INTRODUCTION:

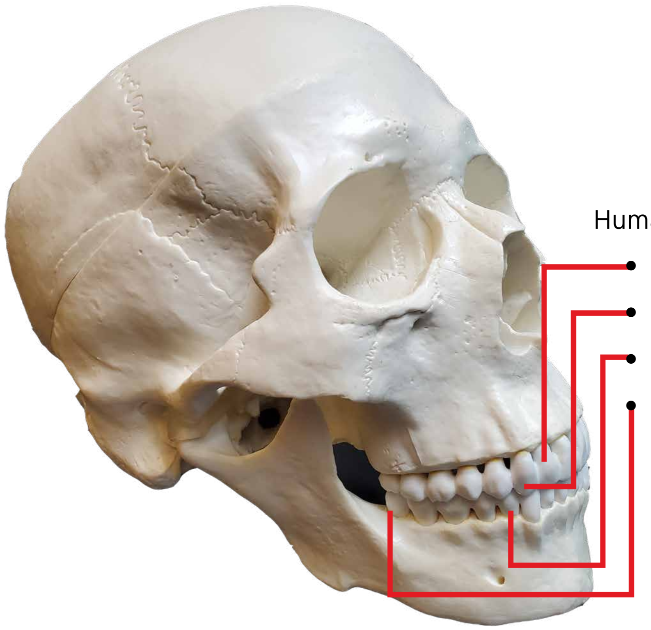
Teeth are specialized tools for eating. The shape of teeth indicates what type of food a creature eats. **Carnivores**, or meat-eaters, usually have sharp, pointed teeth, like the edge of a knife. Their teeth are used for hunting as well as eating their **prey**, by cutting through or tearing meat off bone. **Herbivores**, or plant-eaters, usually have flatter, rougher teeth used for mashing and grinding up tough plants.

When a **paleontologist** discovers the preserved, or **fossilized**, teeth of an extinct animal, they compare the fossilized teeth and jaws with those of animals living today to determine if an animal was a carnivore or herbivore. The teeth can give clues to not only whether that creature ate meat or plants, but also what prey or plants might have been available to eat in that creature's **environment**.

DIRECTIONS:

1. Look at your own teeth in a mirror. Do all of them look the same? How many types of different-shaped teeth do you see? Describe or sketch your observations:

Imagine trying to bite into something like an apple with just your molars or trying to chew a piece of chicken with only your front teeth. This would be difficult! Having a combination of sharp and flat teeth allows us to eat both meat and plants. This makes us omnivores.



Humans have four types of teeth in our mouths:

- **Incisors — chisel-shaped, used for nipping, cutting**
- **Canines — sharp-pointed, used for biting, tearing**
- **Premolars**
- **Molars**

Premolars and Molars: broad, used for chewing, crushing, grinding

2. Now compare the teeth between a modern Texas carnivore and herbivore. What do you notice? Look at the shape and size of the teeth.

Bobcat

- Mammal
- Carnivore
- Teeth description
  - Four large, sharp, pointy canines
  - Top and bottom front incisors
  - Very pointy, sharp, blade-like premolars and molars

NPS | Chaco Culture National Historical Park

White-tailed Deer

- Mammal
- Herbivore
- Teeth description
  - Lots of wide, flat/bumpy premolars and molars
  - A gap with no teeth between bottom incisors and back molars
  - No top incisors, instead deer have a hard upper palate

NPS | Montezuma Castle National Monument

NOTE: Animals not to scale.

3. Now it's your turn! Observe the jaws of the animals shown below. Does the animal have teeth? If so, describe the characteristics of the teeth. What food might this animal eat? Record if this animal was a carnivore or herbivore.

ANIMAL		TEETH OBSERVATIONS	CARNIVORE OR HERBIVORE?
1. *Tenontosaurus*	Dinosaur		
2. *Tyrannosaurus*	Dinosaur		
3. *Tylosaurus*	Marine Reptile		
4. *Xiphactinus*	Fish		
5. *Alamosaurus**	Dinosaur		
6. *Mammuthus*	Mammal		
7. *Caracara*	Bird/Avian Dinosaur		

*No complete skull has yet been found for *Alamosaurus*, so this skull is a representation of what it might have looked like. Luckily, most sauropod skulls look very similar, and a few *Alamosaurus* teeth have been found.

1. *Tenontosaurus*

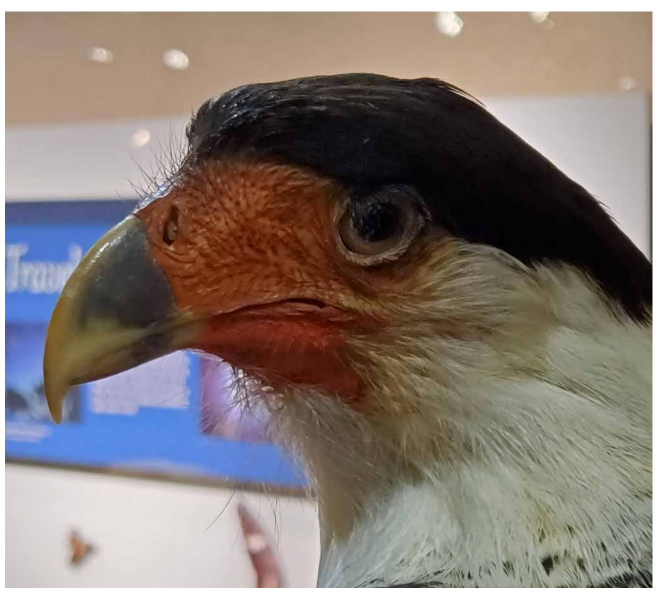
2. *Tyrannosaurus*

3. *Tylosaurus*

4. *Xiphactinus*

5. *Alamosaurus**

6. *Mammuthus*



7. *Caracara*

QUESTIONS

1. How many carnivores did you identify?

2. How many herbivores did you identify?

3. Was it ever hard to tell what an animal ate? What made it difficult?

4. Are there other clues that might help you determine if the animal is a carnivore or an herbivore?

ANSWER KEY

ANIMAL		TEETH OBSERVATIONS	CARNIVORE OR HERBIVORE?
1. *Tenontosaurus*	Dinosaur	• Broad, flattish molars in back of mouth • 'Beak', no teeth in front of mouth	Herbivore
2. *Tyrannosaurus*	Dinosaur	• All thick, pointed teeth of varying sizes • Some curved back • *Tyrannosaurus rex* teeth were distinctively thick and strong. Combined with its powerful jaws, it could crunch through bone.	Carnivore
3. *Tylosaurus*	Marine Reptile	• Piercing, cone-shaped teeth for gripping slippery prey like fish • Curved-back	Carnivore
4. *Xiphactinus*	Fish	• Sharp, pointy • Thinner • Varying sizes	Carnivore
5. *Alamosaurus*	Dinosaur	• Dull, robust • Peg-like • Good for "raking" in leaves off of branches	Herbivore
6. *Mammuthus*	Mammal	• Flat chewing surface with ridges, similar to a file • Mammoths would have had 4 of these in their mouths - 2 on top and 2 on bottom.	Herbivore
7. *Caracara*	Bird/Avian Dinosaur	• No teeth! • Sharp, 'hooked' beak for tearing	Primarily a Carnivore, will also accept Omnivore

ANSWER KEY

1. How many carnivores did you identify? 4

2. How many herbivores did you identify? 3

3. Was it ever hard to tell what an animal ate? What made it difficult?
   Sometimes, for extinct animals like *Alamosaurus*, whose teeth do not look like what we typically think of for herbivores, it can be difficult to figure out what they ate or how they ate. Especially because – unlike living animals – paleontologists cannot observe the daily behaviors of extinct animals.

   Some animals, such as birds, do not have teeth. To know what they ate, we look at the size and shape of their beaks and feet. For the *Caracara*, its sharp, hooked beak and talons are both good for tearing meat.

4. Are there other clues that might help you determine if the animal is a carnivore or an herbivore?
   When possible, observing the whole skull, and not just the teeth, helps provide more clues as to whether an animal was a carnivore or an herbivore. Are the eyes more forward facing, like the bobcat? Eyes that face forward allow for an animal to judge depth more accurately, helping them pounce on prey.

   Or are the eyes more on the sides of the head, like the deer? Eyes on either side of the head allow for greater peripheral, or side, vision. This allows a deer with its head down munching on grass to keep an eye out for approaching predators on either side.

   Be careful! Dinosaur skulls are full of openings. Sometimes the holes for the nose can be mistaken for the holes for the eyes (orbitals).

Let's Talk about Tracks

WHAT CAN PALEONTOLOGISTS LEARN FROM DINOSAUR FOOTPRINTS?

