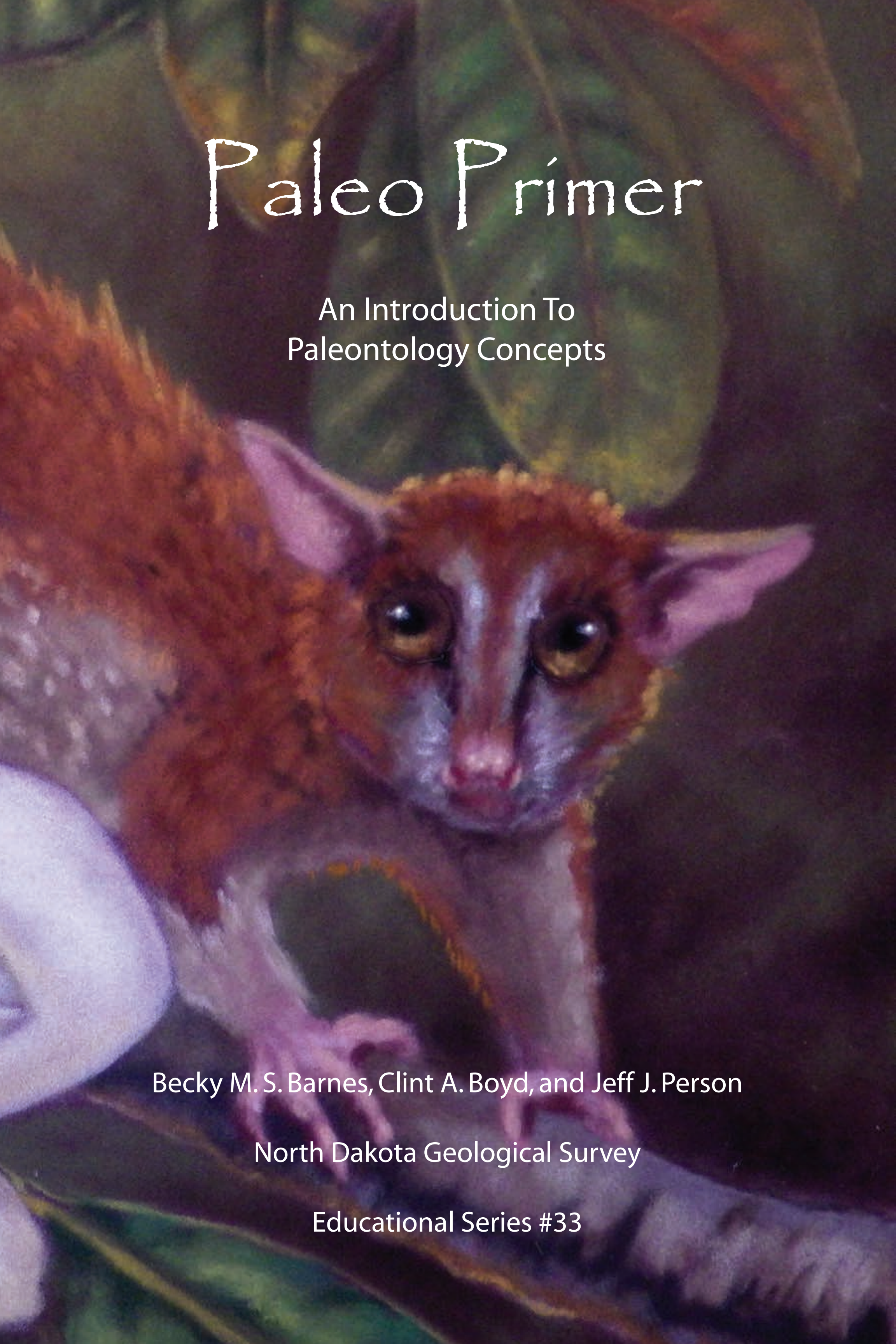

Paleo Primer

An Introduction To Paleontology Concepts

Becky M. S. Barnes, Clint A. Boyd, and Jeff J. Person

North Dakota Geological Survey

Educational Series #33

All fossils within this publication that reside in the North Dakota State Fossil Collection are listed with their catalog numbers.

North Dakota Geological Survey
600 East Boulevard
Bismarck, ND 58505
https://www.dmr.nd.gov/ndfossil/

Cover: *Glasbius twitchelli*, 2016, by Becky Barnes

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The Study Of...

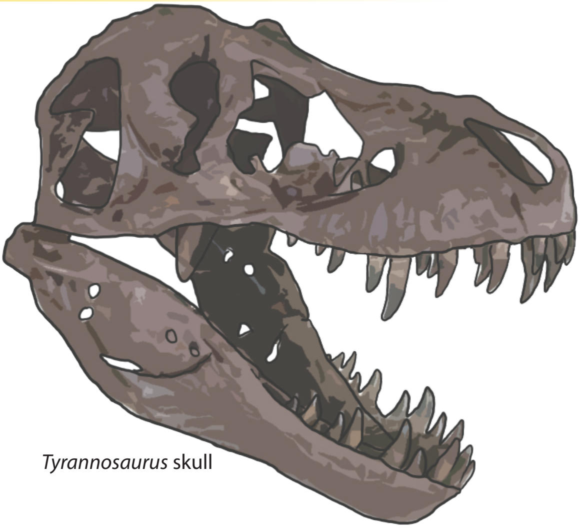
This is the first in a series of books that dig deeper into North Dakota's prehistory. The environment across the state has changed many times over millions of years. This is known because of different areas of scientific study.

Fennec fox & oak leaf

Biology (bio = life, ology = study) is the study of living things, such as animals, plants, fungi, and bacteria.

Rock hammer and rocks

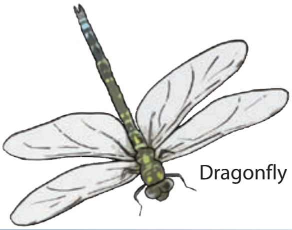
Geology (geo = earth, ology = study) is the study of Earth, rocks, the processes of how they change, the study of the products formed (i.e. coal, oil), and the study of Earth's history.



Tyrannosaurus skull

Paleontology (paleo = ancient, ology = study) combines biology and geology, in order to examine ancient life and environments. This includes things like plants, pollon, snails, fish, dinosaurs, birds, and mammals.

As there are different types of geologists and biologists, there are also different types of paleontologists. For example:

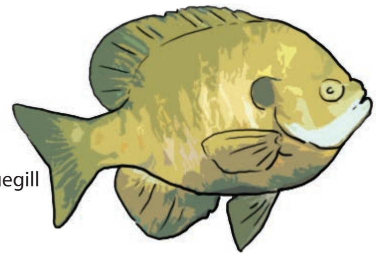


Dragonfly

An entomologist studies insects...

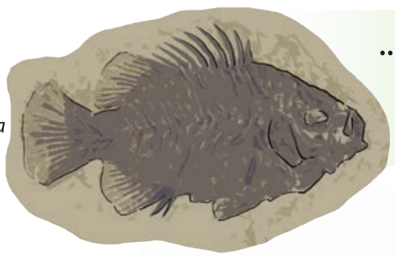
...and a paleoentomologist studies fossil insects.

Fossil dragonfly



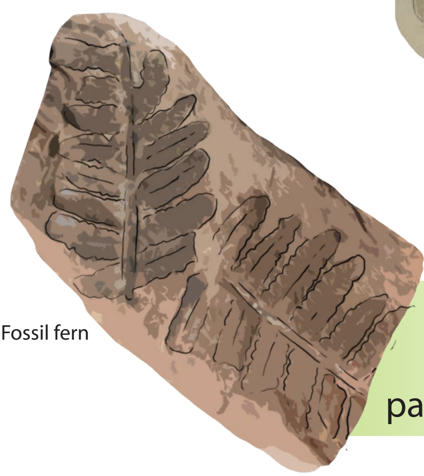
Bluegill

An ichthyologist studies fish...



Fossil *Priscacara*

...and a paleoichtheologist studies fossil fish.



Fossil fern

Fern

Can you guess what a paleobotanist studies?

The next few sections will take a closer look into biology and geology to see how they are important to paleontology, fossils, and the world beneath our feet.

Geology...

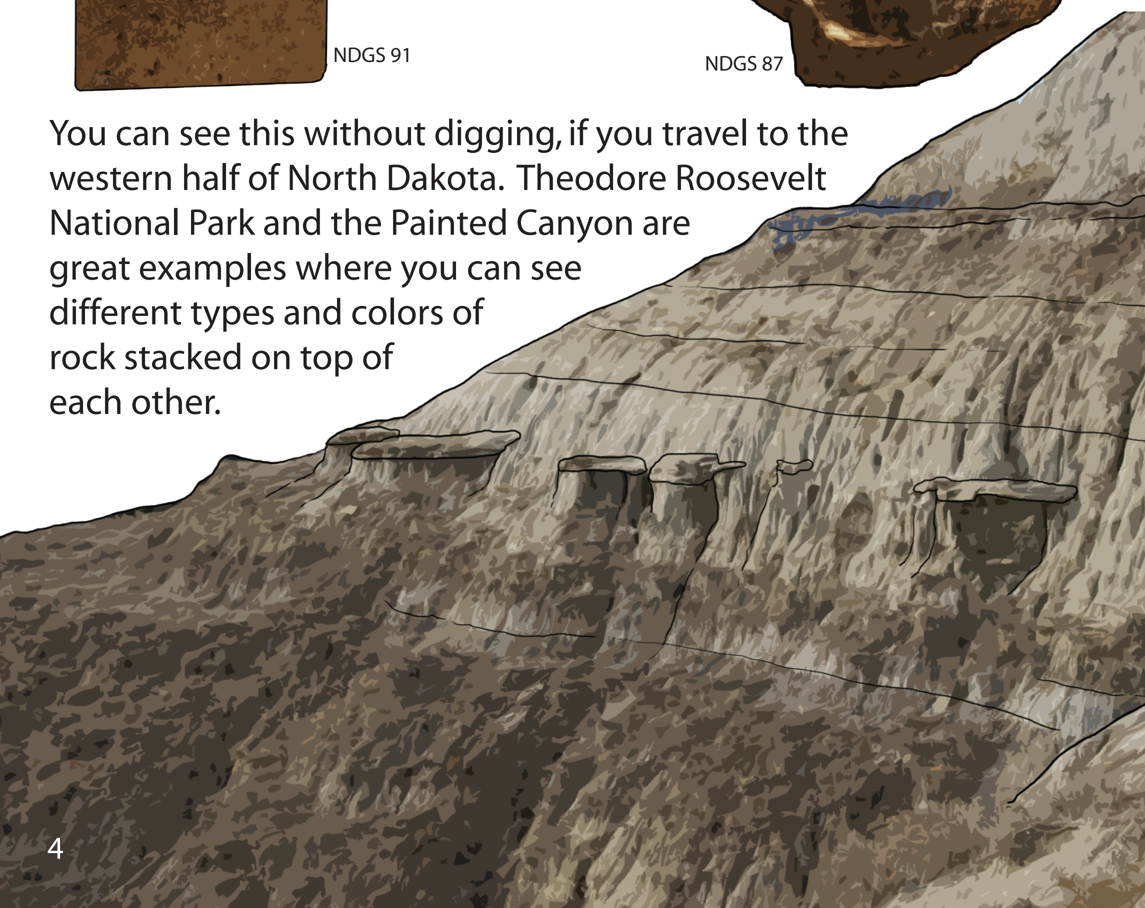
Most of the time people can only view the rocks at the surface, above ground. Some geologists, using special equipment, can drill "core samples" – rock from underground. This is a good way to look at how rock layers change vertically (up-and-down).