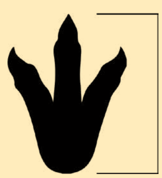
Additional Materials:

- Calculator (optional)

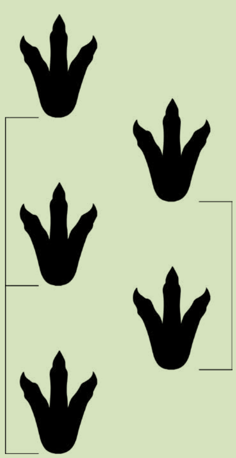
INTRODUCTION:

Fossils are the remains of something that was once alive. **Paleontologists** analyze fossilized remains to gain clues about what past environments and creatures living in those environments were like. Fossils can be classified into two major groups – body fossils and trace fossils. **Body fossils**, such as bones, teeth, wood, and leaves, are preserved remains of dead organisms. **Trace fossils** are preserved evidence of animal activity, like footprints or skin impressions.

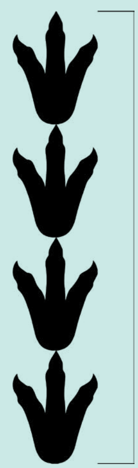
With one footprint and the help of some useful equations, paleontologists can determine the height of a dinosaur's hips, and the body length of a dinosaur. It all starts with measuring the length of the dinosaur footprint. If there are multiple footprints, paleontologists can measure stride length– the distance between two footprints made by the same foot. This measurement and hip height are used to determine the relative speed of dinosaurs.



Footprint length: measured from the back of the foot to the tip of the longest toe

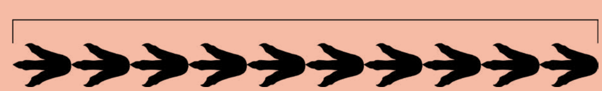


Stride length: distance between footprints. Be careful though, they must be from the same foot.



Hip Height: Footprint length x 4 (This is the leg length of the dinosaur.)

Body length: Footprint length x 10



Now it is your turn to analyze footprint data to see if a dinosaur was walking, jogging, or running!

DIRECTIONS:

1. Use the information in the Dinosaur Resource Book to identify the average footprint length for each dinosaur. Record this information in the data table.
2. Find Hip Height for each dinosaur by multiplying the footprint length by 4.
3. Divide Stride length by Hip Height.
4. Determine if the dinosaur was walking, jogging, or running:

   Walking: Stride length ÷ Hip height < 2.0

   Jogging: Stride length ÷ Hip height is between 2.0 - 3.0

   Running: Stride length ÷ Hip height > 3.0

DINO NAME	Footprint Length FP	Hip Height FP x 4	Stride Length	Stride ÷ Hip Height	Walking <2.0, Jogging 2.0-3.0, or Running >3.0
Nanuqsaurus hoglundi			128 cm		
Tyrannosaurus rex			768 cm		
Deinonychus antirrhopus			186 cm		
Tenontosaurus dossi			230 cm		
Pachyrhinosaurus perotorum			144 cm		

Notice, the units are in centimeters. Scientists use the metric system, also known as the* ***International System of Units**, to communicate and compare data.*

Questions:

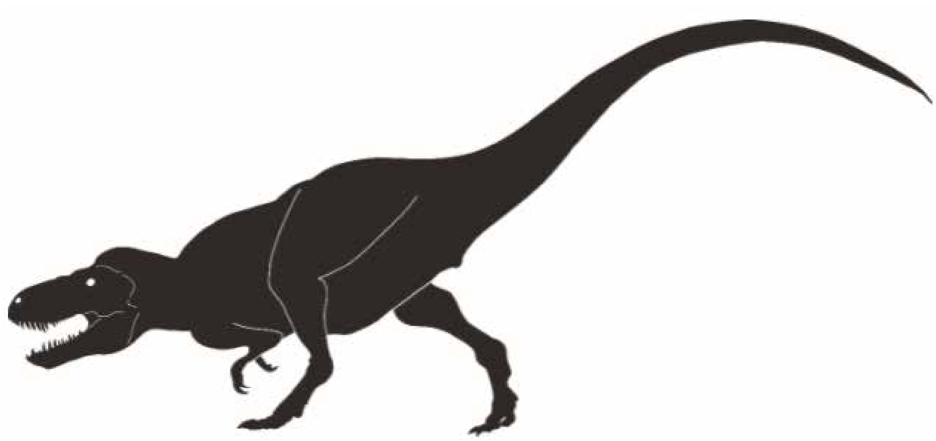
1. Paleontologists can also determine the body length of a dinosaur from footprints, using the equation Footprint length x 10. Which dinosaur on this list was the longest? The shortest?

2. At one point, scientists thought *T. rex* was really fast! New studies suggest they were relatively slow. Can you think of any reasons why they wouldn't be a fast dinosaur?

Nanuqsaurus hoglundi (NA-nook-SORE-us HOE-glund-ee)

Average Foot Size: 40 cm

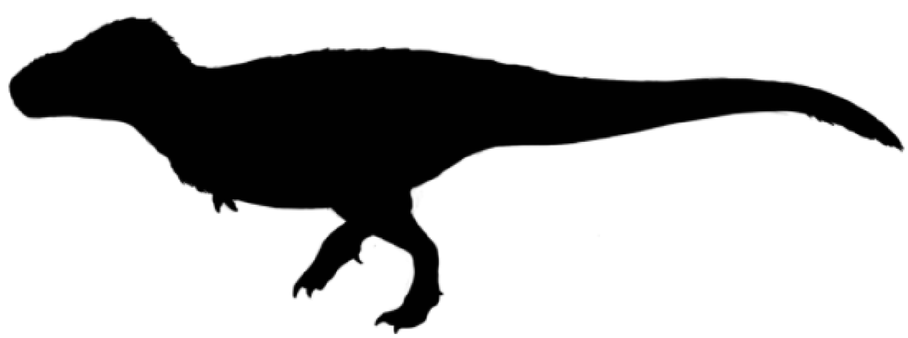
Fun Fact: The name literally means *polar bear reptile* as it comes from the remote and cold lands of Northern Alaska.



Tyrannosaurus rex (tie-RAN-oh-SORE-us reks)

Average Foot Size: 80 cm

Fun Fact: Unlike most other carnivorous dinosaurs, *Tyrannosaurus rex's* bigger teeth look more like bananas!



Tyrannosaurus rex silhouette by Emily Willoughby (under CC BY-SA 3.0 license: https://creativecommons.org/licenses/by-sa/3.0/)

Deinonychus antirrhopus (dye-NONN-ick-us ann-ter-HOPE-us)

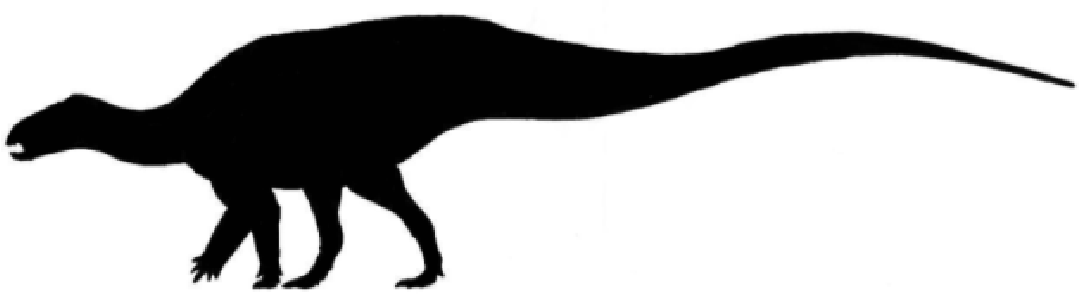
Average Foot Size: 15 cm

Fun Fact: The book *Jurassic Park* based it's "*Velociraptors*" on this North American dinosaur instead of the actual smaller *Velociraptor* from Asia. The movie version was even larger, more like the related *Utahraptor* in size!

Tenontosaurus dossi (ten-NON-toe-SORE-us DOSS-ee)

Average Foot Size: 23 cm

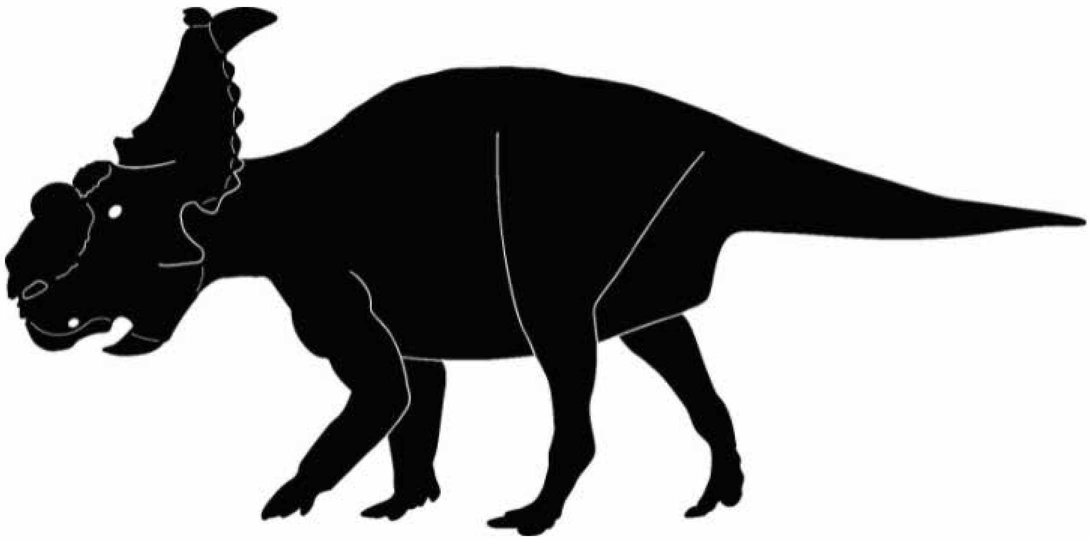
Fun Fact: One famous *Tenontosaurus* skeleton was found with remains of multiple *Deinonychus*, suggesting that these predators may have hunted in packs.



Pachyrhinosaurus perotorum (pak-ee-RYE-no-SORE-us purr-row-ORR-um)

Average Foot Size: 30 cm

Fun Fact: The last of the horned dinosaurs as characterized by a small circular frill and no brow horns unlike the *Triceratops*.



ANSWER KEY

DINO NAME	Footprint Length FP	Hip Height FP x 4	Stride Length	Stride ÷ Hip Height	Walking <2.0, Jogging 2.0-3.0, or Running >3.0
Nanuqsaurus hoglundi	40 cm	160 cm	128 cm	128/160=0.8	Walking
Tyrannosaurus rex	80 cm	320 cm	768 cm	768/320=2.4	Jogging
Deinonychus antirrhopus	15 cm	60 cm	186 cm	186/60=3.1	Running
Tenontosaurus dossi	23 cm	92 cm	230 cm	230/92=2.5	Jogging
Pachyrhinosaurus perotorum	30 cm	120 cm	144 cm	144/120=1.2	Walking

Notice, the units are in centimeters. Scientists use the metric system, also known as the* ***International System of Units**, to communicate and compare data.*

Questions:

1. Paleontologists can also determine the body length of a dinosaur from footprints, using the equation Footprint length x 10. Which dinosaur on this list was the longest? The shortest?
   Longest: *Tyrannosaurus rex* Shortest: *Deinonychus antirrhopus*

2. At one point, scientists thought *T. rex* was really fast! New studies suggest they were relatively slow. Can you think of any reasons why they wouldn't be a fast dinosaur?
   Answers may vary. An example may be: They were too heavy to have both feet off the ground at the same time.

POST-VIDEO ACTIVITIES

Learning from Leaves

Fossils: From Discovery to Display

Learning from Leaves

WHAT CAN THE SHAPE OF LEAVES TELL US ABOUT PAST ENVIRONMENTS?

Additional Materials:

- Scissors
- Tape or glue

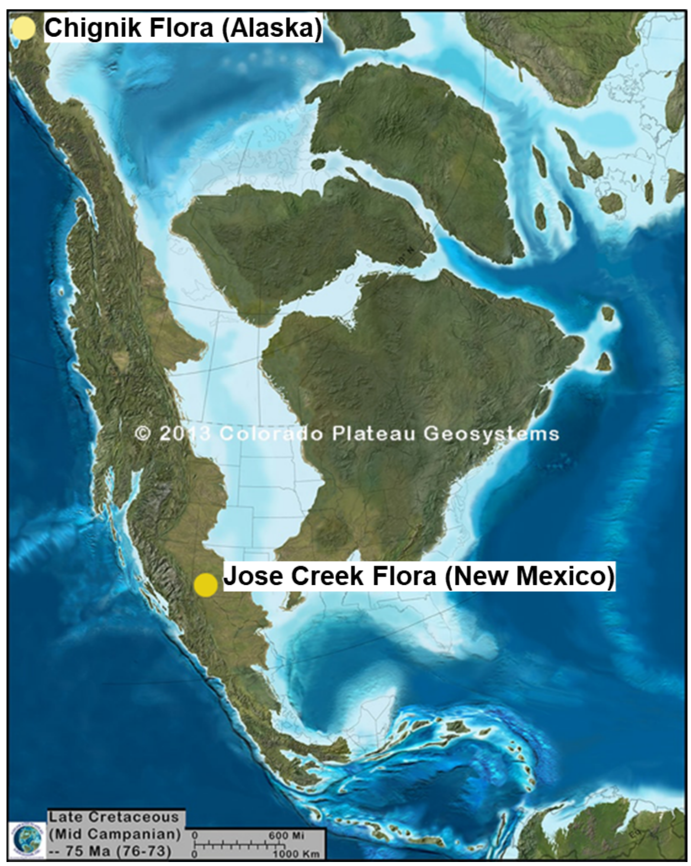
INTRODUCTION:

Fossils are the remains of something that was once alive. **Paleontologists** analyze fossils to gain clues about what past environments and creatures living in those environments were like. **Paleobotanists** specialize in plant fossils.

Both plants and animals are adapted to their environments. If the climate changes, their adaptations may not be as helpful for survival as they once were. Animals can move to new environments that better suit their needs and adaptations. Plants are not able to do this, which makes them great indicators of environmental change! Some plant features relate directly to climate, and paleobotanists can use this information to reconstruct past environments.

Paleobotanists may complete a Leaf Margin Analysis to determine the Mean Annual Temperature, or the average temperature, of a region. They examine the flora – the plants that lived together in a certain region and time period – and sort the different types (or species) of leaves based on a characteristic of their leaf edges into 2 major groups: smooth, and toothed. The proportion of species with smooth-edged leaves in a flora can be used to calculate the mean annual temperature. The more smooth-edged leaves in an environment, the warmer it tends to be.

Now it is your turn to do this for two environments from the **Cretaceous period**! The Cretaceous period (145-66 million years ago) is remarkable for famous dinosaurs, such as *Tyrannosaurus rex*, *Velociraptor*, and *Triceratops*, as well as the appearance and spread of flowering plants across the globe. During the Cretaceous, the Earth's climate was in a greenhouse state – it was overall warmer, the poles were not covered with ice sheets, and sea level was higher. The two fossil sites are about the same age, but one is from Alaska and the other from New Mexico.



North America 75 million years ago.
Note that the Western Interior Seaway divides the continent latitudinally, due to higher sea level. Study sites are marked with yellow dots. Maps from Colorado Plateau Geosystems (https://deeptimemaps.com)

Leaf Activity content developed in collaboration with Jaemin Lee and UC Berkeley.

DIRECTIONS:

1. Cut out the leaves from one of the fossil sites in the Leaf Booklet.
2. Examine and sort the leaves into 2 groups: toothed and smooth.
   Note: Leaves aren't always perfectly fossilized! Make sure you are examining the actual leaf margin (the edge of the leaf), not the broken edges!

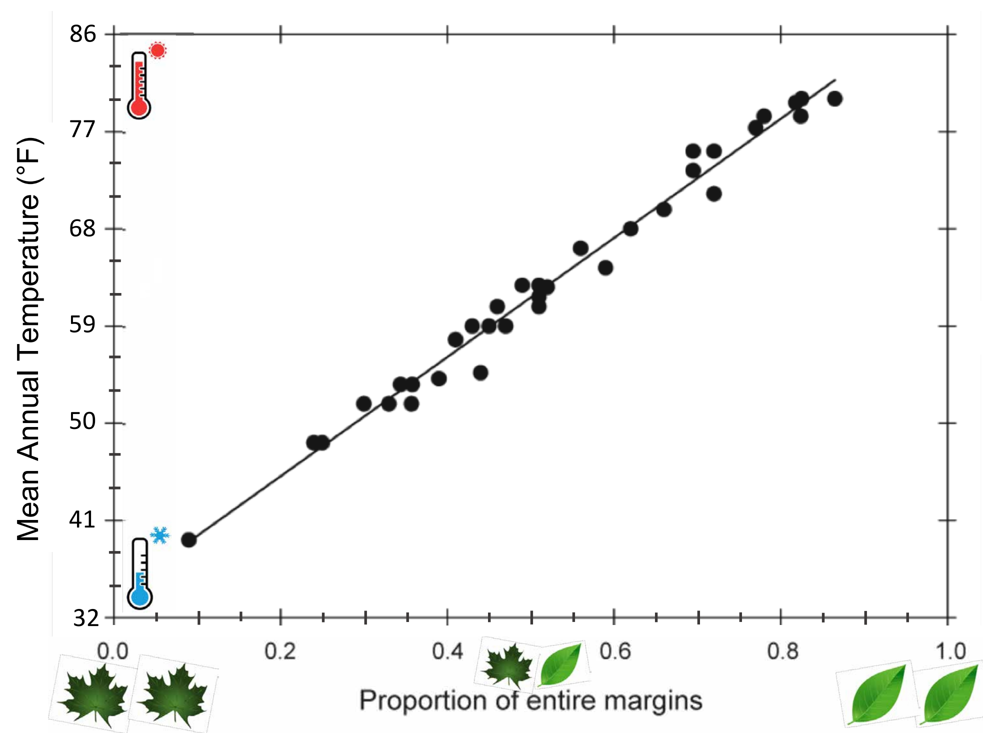
Toothed leaves have serrations, like a saw blade, along the edges of the leaf. The serrations are called "teeth" and can vary in size or shape: some are sharp and jagged, and some are more rounded.