NDGS 91

Two core samples from the Mississippian (318-359 million years old), showing fossil coral (left) and a fossil snail (right).

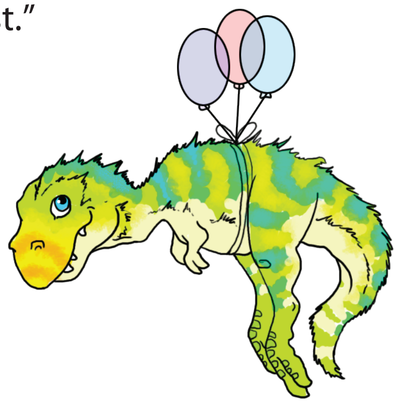
NDGS 87

You can see this without digging, if you travel to the western half of North Dakota. Theodore Roosevelt National Park and the Painted Canyon are great examples where you can see different types and colors of rock stacked on top of each other.

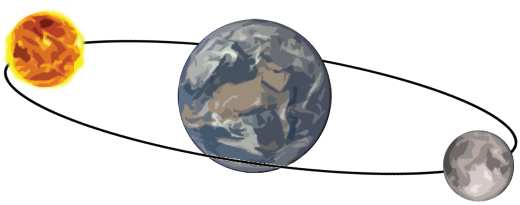


James Hutton

Part of what a geologist studies are the processes that shape the face of the earth. James Hutton (1726-1797), the "Father of Geology," saw the earth around him as an ever changing structure. The events that occur in the present time are the same as those that occured in the past - a concept he called **uniformitarionism** (U-ni-form-. i-tAr-E-on-ism) This is a big word, that Sir Charles Lyell (1797-1875) summarized as "The present is key to the past."



This means that in the age of dinosaurs, gravity didn't suddenly stop working...

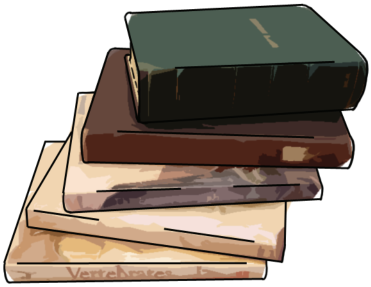


...or that the sun circled around Earth...

...or rivers stopped running.

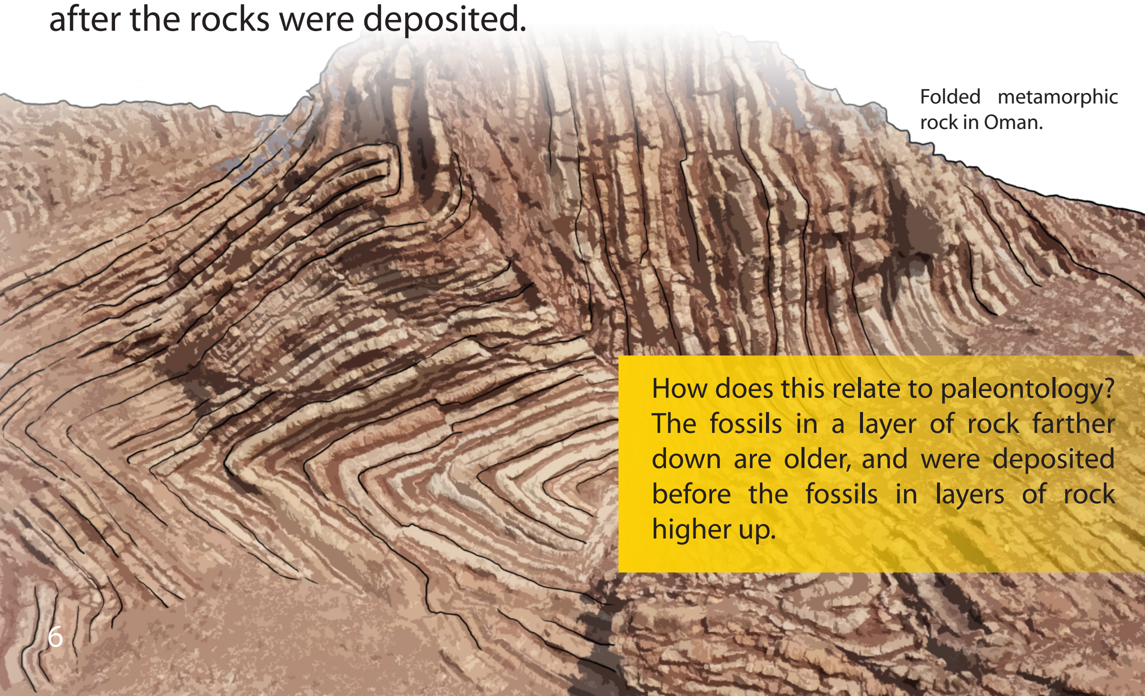
Stratigraphy...

The layers seen in rock are an example of **stratigraphy**, as well as a concept called the **Law of Superposition**. This translates into a simple idea: the rocks on bottom were deposited first – and are older. The rocks on top were deposited last – and are younger. As if you were stacking a pile of books – the one on the bottom was put there first, and the one on top was placed last.



Superposition =
to overlap, to layer

Meanwhile, the **Principle of Original Horizontality**, tells us that when each layer of rock was deposited, it was done in a horizontal position. This means thanks to gravity, objects naturally try to smooth themselves out. Like when you pour water onto the floor, or lava flows from a volcano. If there are no edges to confine them, the liquid (or small rocks!) flows outward evenly. This way, when you see folds or wiggles in rock layers, you know that the bending happened after the rocks were deposited.



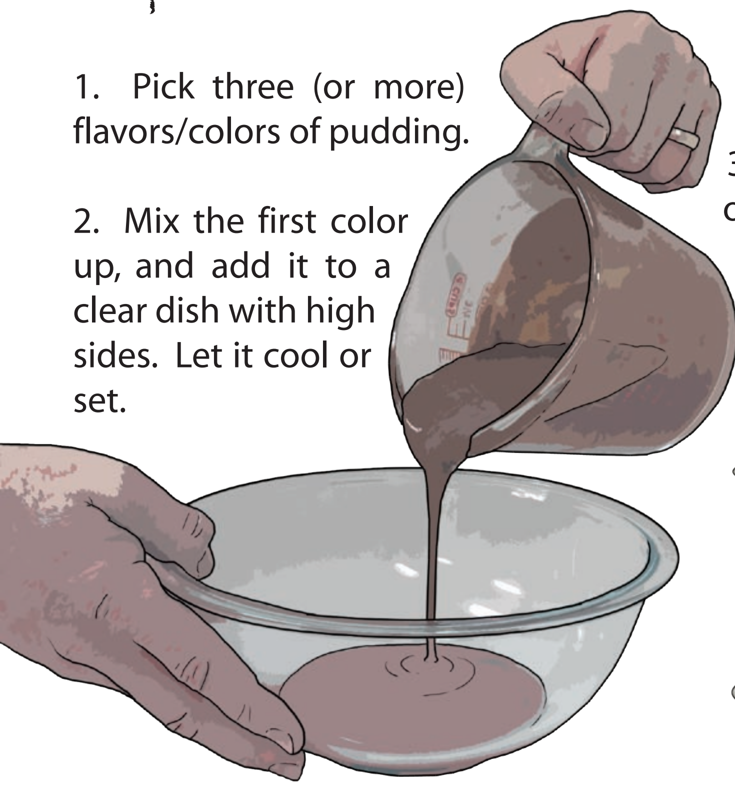
Folded metamorphic rock in Oman.

How does this relate to paleontology? The fossils in a layer of rock farther down are older, and were deposited before the fossils in layers of rock higher up.

Experiment Time!

1. Pick three (or more) flavors/colors of pudding.

2. Mix the first color up, and add it to a clear dish with high sides. Let it cool or set.



3. Add each of your other colors, letting them cool or set in between each layer.

4. Optional - add a layer of crushed cookie "dirt" to top it off!

Results!

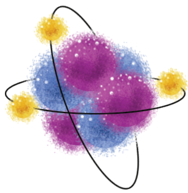
The color on the bottom, the first one you added, is the oldest, while the color on top is the newest - this is Superposition.

The colors evened themselves out into relatively flat layers - this is Original Horizontality.

Let's Break This Down...

One way scientists determine the age of a fossil is by using radioactive decay. Everything breaks down over time – food, rocks, soil, and even atoms, which are the building blocks for everything you can see and touch. Some things take a long time to break down; others a short time. The nice thing about using atoms to help determine how old something is, is the time they take to decay is fairly constant.

Lithium atom with 3 protons, 3 neutrons, and 3 electrons.



An atom is composed of protons (positive) and neutrons (no charge) in the nucleus, surrounded by electrons (negative).

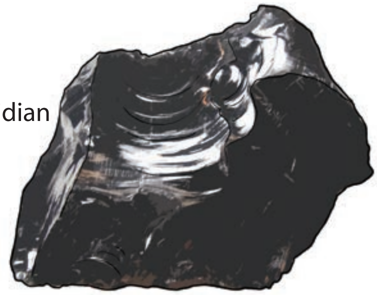
Fossils themselves often can't be directly dated. Instead, we date layers of rock near the fossil, often volcanic ashes. Once a lower and an upper ash layer are aged, you can then give a time bracket to anything between them. If the lower ash layer is 64 million years old, and the next ash layer up is 60 million years old, you know everything sandwiched in the middle is between 64 and 60 million years old.