Smooth leaves do not have serrations or teeth along the leaf margin. They are smooth.

3. Record the number of toothed leaves and number of smooth leaves found at your site.
4. Find the proportion of smooth leaves:

   # of smooth leaves ÷ total # of leaves =

5. Use the scatter plot below and the proportion of smooth leaves from the site to determine the mean annual temperature.



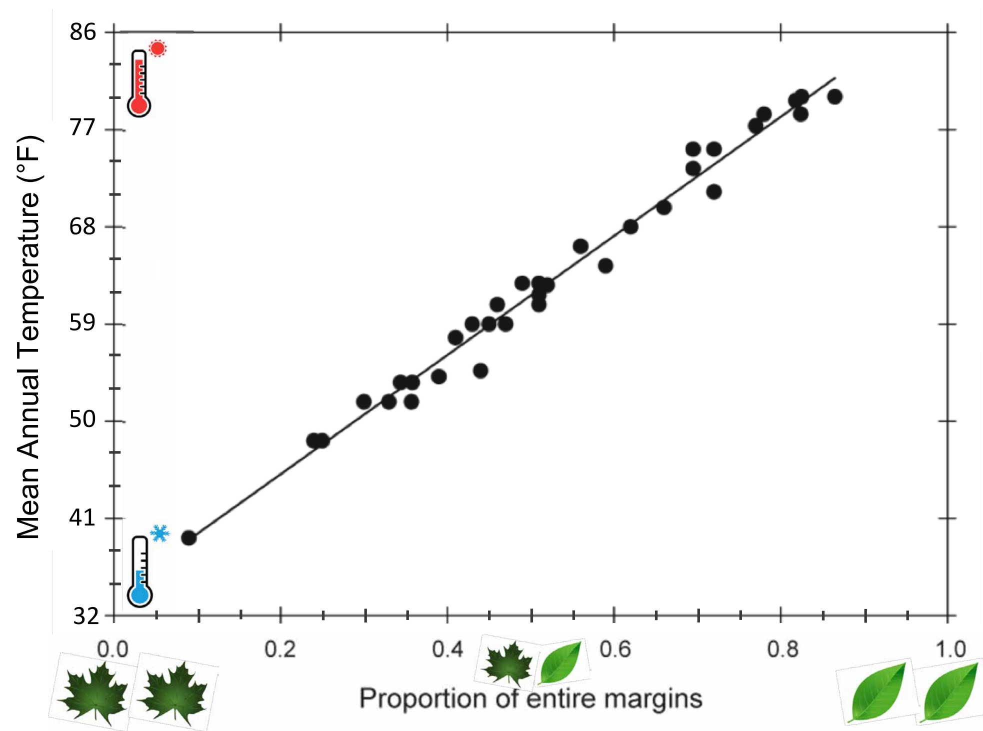
Data Log

Fossil Site: ______________________________

DATA TABLE:

# OF SMOOTH LEAVES	
# OF TOOTHED LEAVES	
TOTAL # OF LEAVES	

Determine the mean annual temperature using the scatter plot and proportion of smooth leaves:



Mean Annual Temperature: __________

Wolfe, J.A. 1979. Temperature parameters of humid to mesic forests of Eastern Asia and relation to forests of other regions of the Northern Hemisphere and Australasia. U.S. Geol. Surv. Prof. Pap. 1106: 1–37.

QUESTIONS

1. The current mean annual temperature for Chignik, Alaska is 38.5ºF. Using the scatter plot above, do you think they would have more smooth leaves, or toothed leaves? Why?

2. The current mean annual temperature for Elephant Butte State Park, New Mexico- close to the Jose Creek Fossil site, is 62.6ºF. Using the scatter plot above, do you think they would have more smooth leaves, or toothed leaves? Why?

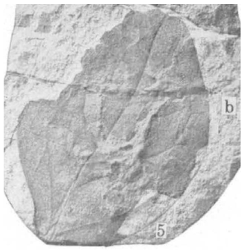
3. The mean annual temperature in Elephant Butte State Park, New Mexico today is not too different compared to what it was 75 million years ago, but is in the middle of the Chihuahuan desert. Why do you think the plants there are so different today compared to then? Hint: Think about what else plants need to survive and thrive in their environments.

Leaf Booklet:

CHIGNIK FORMATION (ALASKA)

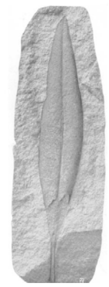
Cut out and examine the images below. Sort them into two groups: toothed and smooth.

C1



C2

C3



C4

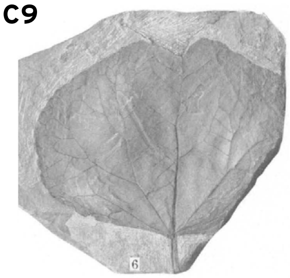
C5

C6

C7

C8

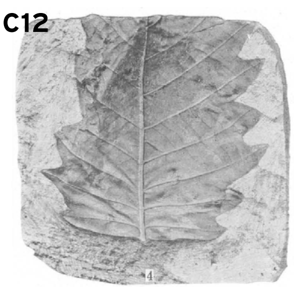
C9



C10

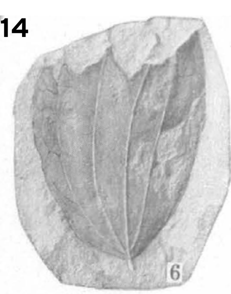
C11

C12



C13

C14

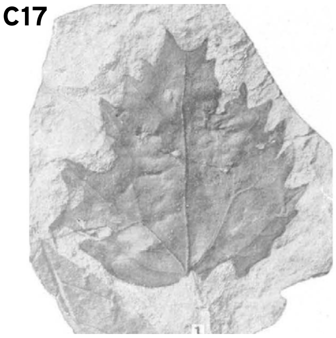


Alaska fossils: Hollick, A., 1930. The upper Cretaceous floras of Alaska. United States Geological Survey Professional Paper 159, 123 p., 86 plates.

C15

C16

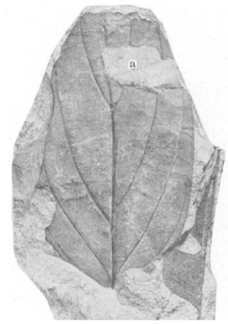
C17



C18

C19

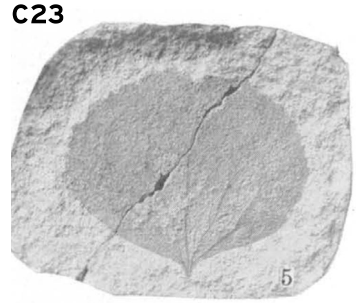
C20



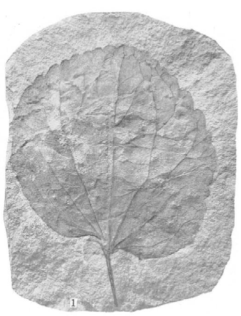
C21

C22

C23

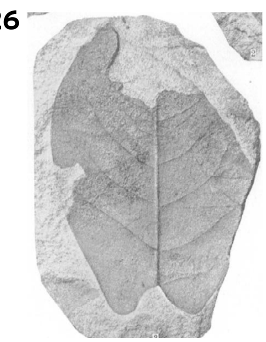


C24



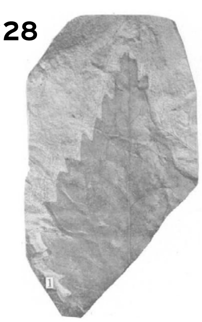
C25

C26



C27

C28

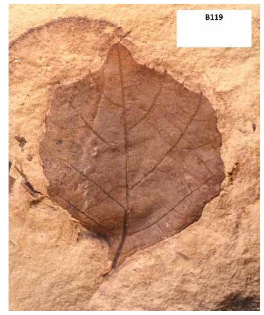


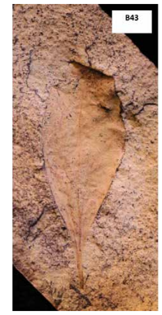
JOSE CREEK FORMATION (NEW MEXICO)

Cut out and examine the images below. Sort them into two groups: toothed and smooth.

J1


J2


J3


J4


J5


J6


J7


J8

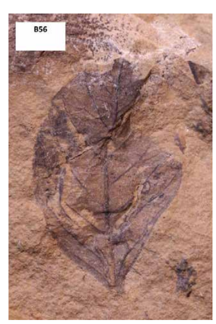

J9


J10


J11


J12


J13


J14


New Mexico fossils: Imaged by Dori Contreras and Jaemin Lee. Fossil specimens from University of California Museum of Paleontology and Perot Museum of Nature and Science.