Much like a sandwhich, the bread is the first and last parts laid down, and everything inside was placed between those times.

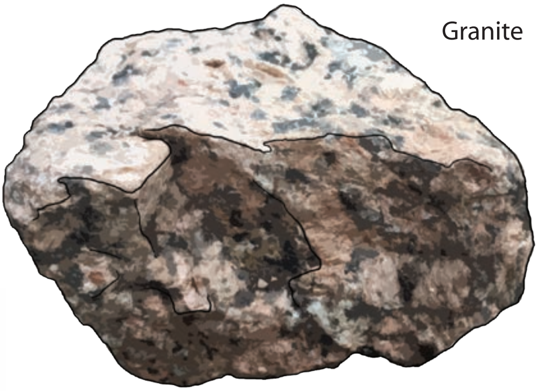
Types Of Rock...

Rocks and sediment can tell us a lot. Rocks created from cooled lava or magma are called igneous. Obsidian (volcanic glass) and granite (a building stone) are two you might be familiar with.

Obsidian

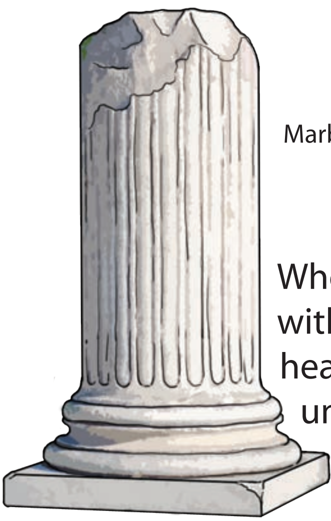


Granite



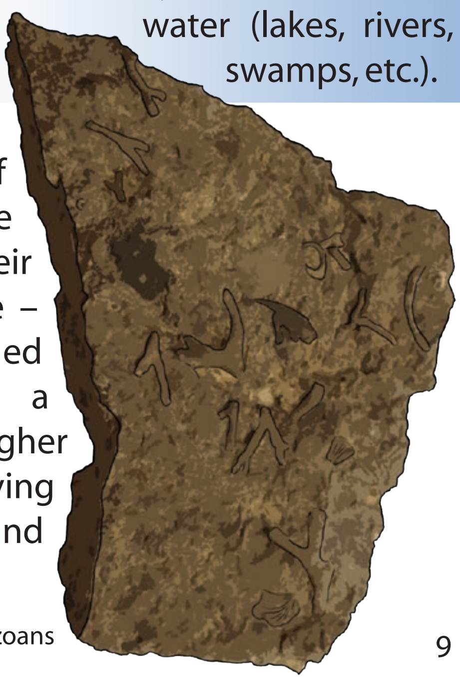
Over time, rocks can be broken down by rain, frost, wind, tumbling, or other physical and chemical causes. Sand, clay, silt, and mud can all come from rocks breaking down.

When those smaller bits are deposited, and compressed into rock again, they are called sedimentary. Sandstone, mudstone, and siltstone are examples, and are often deposited by wind (deserts), or water (lakes, rivers, swamps, etc.).



Marble column

When rocks are met with great amounts of heat and pressure underground, their form can change – they are then called metamorphic. Quartzite is a metamorphosed sandstone that's tougher than concrete. Marble, used for carving and building, was once limestone – and can occasionally contain fossils as well!



Limestone with shells and bryozoans

Fossils In Rocks...

Unless a plant or animal was caught in a volcanic lava flow, fossils are generally found in sedimentary (i.e. sandstone and mudstone) and metamorphic (i.e. marble) rocks. Those that are in metamorphic rocks are usually squished or twisted from heat and pressure. Most mudstones or sandstones are formed in water environments. How fast the water is moving (how energetic the water is) determines the size of sand or mud particles (the individual pieces that make up sand or mud) which are moved.

Strong, fast moving water, such as river rapids, can move larger pebbles and rocks, and don't let smaller pieces settle to the bottom.

At left is an Oligocene rhino jaw (*Subhyracodon*) from a sandstone channel. The stream here had higher energy, and did not allow small particles of mud to collect.

Slow moving, calm waters, such as ponds or swamps, have much muddier bottoms, because there is not a lot of energy in them to keep the particles suspended (caught up in the water).

NDGS 2503

Above right is a jaw from a Paleocene fish (*Esox*) from a mudstone swamp bottom. The swamp was rich in vegetation, which left behind thin bands of coal. The lower energy environment made for a murky, muddy bottom to the swamp.

Experiment Time!

1. You will need a clear jar with a tight lid, coarse sand and pebbles, a bit of water-based clay (if available), some dirt, and water.

2. Add everything together in the jar.

3. Tighten the lid, and shake thoroughly. Set aside in an area where you can check on it periodically without touching it. A window or other area with a good light source works well.

Results!

After you stopped shaking the jar, what settled down to the bottom first? How long did it take for all of the sand to reach the bottom of the container? What about the clay and dirt? How long did it take for the jar to completely clear?

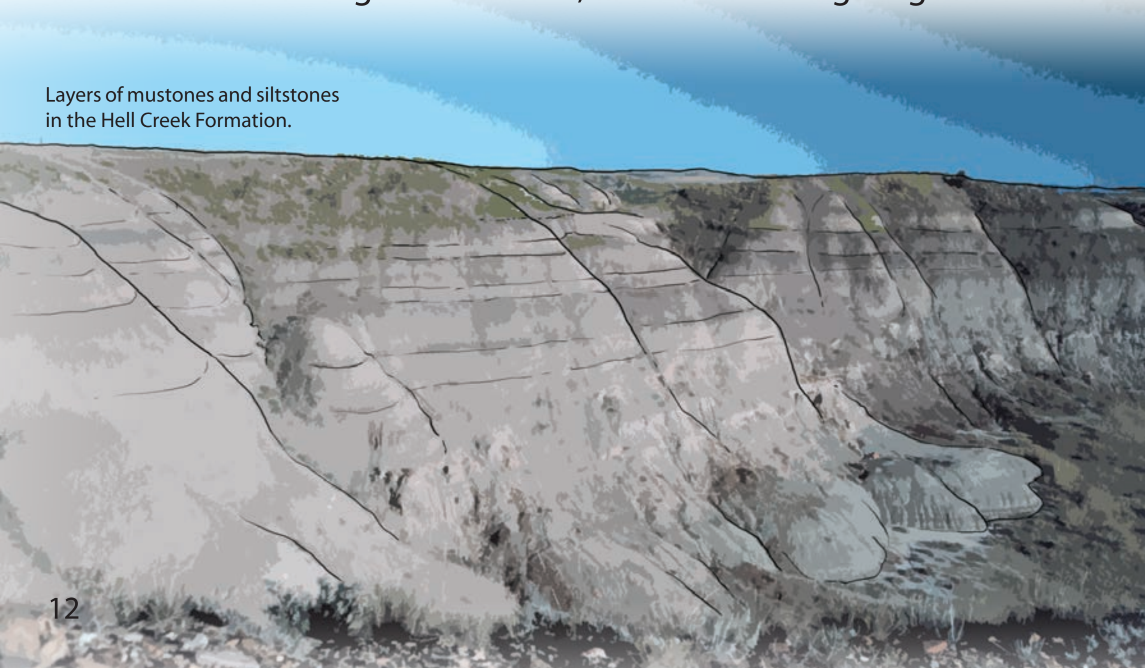
Once clear, see how much the fine particles on top move if you gently bump the jar. Small particles of dirt, clay, and sand move easily, while the larger sand and pebbles take more action (energy) on your part to get them to move again.

Environment Clues...

What happened in your experiment is similar to what happens, and happened, in lakes and rivers across North Dakota. If a fossil is surrounded by super-fine mudstone, that environment used to be a very low energy, calm area.

Mural of what Medora, ND might have looked like 50-65 million years ago. Fine mudstones around the fossils mean the environment used to be a calm, swampy area, rich in vegetation.

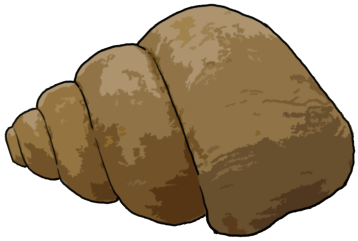
If a fossil is surrounded by sandy sediment, the environment had a little more energy, and the water was moving faster. Sometimes in the stratigraphy, you can see a pattern form in the rocks. Big sand, little sand, mud – repeat. This happens when the water flow in the environment goes from fast, to slow, to calm over and over. This is due to water moving into the area, and then leaving it again.



Layers of mustones and siltstones in the Hell Creek Formation.

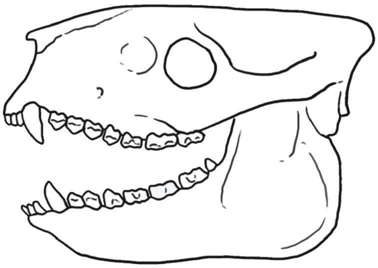
Biology...

When plants and animals fossilize, their hard parts (bones, teeth, wood) tend to preserve better than the soft, squishy bits. This means we are only left with part of the original information, and we have to somehow figure out the rest.



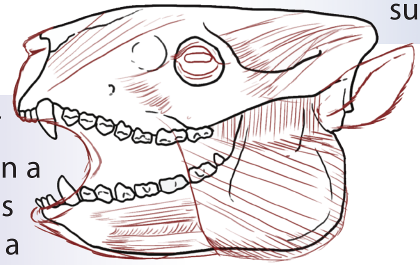
Campeloma snail shell. The soft part of the animal has decayed, leaving behind the calcium shell.

Biology helps out, especially anatomy (bones & muscles), and morphology (form & function). Plants and animals have changed greatly over time, but the basic building blocks are the same. As they face different pressures in their environment, they have to adapt or evolve (change through time), or face extinction.