J15

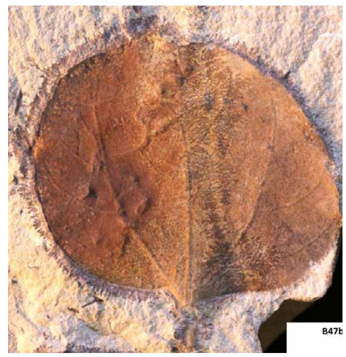

J16


J17


J18


J19


J20


J21


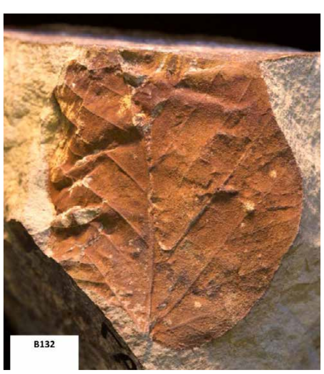
J22


J23


J24


J25


J26


J27


J28


ANSWER KEY

Chignik Formation

Answers to Leaf Images

C Smooth: 1, 3, 4, 8, 11, 14, 18, 19, 20, 21, 25, 26
C Toothed: 2, 5, 6, 7, 9 ,10, 12, 13, 15, 16, 17, 22, 23, 24, 27, 28

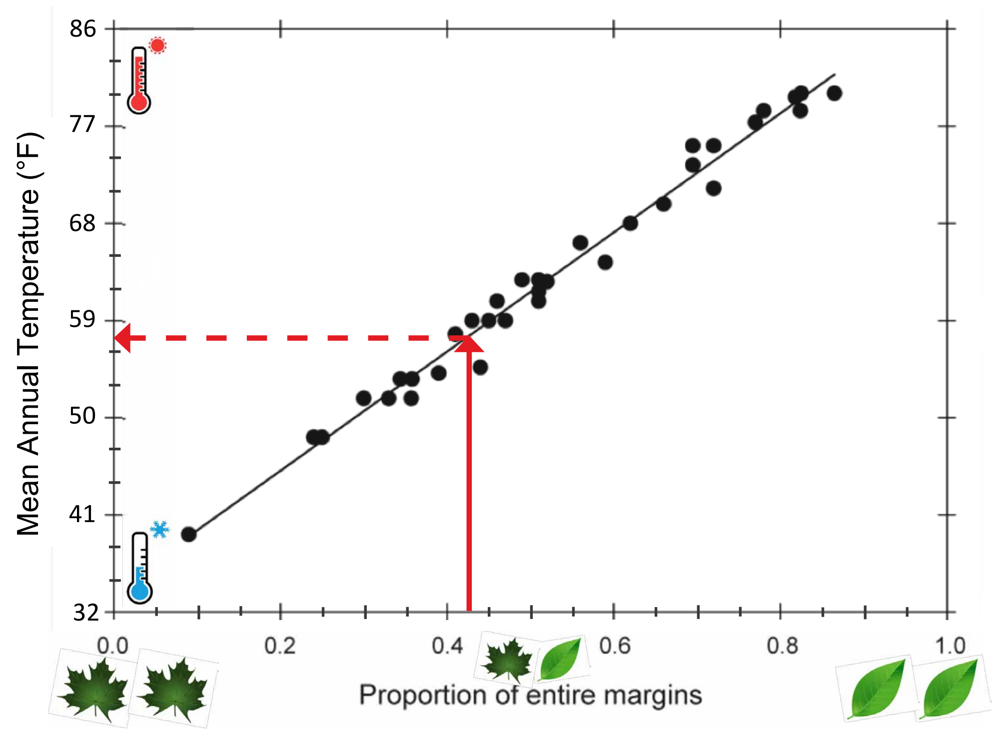
Find the proportion of smooth leaves:

Total # of leaves = 28

# of smooth leaves = 12

# of smooth leaves ÷ total # of leaves = 12/28 = .43

Determine the mean annual temperature using the scatter plot and proportion of smooth leaves:



Mean Annual Temperature: 58°F

(Wolfe 1979)

Jose Creek Formation

Answers to Leaf Images

J Smooth: 2, 4, 5, 7, 8, 9, 12-16, 18-22, 25-28
J Toothed: 1, 3, 6, 10, 11, 17, 23, 24

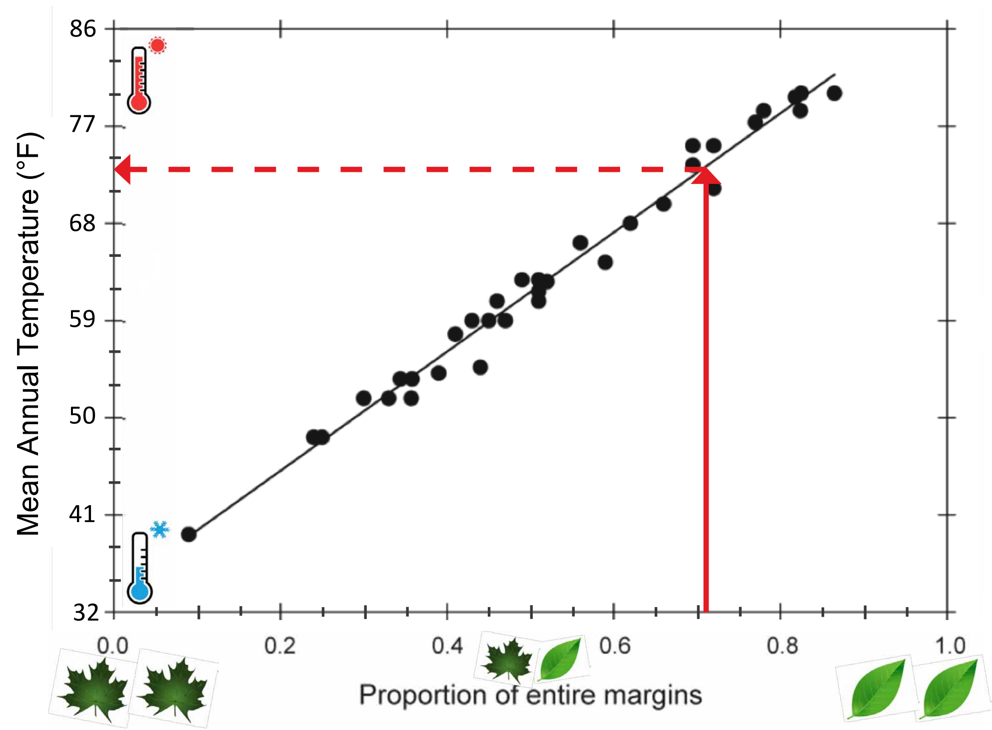
Proportion and Scatter Plot:

Total # of leaves = 28

# of smooth leaves = 20

# of smooth leaves ÷ total # of leaves = 20/28 = 0.71

Determine the mean annual temperature using the scatter plot and proportion of smooth leaves:



Mean Annual Temperature: 73°F

(Wolfe 1979)

QUESTIONS

1. The current mean annual temperature for Chignik, Alaska is 38.5°F. Using the scatter plot above, do you think they would have more smooth leaves, or toothed leaves? Why?

   Chignik, Alaska would have more toothed leaves, based on the figure provided.

2. The current mean annual temperature for Elephant Butte State Park, New Mexico- close to the Jose Creek Fossil site, is 62.6°F. Using the scatter plot above, do you think they would have more smooth leaves, or toothed leaves? Why?

   Based on the scatter plot above, the flora would contain less smooth leaves (more toothed leaves).

3. The mean annual temperature in Elephant Butte State Park, New Mexico today is not too different compared to what it was 75 million years ago, but is in the middle of the Chihuahuan desert. Why do you think the plants there are so different today compared to then? Hint: Think about what else plants need to survive and thrive in their environments.

   Answers will vary. One example may be: Plants need water to survive, there isn't much precipitation in the desert, so it could impact on the types of plants growing in the area.

Notes to the Educator:

- You may ask students to analyze leaves from a single site, or from both sites. Students will need 2 copies of the data log to analyze leaves from both sites.
- Depending on how students sort their leaves, their proportion and temperature may be slightly different than what is shown on the answer key. Ask students to support their reasoning.

Fossils: From Discovery to Display

HOW DOES A FOSSIL GO FROM BURIED IN THE GROUND TO A MUSEUM DISPLAY?

Additional Materials:

- Scissors
- Envelope, or paper bag
- Tape or glue

INTRODUCTION:

Finding **fossils** isn't all that a paleontologist does. They have to examine the fossils too! Just like other branches of science, this takes a team of people with different skills all working together towards a common goal. They have to be willing to debate and change their interpretations of the science as the available data evolves.

- **Paleontologist:** a scientist that studies prehistoric life
- **Fossil Preparator:** someone who works to remove a fossil from its matrix and prepare it for study or display
- **Museum Curator:** a person who oversees a collection of objects, in this case fossils!

Before you begin: Cut the fossil sheet along the dotted lines and put the pieces into an envelope or bag.

FIELD JOURNAL:

Thank you for joining Dr. Ron, Dr. Dori, and the Perot Museum of Nature and Science team in the field! It is always helpful to have another paleontologist on site. Let's start digging! The fossils won't find themselves.

Day 1: You worked hard today and were able to recover 4 fossils. Good work team!

- Without looking, take 4 fossils from your envelope.

Back at camp, you are excited to get started studying your find. Take the next 3-5 minutes examining the fossils. Try putting them into different arrangements to see if you notice any patterns. What animal, or animals, do you think these fossils might belong to?

Record or sketch your observations.

Day 2: A bright new day, perfect for a fossil hunt! You decide to keep looking at the same location, hoping you are able to find more fossils. Great news – the team recovers 3 more fossils!

- Without looking, take 3 fossils from your envelope.

At the end of the day, you head back to camp. Spend the next 3-5 minutes analyzing the fossils. Try putting them into different arrangements. With this new evidence, do any new patterns emerge?

Record or sketch your observations.

Day 3: The last day in field! By now you are pretty tired and the rock layers containing the fossils are hard and tough to get through. But you press on, excited to see what the day brings. Wonderful news, you recover 3 more fossils!

- Without looking, take 3 more fossils from your envelope.

It is the final night at camp- of course you spend time examining the day's find! Spend the next 3-5 minutes examining the fossils. Try putting them into different arrangements. With this new evidence, do any new patterns emerge?

Record or sketch your observations.

What animal do you think these fossils belong to? Try to be specific.

BACK IN THE PALEO LAB:

Step 1: Welcome back to the Perot Museum of Nature and Science! Today you will join Hillary, Myria, and Briana in the Fossil Prep lab. After removing the protective field jacket for transport, there is still a good amount of matrix around the bones. Fossil preparators clean up the fossils by removing the surrounding rock and restore them by puzzling the pieces back together.

- Use your scissors to cut closer along or near the solid lines.

Take another 3-5 minutes to investigate the fossils. With the bones cleaned, is it easier to see how they might fit together? Are you able to reconstruct part of a skeleton?

Record or sketch your observations.

Step 2: Now that the fossils are cleaned up, Karen and Tim from the collections team can label them, and find a home for them within the museum's storage areas. There, Dr. Ron and Dr. Dori, or other paleontologists, can examine the fossils in detail.

Take a final 3-5 minutes assembling your fossils. Use the Resource Manual to compare your fossils to those in the images. Do you notice any similarities or differences? Do the images give you any further clues for how the fossils might fit together?

Tape or glue your arrangement here:

Step 3: WOW! What a journey these fossils have made! The last stop is to be put on display at the Perot Museum. Karen, Tim, and the fossil preparators will now prep the fossils to be ready for display. Dr. Ron or Dr. Dori gathers the information to tell the story of the fossils, and advise the people making the exhibit on how to display or pose the specimens.

Thank you for your help in the discovery, recovery, and preparation of this new fossil find! Many visitors will be able to enjoy and learn from your scientific contribution.

QUESTIONS

1. How did your arrangement change when you added more fossils? Did it change your initial idea of what animal, or animals, the fossils belonged to?

2. Did your thinking change after using the resource book? How so?

3. Describe or illustrate what you think this animal, or animals, may have looked like when it was alive.

4. It is very rare to discover a complete skeleton at one field site. Do you think it would have helped your investigation to have looked at all of the fossils from the envelope? Pull out the remaining fossils to see.

Resource Book:

Edmontosaurus sp.

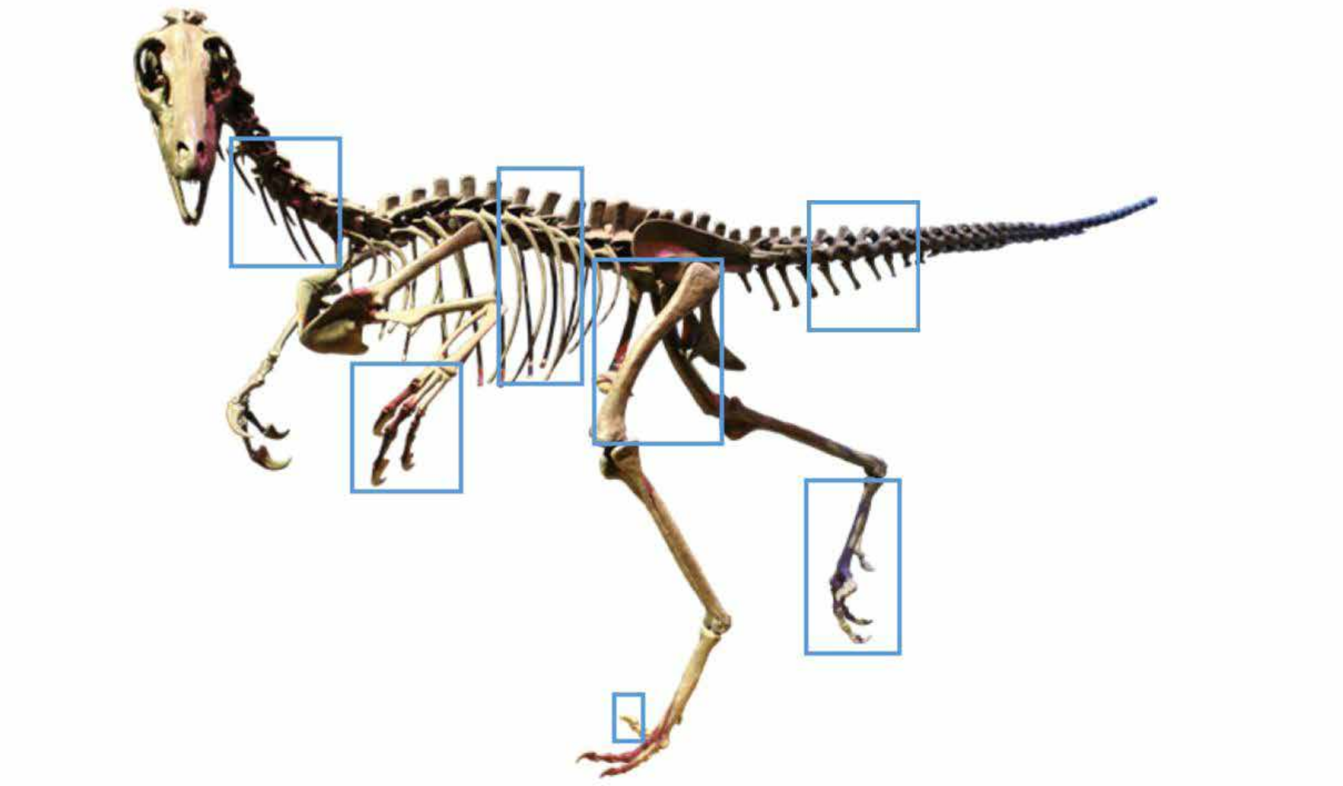
Troodon sp.

Resource Book:

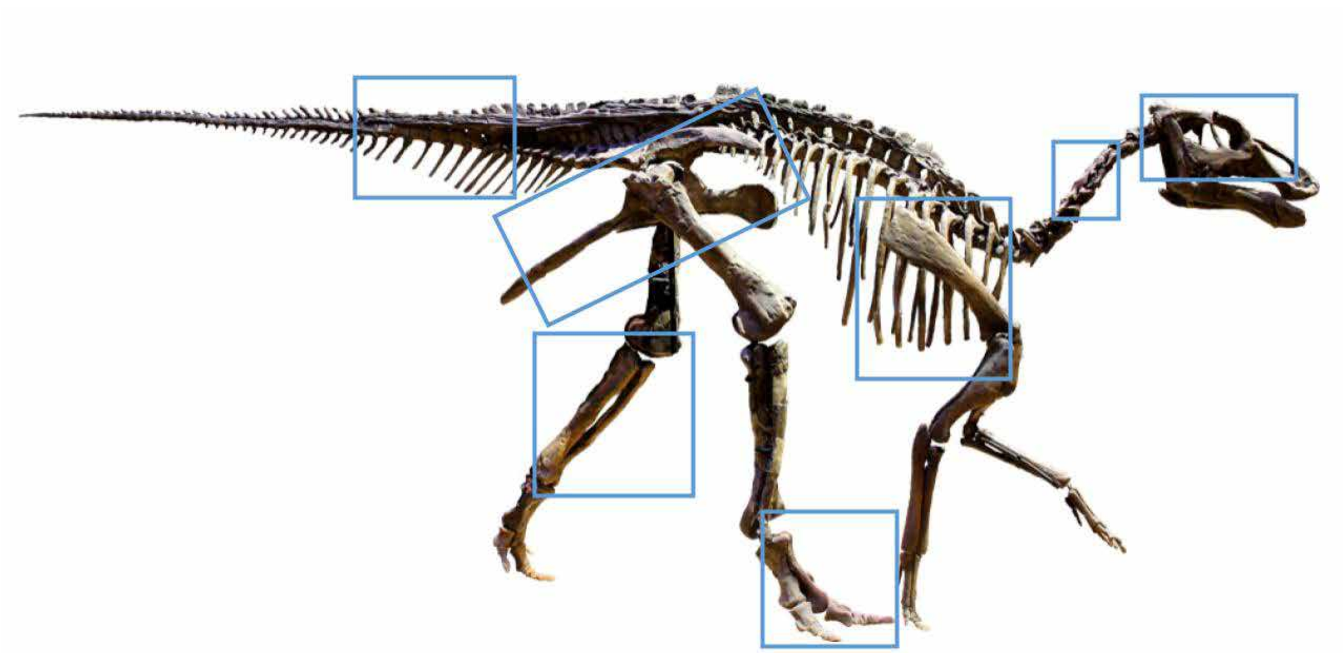
Nanuqsaurus hoglundi

Pachyrhinosaurus perotorum

Fossil Key:



Troodon sp.