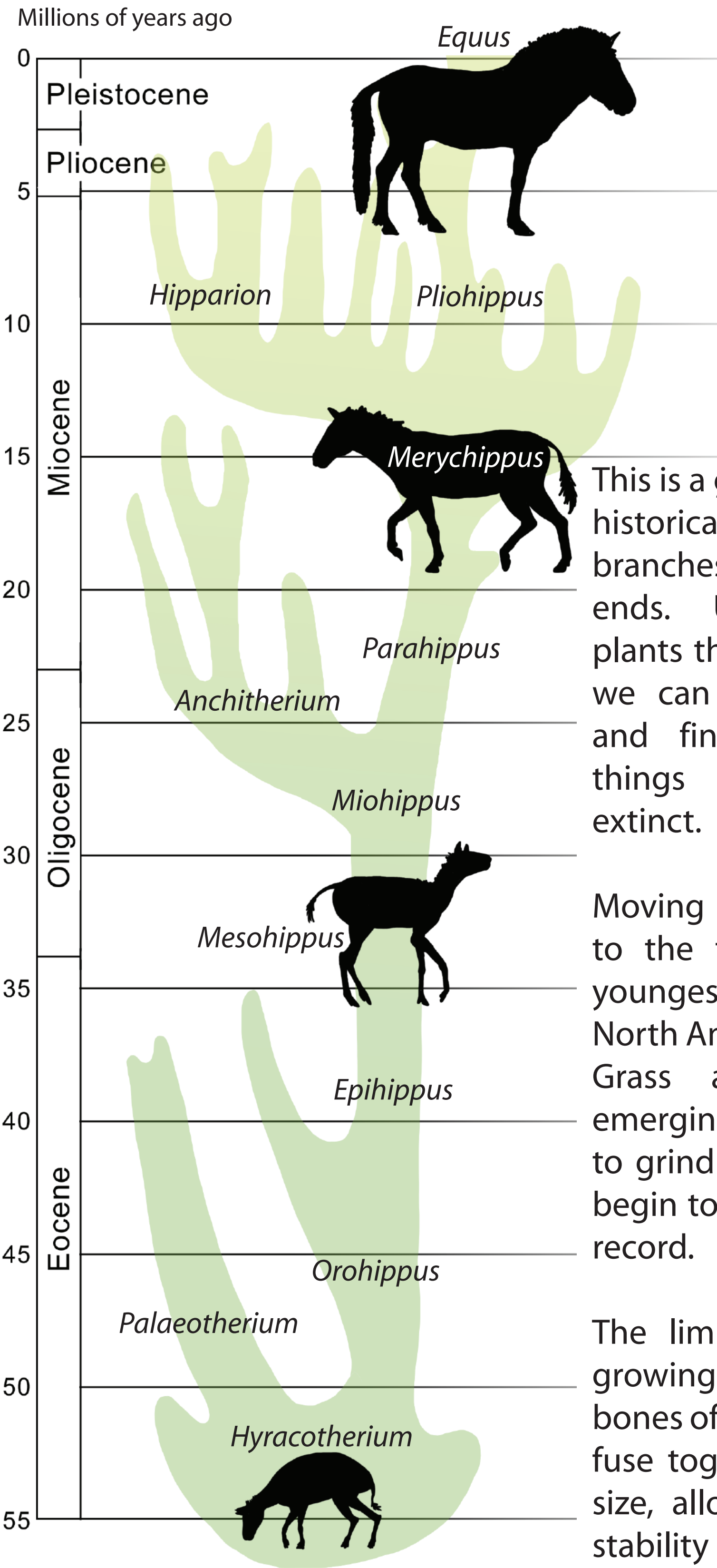
At left is the skull from a mid-sized mammal called an oreodont, specifically *Merycoidodon*. What did this animal look like while alive?

Even though it has no modern descendent, the bones are very similar to other living animals, such as sheep or pigs.



Applying knowledge of where muscles attach on a modern animal to this fossil specimen gives us a general outline.

Teeth can tell us about what the animal was eating, and the environment that type of food is known to grow. While we may not know all the soft features (skin or fur patterns, pupil shape, ear shape, hair, etc.), we can infer what they looked like from similar creatures.



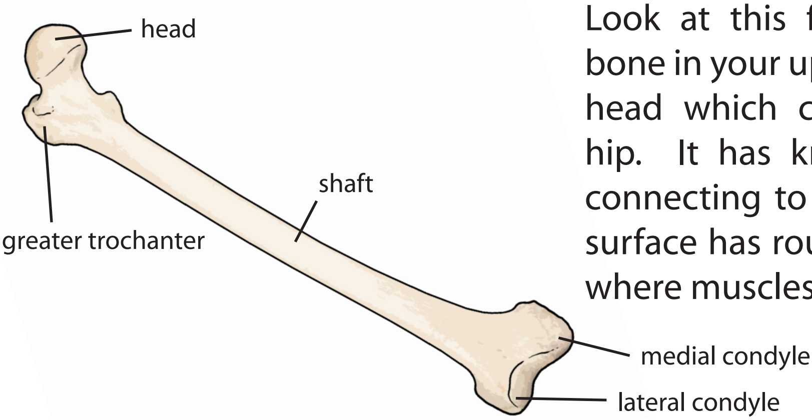
This is one of the better known trees (also called a **cladogram**), showing the evolution of the modern horse. As you can see it is not a straight line.

This is a great example of a historical tree – lots of branches, and lots of dead ends. Using animals or plants that are alive today, we can trace backwards and find similarities to things that have gone extinct.

Moving from the bottom to the top, or oldest to youngest, the landscape in North America is changing. Grass and prairie are emerging, and teeth suited to grind the coarse plants begin to show in the fossil record.

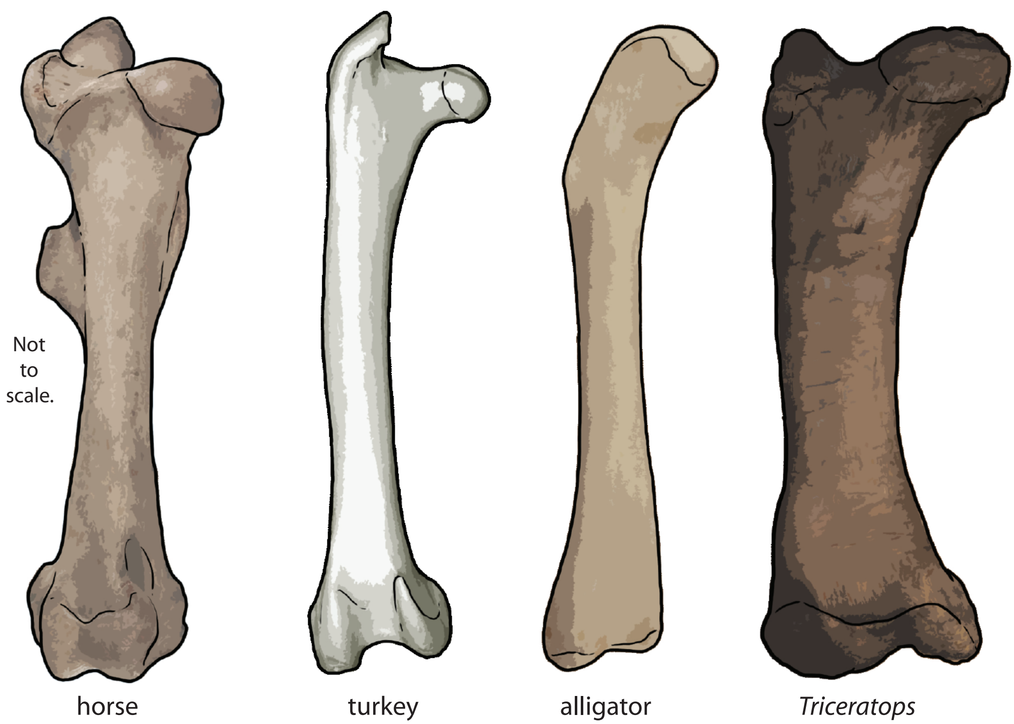
The limbs of horses are growing longer, and the bones of the hand and foot fuse together or shrink in size, allowing for greater stability and speed.

We're Not So Different...



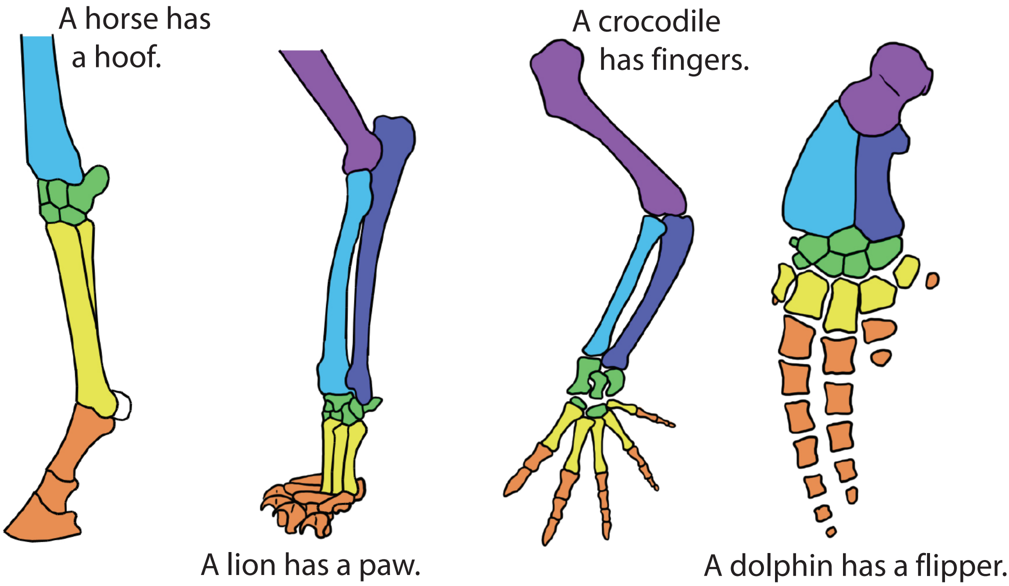
Look at this femur, the long bone in your upper leg. It has a head which connects to the hip. It has knobs (condyles) connecting to your knee. The surface has rough parts (scars) where muscles attach.

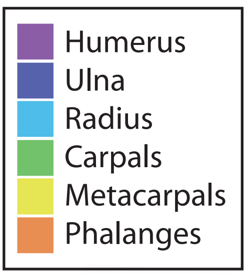
If you compare your femur, to that of a horse, turkey, alligator, or dinosaur, the basic shapes are there because the bone is serving the same purpose in all of those other animals. It may be longer, shorter, curved – but you can still tell it is a femur. This is called comparative anatomy – you are comparing the building blocks of one creature to another, and looking for similarities and differences.



Next time you cook a chicken or turkey, look closely at the bones - can you find the femur?

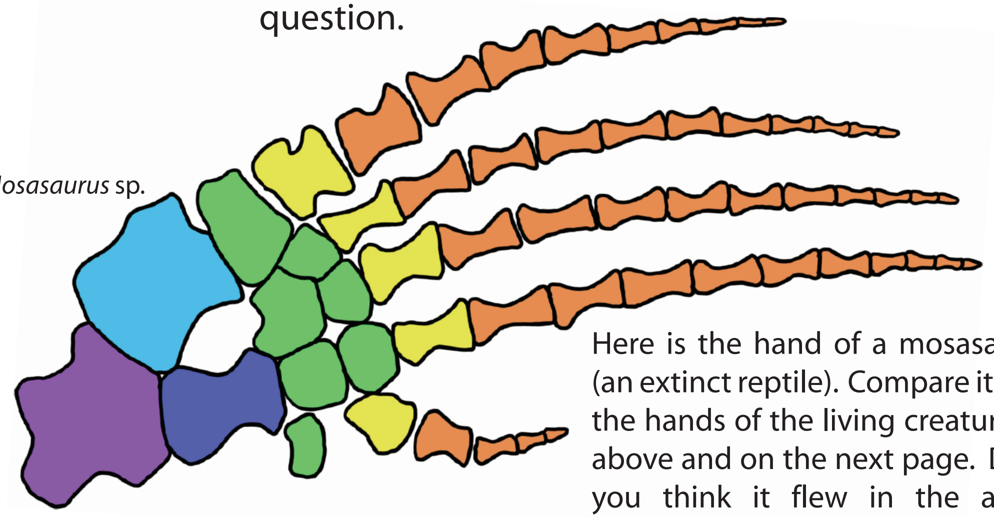
Other bones in the body have seen great changes in different kinds of animals. Lets take a look at the hand from some living creatures:





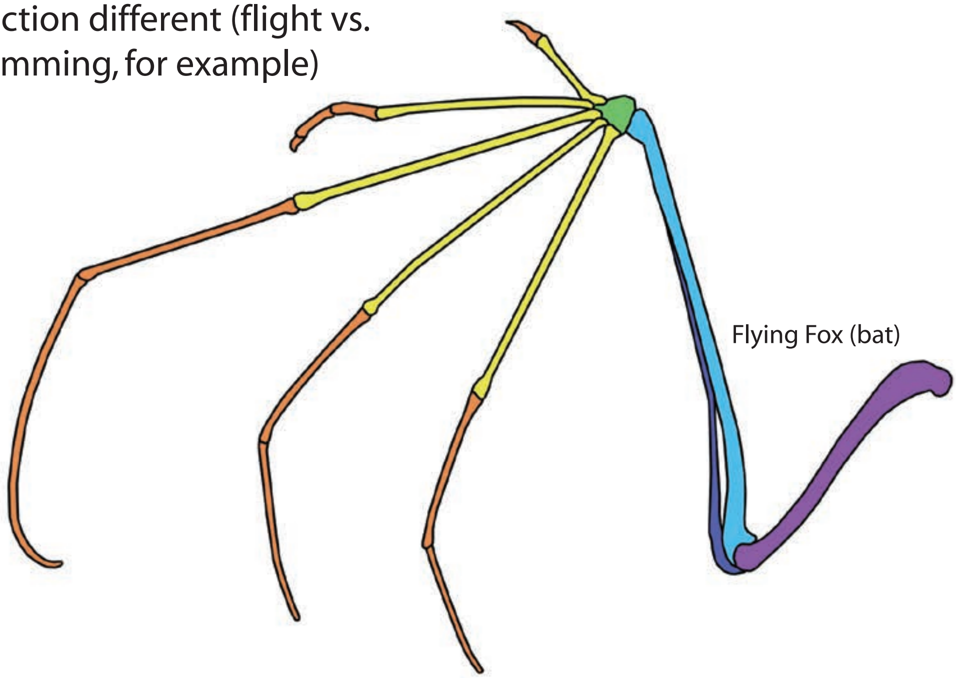
Those hands may look drastically different, but the basic bones are the same. These kinds of clues help us figure out how prehistoric animals lived, even if they did not leave any living relatives. We look to modern animals which have similar adaptations for how they walk, swim, fly, eat, or run, and compare them to our creature in question.

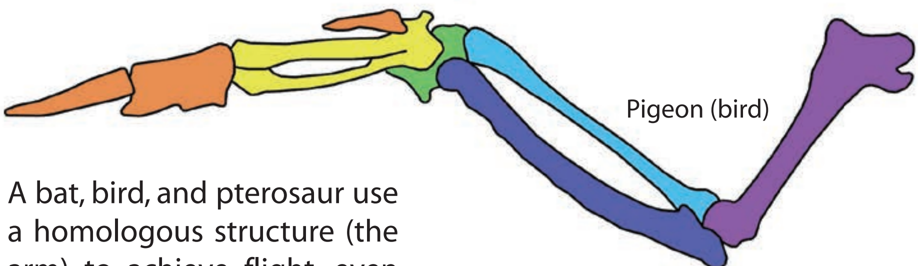
Mosasaurus sp.



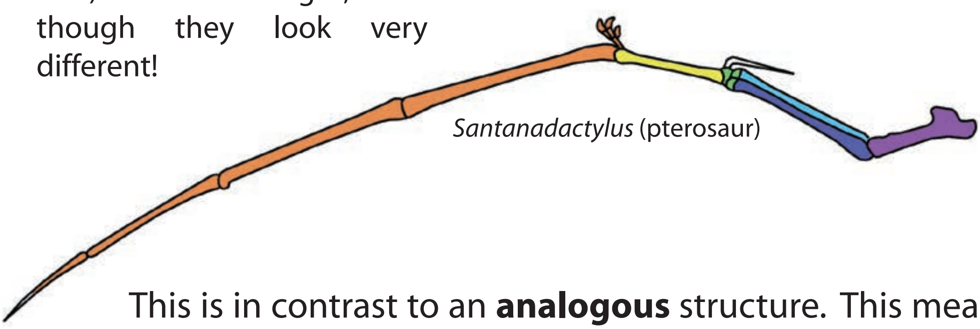
Here is the hand of a mosasaur (an extinct reptile). Compare it to the hands of the living creatures above and on the next page. Do you think it flew in the air? Walked on land? Or swam in the water?

All of these limbs are considered **homologous** structures, meaning they are the same bones anatomically, even if they look different, and function different (flight vs. swimming, for example)





A bat, bird, and pterosaur use a homologous structure (the arm) to achieve flight, even though they look very different!



This is in contrast to an **analogous** structure. This means that two things may function similarly, but are not related. Like the spines on a cactus and the spines on a porcupine - both are for defense, both are pointy! However, one is a plant, the other an animal, with no real common ancestor between them.

Paleontology...

Paleontology has a very long history with humans. People have always been inquisitive problem solvers, and for as long as they have been finding fossils, they have been trying to describe what they came from.

Many mythological monsters may have their beginnings with fossils. If you were an ancient Egyptian or Roman, and you came across giant bones from a creature you had never seen, how would you describe it to your friends?

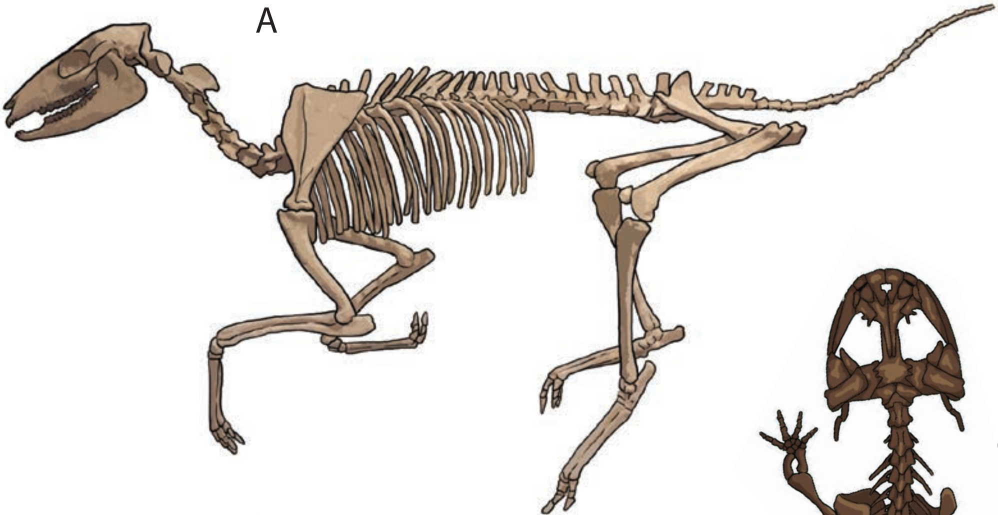
Protoceratops bones

Just like today, you have to start from bones and work your way out. If you didn't know dinosaurs existed, you might try and reconstruct it with features from animals you had seen. You may combine parts from many animals together, and make up a new animal.

Griffin of Salisbury

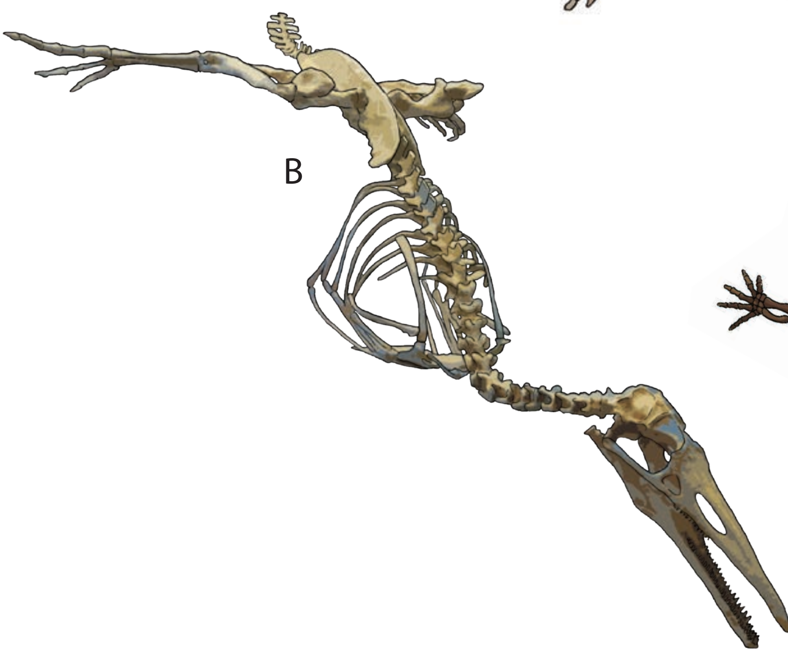
Experiment Time!