Edmontosaurus sp.

Meet the Team!

Meet the amazing paleontologists and collection specialists that further the Museum's mission through ongoing research and discovery! We have asked them all how they became interested in their field, what their favorite part of their job is, what their favorite prehistoric organism or collection piece is, and what career advice they would give young paleo enthusiasts.

DR. RON TYKOSKI

Director of Paleontology & Curator of Vertebrate Paleontology

I wanted to be a paleontologist for as far back as I can remember. I was always fascinated by fossils, dinosaurs, and all things prehistoric. My favorite part of my job is the thrill of discovery. I love that moment when the lightbulb in your head lights up, when you realize you just discovered something completely new. Something no one else has ever seen before, or a connection no one made before.

I've conducted research in the fossil collections of places like The University of Texas at Austin, the Museum of Paleontology at the University of California at Berkeley, the Museum of Northern Arizona, and of course at the Perot Museum. Some of the more spectacular projects I've overseen here have been the preparation of the skull of the ceratopsian dinosaur *Pachyrhinosaurus perotorum* from Alaska, the description and naming of North America's oldest fossil bird *Flexomornis howei* from Grapevine, Texas, and the preparation of the Museum's series of huge neck vertebrae of the giant sauropod dinosaur *Alamosaurus sanjuanensis* from Big Bend National Park.

Favorite Dinosaur:
"Syntarsus" kayentakatae. A small-ish, meat-eating dinosaur from Early Jurassic age rocks (around 185-180 million years old) of northern Arizona.

Career Advice:
Be prepared to spend a LOT of time in school, but don't limit your learning to just what is taught in the classroom. Read! Look for information about geology, biology, ancient organisms, modern organisms, and everything in between. If fieldwork appeals to you, learn how to camp, hike, and live outdoors. Learn to think, be curious, investigate, and always ask "why?". Then seek the answer!

DR. DORI CONTRERAS

Curator of Paleobotany

Although everyone generally loves fossils, I didn't consider being a paleontologist until well into college. I was training as a botanist and was interested in living plants. I became interested in studying fossils when I realized that they allow us to ask and answer so many more questions – they provide the only direct information about the history of the Earth and help explain much of what we see around us today. Plus, a lot of fossil plants are really weird and fascinating to try to understand!

Being a curator at a museum allows me to work directly with fossils all the time and to help build collections that are preserved for future generations. I also get the opportunity to share what we learn with the general public, hopefully sparking in others a fascination with the incredible history of life on Earth!

I've had the opportunity to do field work and collected fossils in New Mexico, California, Argentina, and now in Texas. Collecting fossils is still one of the things I enjoy the most – the rush of discovery as you crack open a rock with a hammer to reveal a leaf or other fossil that has been entombed for many millions of years! It's even better when you immediately know you found something really beautiful or scientifically important.

Favorite Fossil Plant:
My favorite fossil plants are the Cretaceous fossil redwoods, which are in a group called the sequoioids. These are the earlier relatives of the giant redwood trees that today either live in isolated patches in California or one species in a valley in China. They used to occur all over the world when dinosaurs roamed. Their leaves preserve nicely and they make for lovely fossils, but for me they are particularly special as because they are the first group of fossils I ever worked on describing.

Career Advice:
From a school perspective, study as much biology and geology as possible, and be prepared to continue beyond your bachelor's degree. But, perhaps as important, is to get as much early hands-on experience and exposure to the career as possible. That means volunteering in museums, if you can, to get field and collections experience, or doing research as an undergraduate in paleontology, biology, or geology to get a taste for what doing science actually involves. It's a long career path, and those experiences will not only help you progress along that path, but will also help you figure out what you enjoy doing (or not doing!).

HILLARY CEPRESSMCLEAN

Fossil Lab Manager

I was very lucky to have grown up living down the street from the Denver Museum of Nature and Science. From mummies to diorama halls, I loved it all, but my absolute favorite place in the museum was the dinosaur exhibit, *Prehistoric Journey*. Fast forward about 20 years, and I started my career as a paleontologist by being an exhibit volunteer for the Denver Museum. In the Denver lab, I learned how to prepare fossils for research and display and I even got to go out on awesome dinosaur digs in Utah, Wyoming, New Mexico, and Colorado!

From my time at the Denver Museum to where I work now at the Perot Museum, I have gotten to prepare some amazing dinosaur specimens and discover some of them on my own! Getting to put back together bones and slowly remove them from the surrounding rock is one of my favorite things about my job. Being the first person to see the bones from a dinosaur since it died millions of years ago is very special and I really enjoy the different challenges preparing a fossil can entail.

Favorite Dinosaur:
I hope to someday prepare fossils from my all-time favorite ceratopsian dinosaur called "*Diabloceratops*." It is related to its bigger cousin the *Triceratops*, but what makes this dinosaur special is the two large horns that sprout out from the top of its frill! The Museum has a ceratopsian of its own that is also one of my favorites and one that I have actually got to work on now – *Pachyrhinosaurus perotorum*!

Career Advice:
My advice to anybody interested in getting into Paleontology as a career is to do well in school and try to find a museum or university where you can volunteer. Volunteering is how you gain valuable experience that most employers and graduate school professors are looking for!

MYRIA PEREZ

Fossil Preparator

I have been fascinated with dinosaurs since I was a kid. I started my journey towards becoming a paleontologist by becoming a volunteer at the Houston Museum of Natural Science when I was just twelve years old. I went to college and studied geology and anthropology at Southern Methodist University while working in the fossil labs on campus. During my college years, I conducted research on ancient marine reptiles called ichthyosaurs and was a part of a Smithsonian Institution exhibition on Cretaceous marine reptiles from Angola, *Sea Monsters Unearthed: Life in Angola's Ancient Seas*.

I work in the visible Paleo Lab on Level 4 of the Museum, cleaning fossils including those from Northern Alaskan *Pachyrhinosaurus*, while also doing science communication outreach to inspire young women in STEM as an AAAS IF/THEN Ambassador.

Favorite Prehistoric Creatures:
Plesiosaurus and *Diplocaulus*. Neither of these is a dinosaur. *Plesiosaurus* was a long-necked marine reptile that lived in the Early Jurassic seas which once covered modern-day England. *Diplocaulus* was an amphibian characterized by its "boomerang"-shaped skull discovered in Permian age rocks of North America and Africa.

Career Advice:
My biggest piece of advice is to be brave and ask your questions!

BRIANA SMITH

Fossil Preparator

Ever since I saw *Jurassic Park* as a kid it was like a lightbulb flipping on, I couldn't imagine being anything other than a paleontologist. (Though I'm sure as a child I imagined that someday science would actually see us bringing dinosaurs back to life and I would get to work with them.) As an adult I realize that's never going to happen, but I'm still more than happy working with their bones. My favorite part of the job is finding fits between fossil pieces. You have no idea how SATISFYING it is when two pieces of bone just "click" so nicely together like puzzle pieces.

So far, I've had the opportunity to do fieldwork three times right here in Texas, once in Ellis County and twice in Cooke County. In Ellis County I helped dig up Ellie May, the Columbian Mammoth on Level 3 of the Museum, while in Cooke County I got to help dig up a huge turtle and then a sauropod limb bone.

Favorite Dinosaur:
My favorite dinosaur has always been and probably will always be *Triceratops*. I know how basic that sounds — everyone's favorite dinosaur is either that or *T. rex* — but there's just something about this dinosaur in particular that I just LOVE.

Career Advice:
Some advice I can give is to practice your puzzling and art skills. Paleontology is a lot like a jigsaw puzzle on hard mode — you don't know if you even have all the pieces and some of the pieces you do have are broken into even smaller pieces. In prepping the fossils, an artist's eye really helps you to tell between bone and matrix, and finding differences in texture and color between pieces of bone.

KAREN MORTEN

Collections Manager

I grew up going to museums in Chicago. My "Ah ha" moment when I knew I wanted to work in a museum was at the Art Institute of Chicago while walking through their gallery filled with armor and weapons. It was, and still is, an amazing exhibit and I wanted to be able to create that same experience for other people. The favorite part of my job is being in the galleries at the Perot Museum and hearing our visitors' joy in what they are seeing, whether it be a dinosaur towering above them or a black bear staring at them as they come off the elevator.

As the Collections Manager, I do not do any fieldwork. My job is to care for, and document the use of, the specimens after they come to the museum. It requires a lot of paperwork and recording specimen data (collected by the field teams) in our database. I take care of all of our collections, not just fossils. I get to work with birds, mammals, insects, plants, reptiles, and amphibians. We also have a collection of rare books and the museum's archives that require my attention.

Favorite Collection Piece:
The melanistic jaguar that is in the *Discovering Life Hall*. Instead of the usual yellow fur with black spots, it is a beautiful burgundy color with black spots.