A



C

B



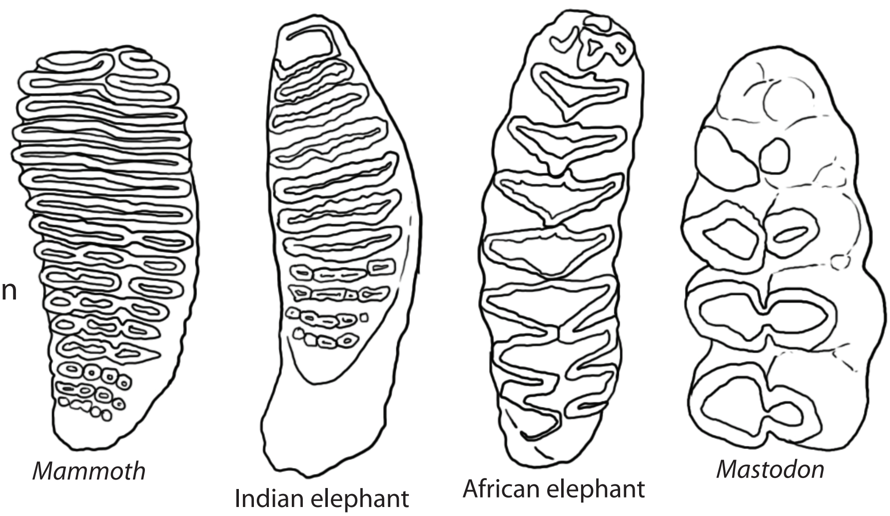
Use the bones above, and draw what you think the living animal looked like. Do the bones look similar to anything you've seen in a zoo? Beaks, teeth, feet, toes, tails. How would you describe your discovery to someone who has never seen these before? Based on the bones, can you tell if they had feathers? Fur? Scales?

A: Mesohippus B: Hesperornis C: Piceoerpeton

The Father Of Paleontology...

As the fields of science have advanced with people, so has our understanding of prehistoric animals. Georges Cuvier (1769-1832) made great strides in the field of comparative anatomy – comparing the bones of different animals. Prior to Cuvier's work, extinction (where a plant or animal no longer exists) was a concept that had yet to take root. People believed that everything alive today had always been alive; that everything that had ever existed was still alive today.

Tooth Comparison



Cuvier compared the bones of modern African and Indian elephants, and also bones from mammoths and mastodons in the Americas and Siberia. He discovered the mammoths and mastodons were different from living elephants. As they were such large creatures, he figured they would be unable to hide from man in the wild, and concluded that they were no longer alive on Earth: **extinct**.

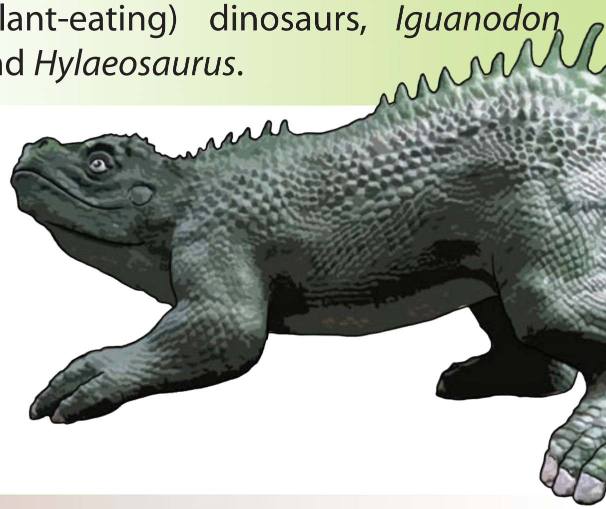
What's In A Name...

Imagine a time when there was no word to describe a dinosaur – because the word hadn't been invented yet! In 1842 Sir Richard Owen (1804-1892) coined the term "Dinosauria," which means "terrible lizard" in Greek; an apt name to describe large reptiles that no longer existed.

In 1824 William Buckland named the first carnivorous (meat-eating) dinosaur *Megalosaurus*...

These sculptures are in the Crystal Palace Park, in London, sculpted by Benjamin Waterhouse Hawkins in 1854.

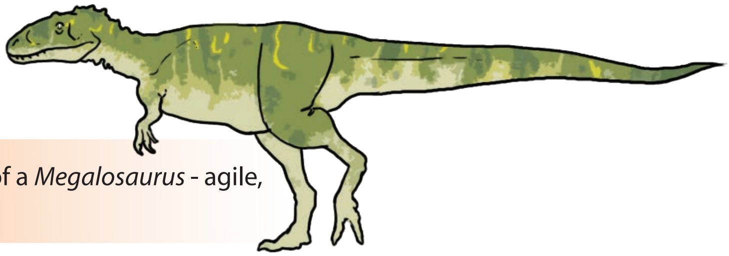
...and in 1825 and 1833, Gideon A. Mantell named the first herbivorous (plant-eating) dinosaurs, *Iguanodon* and *Hylaeosaurus*.



The animals sparked wonder in peoples' minds. With no modern relatives (that people knew of at the time) to compare the monsters to, they were reconstructed like overgrown lizards – wandering around on four legs, slow, ponderous and lumbering.

Since 1842, how we view and draw dinosaurs has changed significantly. Their closest living relatives are birds not lizards. They went from slow exothermic (cold-blooded), to active endothermic (warm-blooded).

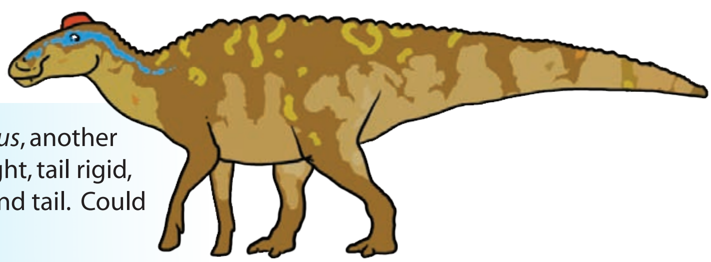
1800's *Megalosaurus* - very lizard-like, slow, classic reptile.



Modern reconstruction of a *Megalosaurus* - agile, active, bipedal, bird-like.

From their tails dragging along the ground, to more muscular balanced forms. From scaly reptilian, to feathered, spined, and colorful.

Early concept of a *Trachodon*. Lumbering, tail dragging - what we call the "kangaroo" pose.



Modern version of *Edmontosaurus*, another duck-billed dinosaur. Back straight, tail rigid, much more muscle in the hips and tail. Could walk on two or four legs.

As the field of paleontology advances, so to will our understanding of dinosaurs and other fossils.

Fossils...

Fossils are the remains of plants and animals, dug up from the ground. What you see in a museum, and what is excavated from the ground, can be vastly different. Sometimes a paleontologist (a scientist who works with fossils) will get lucky, and stumble across a "Lagerstätten" (German for "storage place") of fossils, but most of the time they only find random bits and pieces.

Above is an example of a Konzentrat-Lagerstätten, or a "concentration" of bones in a layer. Below is a Konservat-Lagerstätten, or "conservation," of an *Archaeopteryx* with outstanding preservation.

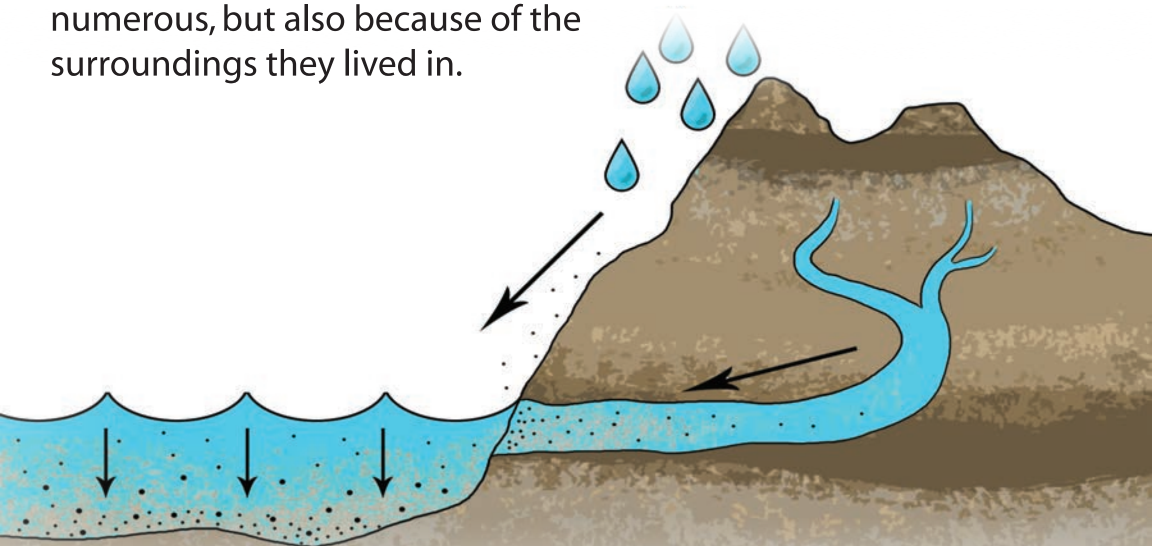
Under very rare circumstances, the soft parts of plants and animals can be found fossilized – Dakota the dinomummy is an example of a dinosaur recovered with vast patches of skin.

NDGS 2000

The word "mummy" refers to the preservation of the animal before it became a fossil. Not to be confused with mummies from Egypt - Dakota, an *Edmontosaurus*, is a natural mummy; the animal was buried in sediment very quickly after it died, and dried out, preserving the skin.

Usually when something dies, scavengers pick at it for food, and may remove pieces, so what is left when the remains are buried tend not to look very complete. This is why it's hard to find a complete skeleton. Unless it was buried very quickly, and avoided scavengers, what's left can look like a jumbled mess.

Plants or animals fossilize more often in a water environment. Water is a **depositional** environment, meaning that dirt and sediment are constantly being washed from land into the water, down to the bottom (ocean floor, river or lake bed) to bury any plants or animals. Fossils of shells can be quite common, in part because they were numerous, but also because of the surroundings they lived in.

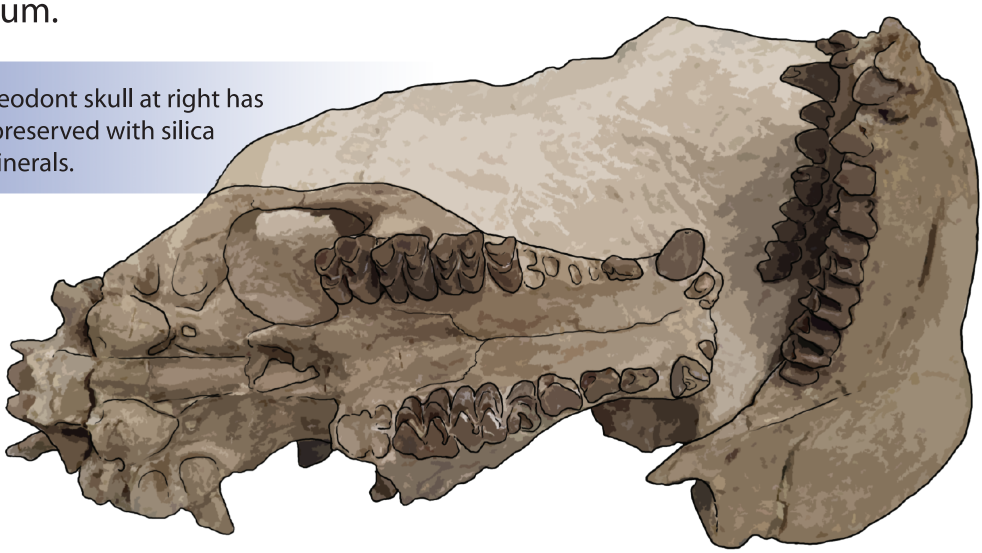


On land (typically an **erosional** environment) wind and rain are constantly wearing down the land, instead of adding to it. However, some land environments, like a desert, are very good at preserving skeletons and mummies. A very famous dinosaur duo was found in Mongolia, locked in mortal combat: a *Protoceratops* and *Velociraptor* were in the middle of fighting, when a sand dune collapsed over the top of them, preserving their skeletons.

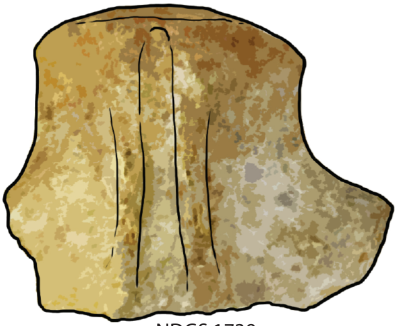
Mineralization / Replacement

In most cases fossils are essentially rock, and take on similar mineral qualities to whatever the surrounding rock (called matrix) contains. If a bone fossilizes in matrix high in iron, then it may be darker brown or heavy and sturdy like iron. If there's a lot of gypsum (like plaster or sheetrock) in the matrix, the bone may be soft and fragile, like gypsum.

The oreodont skull at right has been preserved with silica rich minerals.



Two mosasaur (marine lizard) skeletons found in ND – the left one is riddled with gypsum, and is soft, fragile, and difficult to work on. The one on the right is tough, dense, heavy, and covered in iron concretions. Minerals dissolved in water work their way through the ground, and are slowly deposited in the fossil-to-be. This can occur with amazing detail left behind, as with the rings of trees, bone marrow, and enamel striping.



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Molds & Casts...

Sometimes the original fossil material disintegrates, leaving behind an impression in the rock. This negative imprint is called a mold. If other mud or material fills in the hole left by the original, what you have is a cast.

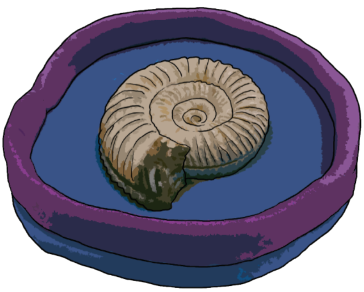
Trilobite cast (positive)

Trilobite mold (negative)

Experiment Time!

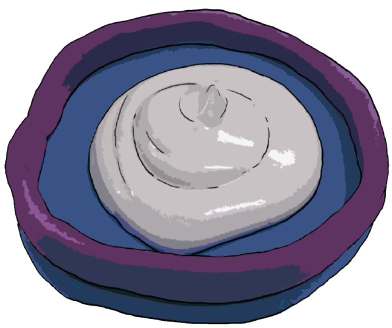
You will need: non-drying modeling clay, plaster, and a shell or other small hard object you wish to copy.

1. Roll out the clay so it is relatively flat. Add a rolled-out clay snake to the edges to make a walled-in area.

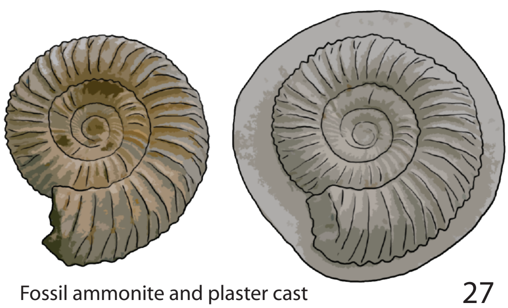


2. Firmly press your shell or other object into the clay, then remove it carefully.

3. Mix up your plaster, and slowly pour it into your new clay mold. Lightly tap the mold on the ouside, or the table it is sitting on, to help release any bubbles.



4. Let the plaster dry, then remove it from the clay mold. Ta-da! You have just created a copy, and now have a positive (plaster cast), and negative (clay mold) of your original shell or object.



Fossil ammonite and plaster cast

Pyritization...

Similar to mineralization, mold, and casts, the main mineral left behind in this case is pyrite, or fool's gold. Pyrite shells can be common, where the original shell has dissolved, but the cast left behind is covered in shiny gold-colored crystals.

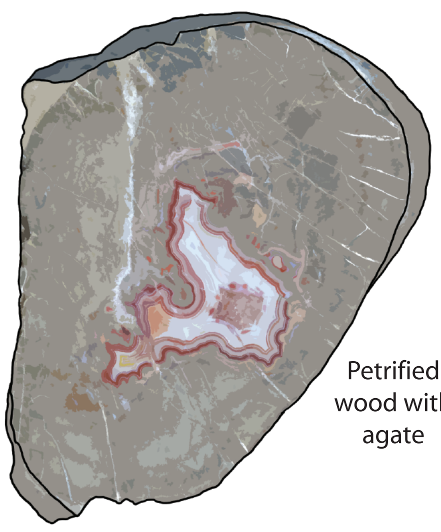
Pyritized ammonite

Agatization...

This is also similar to mineralization and pyritization, where the minerals in groundwater percolating through the fossil are rich in silica, and replace the fossil with agate or chalcedony material. This is very common with petrified wood, but can happen occasionally to bone.

Chalcedony = microcrystalline quartz (includes agate and jasper).

Agate = form of chalcedony with bands of different colors, slightly translucent (allows light to pass through).



Petrified wood with agate

Carbonization...

Many fossil leaves and insects-in-amber are carbonized. When the leaf compacts under pressure, it decays, leaving behind a trace of carbon. Much like the coal you might put in a grill, or the ash that's left over in a fireplace or bonfire.

67 million-year-old leaf in sandstone, found in western North Dakota.

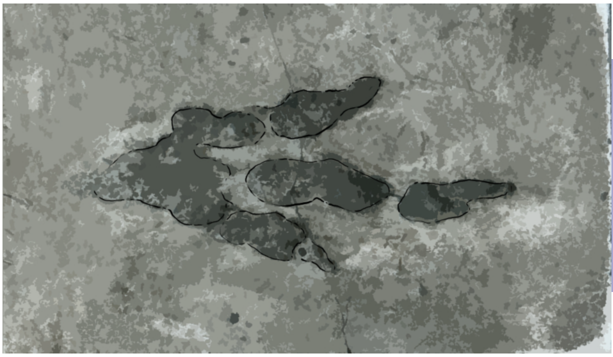
Opalization...

Very rarely, the remains of plants or animals can be replaced with the precious gemstone opal.

Opalized snail shell from Australia, on display at the Chicago Field Museum.

Tracks & Burrows...

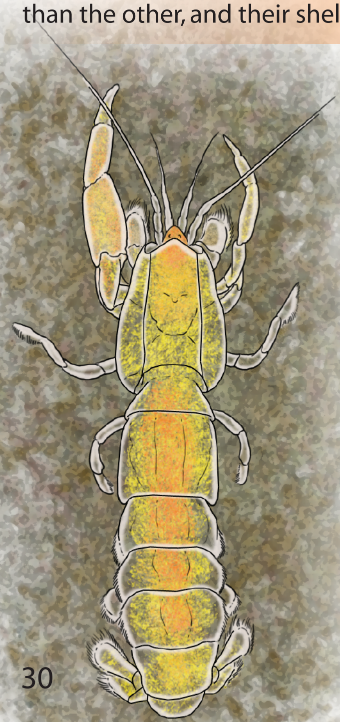
This follows the same method of molds and casts, where the original object is gone. In the case of a track, something like a footprint or feeding track is left by an animal. A burrow, the hollowed out home of an animal, could fill in with surrounding dirt. What's left behind is called a "trace fossil."



An "ichnogenus," or trace fossil track, left by a three-toed meat-eating dinosaur from New Jersey. Because it is hard to link a footprint to an animal, the dinosaur was given the name *Grallator*, meaning "stilt walker."

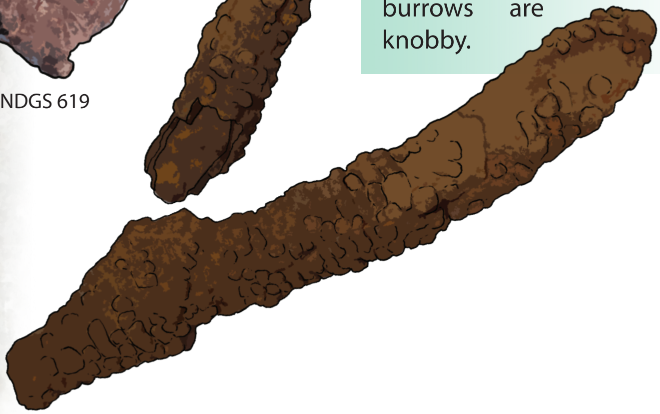
Common trace fossils across ND include burrows from the ghost shrimp. The shrimp is given one name, *Callianassa*, while the burrow is given another name: *Ophiomorpha*.

Callianassa shrimp claw, and reconstructed animal. These shrimp have one pincer larger than the other, and their shells are translucent.



NDGS 619

Ophiomorpha, the shrimp burrows, are pebbly in appearance because the animals would wedge their feces into the walls to keep the soft sand around the burrows from collapsing. Fossils of new burrows are more smooth, while older well-used burrows are knobby.