Career Advice:
I always recommend volunteering at a museum first before investing tons of money into graduate school, just to make sure you know what you are getting into! It also helps to have a passion for history and a desire to record the past from which future generations will learn.

TIM BRYS

Education Collections Coordinator

I have always loved nature; to look for things and just explore. Zoos and natural history museums were my favorite places to visit as a child. The processes of how to prepare natural history specimens were passed down from a great uncle that worked at the Carnegie Museum of Natural History as well as from other family and friends who also loved nature. I was very lucky to have great science teachers that kept me inspired while going through school.

As the Education Collections Coordinator at the Perot Museum, I take care of the live animals, the teaching collection, and help Karen Morton with items in the main collections. What I like most about my job is all the amazing natural items I get to see and work with as well as being able to constantly learn new things from the other excellent museum staff. I have had the chance to help with fieldwork locally in Texas as well as in Wisconsin, Pennsylvania, the island of Anegada and a short while with biodiversity in southern Africa.

Favorite Collection Piece:
When my son was 4 years-old, he found the fossil remains of a dinosaur called a nodosaur while we were out collecting fossils. I was able to help professors from Southern Methodist University to remove the bones from the site and to work on preparing it in their lab.

Career Advice:
If I were to give advice to a young person interested in working at a museum, it would be to always keep learning from anyone you can. Take time to learn from any teacher, professional or person passionate about what you are interested in. Always keep learning and always keep looking. You can't find something if you never look.

RESOURCES

GLOSSARY

Body Fossil - the preserved remains of dead organisms, such as such as bones, teeth, wood, and leaves

Carnivore - an animal that eats primarily meat

Cast (Fossil) - a preservation type that forms within a mold; casts are usually three dimensional

Coprolite - fossilized feces (poop)

Compression - a preservation type in which the organic matter consists of a thin film of carbon

Cretaceous Period - the interval of geological time spanning 143 million to 66 million years ago

Dinosaur - any member of the group of reptiles that includes the last common ancestor shared by *Triceratops* and a chicken (or any other modern bird) and ALL the descendants of that last shared ancestor

What IS a Dinosaur? | Amaze Your Brain at Home

Extinction - when an entire species dies out and is gone forever

Environment - the conditions around a living thing, such as temperature, precipitation, and pollution

Fossil - any record of prehistoric life (older than about 10,000 years)

Fossil Preparator - someone who works to remove a fossil from its matrix and prepare it for study or display

Herbivore - an animal that eats primarily plants

Impression - a preservation type that represents a negative imprint of an organism; no organic material remains

Mold (Fossil) - a three-dimensional preservation type that represents a negative imprint of the plant (compare cast)

Mosasaur - any one of several species of predatory, marine lizard that lived in the later parts of the Cretaceous Period

Museum curator - a person who oversees a collection of objects, such as fossils

Omnivore - an animal that eats both plants and meat

Paleontologist - a scientist who studies ancient life

Paleontology - the study of past life on Earth

Predator - an organism that eats other organisms for food

Prey - an animal that is hunted and eaten by another animal

Permineralization - a kind of fossilization in which the tiny empty spaces within a porous object (like bone or wood) are filled with mineral deposits

Species - the basic unit of biology, a group of naturally-occurring organisms that reproduce with one another apart from other species

Trace Fossil - preserved evidence of animal an organism's activity, like footprints or skin impressions

Western Interior Seaway - a shallow seaway that once covered the central parts of North America during the Cretaceous Period

Texas Paleontology:

DINOSAUR	WHEN LIVED	WHERE LIVED	CARNIVORE OR HERBIVORE?
Acrocanthosaurus	Early Cretaceous Period, around 110-115 million years ago	Oklahoma, Texas, probably other parts of North America	Carnivore
Alamosaurus	Late Cretaceous Period, around 70-66 million years ago	Western Texas, New Mexico, Utah, northern Mexico	Herbivore
Convolosaurus	Early Cretaceous Period, around 110-115 million years ago	North Texas	Herbivore
Deinonychus	Early Cretaceous Period, around 110-115 million years ago	Most of North America, including Texas	Carnivore
Protohadros	Late Cretaceous Period, around 96-97 million years ago	North Texas	Herbivore
Tenontosaurus	Early Cretaceous Period, around 110-115 million years ago	Much of North America, including Texas	Herbivore
Torosaurus	Late Cretaceous Period, around 68-66 million years ago	Western North America, possibly including western Texas	Herbivore
Tyrannosaurus	Late Cretaceous Period, around 68-66 million years ago	Western North America, probably including Texas	Carnivore

NOT A DINOSAUR	WHEN LIVED	WHERE LIVED	CARNIVORE OR HERBIVORE?
Dallasaurus	Late Cretaceous Period, around 90-92 million years ago	North Texas	Carnivore
Edaphosaurus	Early Permian Period, around 290-275 million years ago	North America, Europe, perhaps elsewhere, but most specimens are known from north-central Texas	Herbivore
Seymouria	Early Permian Period, around 290-275 million years ago	North America, Europe, but the original species is known only from North Texas and named after the town of Seymour	Carnivore or Omnivore
Mammuthus columbi	Pleistocene Epoch, around 1.3 million years ago to about 10,000 years ago	Much of North America	Herbivore
Quetzalcoatlus	Late Cretaceous Period, around 70-66 million years ago	Western Texas	Carnivore
Tylosaurus	Late Cretaceous Period, around 90-75 million years ago	North America, Europe, Africa	Carnivore

Prehistoric Texas Plants:

NAME	WHEN LIVED	WHERE LIVED	TYPE OF PLANT
Cordaites	Mississippian – Permian	North America, including North Texas; Europe; China	Extinct gymnosperm that formed trees. Most commonly found as strap-shaped leaves.
Neuropteris	Carboniferous	North central Texas, and many other parts of the world	Seed fern, an extinct group. Known from leaf impressions that are fern-like, but they produced seeds (unlink true ferns).
Sigillaria	Middle Devonian to Early Permian, 383.7 to 254 million years ago	Found in many places throughout the world, particularly common in North America, including Texas.	Tree-like lycopod (club-moss), in the Lepidodendrales group. Commonly known from impressions of the trunk with the impressions of the bases of leaves.
Walchia	Carboniferous to Permian	Commonly found in Texas, New Mexico, and Oklahoma, but can be found many places throughout the world.	Early conifer from a large extinct group – the Walchians.
Palmoxylon	Eocene	East Texas, and much of America	Petrified palm wood (the Texas state stone!)
Frenelopsis ramosissima	Early Cretaceous	North Texas, Maryland and Virginia	Conifer, extinct family Cheirolepidiaceae
Glenrosa	Early Cretaceous	Named for the town of Glen Rose, Texas. There are two species in Texas, others occur across North America, Europe, and Asia.	Conifer, extinct family Cheirolepidiaceae
Leaf fossils of flowering plants, examples: *Daphnophyllum, Laurophyllum, Cinnamomum, Sterculia, Liriodendron, Betulites, Benzoin*	Early Late Cretaceous	In North Texas found in the Woodbine Formation; many species of these types have been recorded elsewhere in North America throughout the Late Cretaceous and early Cenozoic	Broad-leaved flowering plants. Known from leaf impressions.
Phragmites cretaceus	Early Late Cretaceous	Found in North Texas Woodbine Formation, and known from other sites across North America	Possibly a moncot, which is a flowering plant. Known from long strap-shaped leaf impressions.
Petrified wood –many types!	Cretaceous through Eocene	Worldwide, very common in North Texas and Big Bend area (Cretaceous) and East Texas (Eocene).	Conifers and flowering plants

READING LIST

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ONLINE RESOURCES

PEROT MUSEUM EDUCATIONAL RESOURCES

- Amaze Your Brain at Home – Videos and activities to try at home. Be sure to check out Paleontology Week!
- Digging Up Fossils Science Experiment with Paleontologist Myria Perez | GoldieBlox's Curiosity Camp
- Perot Museum's Paleontologists #FossilFriday posts on Twitter
    - @Paleo_Tykoski
    - @DLContreras

PALEONTOLOGY AND FOSSILS

- Geologic Time Scale | GSA
- The Dino Directory | Natural History Museum
- Paleontology Research Guide | Smithsonian
- Paleontology for Kids: Ology | AMNH
- Dinosaur Names | AMNH
- Is it a Fossil? PDF | The Academy of Natural Sciences of Drexel University
- National Fossil Day | National Park Service
- Dinosaurs in Texas | Texas Parks & Wildlife
- Texas Parks with Fossil Finds
    - Dinosaur Valley State Park
    - Big Bend National Park
    - Mineral Wells Fossil Park (One of the few parks where visitors can collect fossils for personal use.)
- Dallas Paleontological Society

STEM CAREERS

- Meet a Paleontologist: Dr. Ron Tykoski
- Meet a Fossil Preparator: Hillary CepressMcLean
- #AskACurator
- IF/THEN Collection | Myria Perez, Fossil Preparator
- Training to Become a Fossil Preparator | AMNH

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