Coprolites...

Another trace fossil, coprolite is a fancy word for fossilized feces or dung. Poop! Why in the world would we collect fossil poop? Poop is left over food – so if we can find that, we can figure out what the creature that deposited it ate.

NDGS 2501

If the coprolite contains bits of crushed up bone, or scales, then it's a good bet the animal that deposited it was a carnivore (meat-eater). The feces at left are from a Paleocene crocodile from North Dakota, and contain fish scales, ribs, and vertebrae.

If the coprolite instead has bits of seeds, twigs, leaves, or bark, then the animal most likely was an hervibore (plant-eater). These feces, at right, are from a Pleistocene (Ice Age) giant ground sloth, comprised of plant fibers visible to the naked eye.

From the Smithsonian Institution, National Museum of Natural History.

Coprolites are also a snapshot into a VERY short amount of time in the life of an animal: one bowel movement. This can give us a sense of what was around to be eaten, and what was in the environment.

Paleontologists...

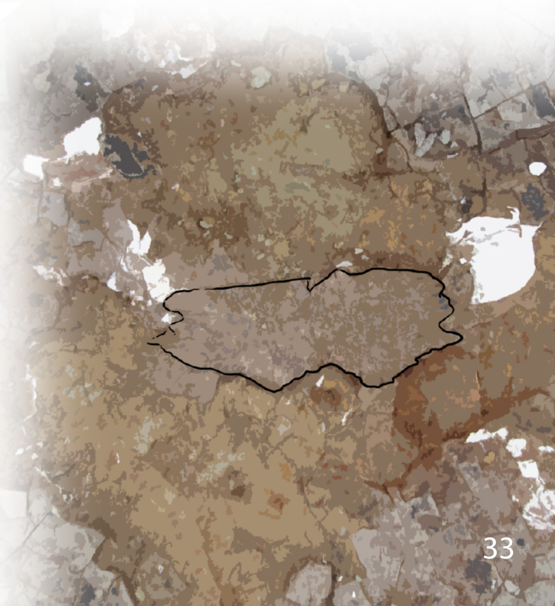
If you have ever seen a TV show or movie where a paleontologist is gently brushing away dirt from a beautiful fossil that looks like it is ready to just put on display in a museum – don't believe it! It is rarely that easy. From finding a fossil in the field, to removing it, bringing it back to a laboratory, cleaning and restoring it, to finding a final home for it – the process can take days to years for each fossil.

A paleontologist needs to learn how to tell rock from fossil – sometimes it's easy, sometimes not – and can go to school for many years to learn how. When walking around searching (called prospecting), they have to keep their eyes on the ground. You wouldn't want to step on a possible fossil! If the fossils are small enough, a person may even have to crawl over a surface during their search.

Fossils may be rock, but they are also fragile. Just like a ceramic plate is hard, but if you drop it, it may break. Because of this paleontologists can't just pull a fossil out of the ground. Each fossil needs to be protected, and it can take a lot of training and practice to figure out what is the best method. Let us follow what might happen…

While hiking around, our paleontologist has come across a corner of bone sticking out of a hillside. Digging through the dirt and rock above a little, they make sure there is more bone heading in to the rock, rather than it being just a fragment.

They continue digging above the bone, taking notes while they work, marking down the condition of the bone, where they are at, how high up in the rock, what the rock is like, and any other information that may be important.



Fish skull bone
NDGS 2502

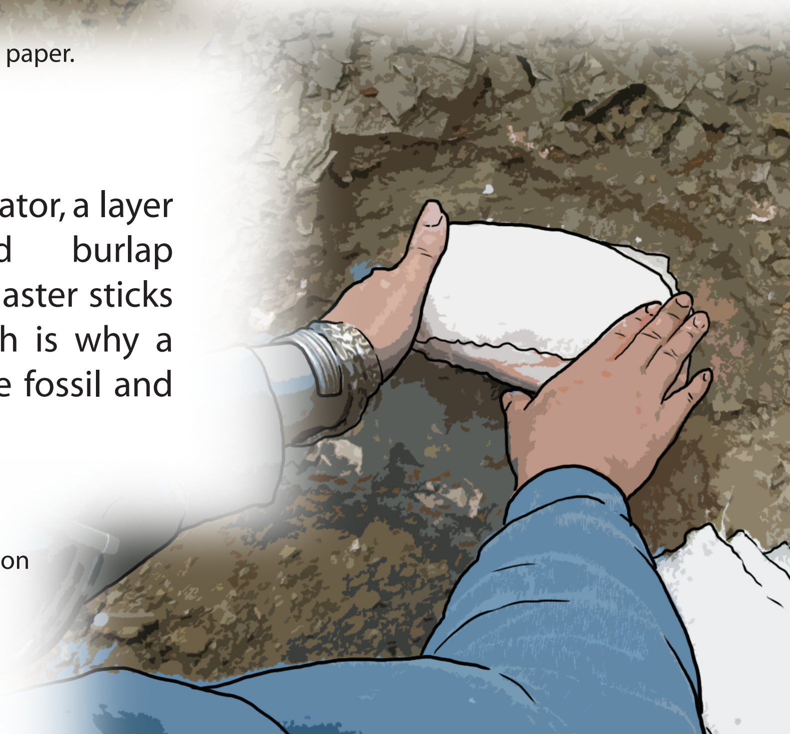
The bone is large, so some support will be needed for transport back to the fossil lab. The paleontologist keeps digging around the bone, but not below – they don't want gravity to accidentally pull the bone down the hillside. After all – the cracks in the fossil are only held together with dirt.

"Trench" around the fish bone.

They cover the surface of the bone with a separator (like toilet paper or paper towels) to add padding, as well as to keep the next layer from touching the bone.

Protective layer of toilet paper.

On top of the separator, a layer of plaster-soaked burlap (fabric) is added. Plaster sticks well to bone, which is why a barrier between the fossil and plaster is needed.



Plaster strips are added on top of the toilet paper.

Fish skull bone flipped upside down.

After the plaster dries, the fossil is now encased in what is called a **jacket** – just like a jacket protects you from bad weather, a jacket protects a fossil during transport and storage. The jacket is flipped upside down, and the bottom is plastered.

More notes are taken, and a field number is added to the fossil to keep track of it. It is now ready to travel. Some fossils like the one at right are small and easy to move. Others, like the crocodile skull below, need some extra planning to move.

Fish skull bone with new Field Number.

Paleontologists and volunteers combine their strength together to move a large crocodile skull.

Preparation...

Back in the lab when the fossil is ready to be worked on, part of the plaster jacket is cut off – after all the field numbers are recorded, of course. Notes are always important! If the fossil being worked on has been in storage for a while, the **fossil preparator** (someone who cleans and restores fossils) may want to recheck the notes written down in the field, to make sure there are no surprises.

Many types of tools are used during fossil preparation...

Dental picks can scratch away little bits of rock and dirt.

Brushes help sweep away loose rubble.

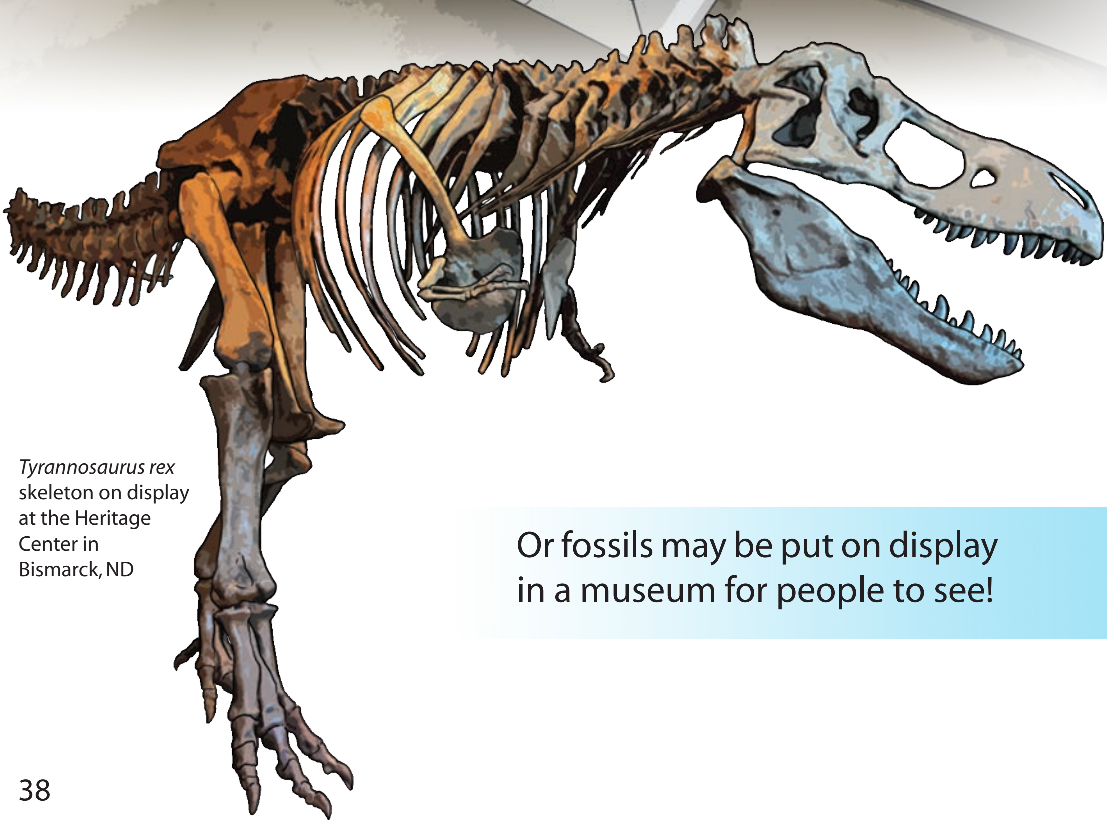
Air scribes are pneumatic (air-driven) chisels that chip away stubborn rock. These come in large sizes to remove a lot of rock, or small for delicate work under a microscope.

Microblasters, also air-driven, can spray small particles like baking soda to help clean rock out of hard-to-reach cracks.

Glue is often needed, as during the cleaning process all of the dirt that was once holding the fossil together is removed. In the Johnsrud Paleontology Laboratory at the Heritage Center in Bismarck, a special glue called **Butvar** is used. This is used because it can be removed easily if needed, or softened and repositioned.

Home Sweet Home...

After a fossil has been cleaned it is properly identified, cataloged, and added to the Collections room. Collections are like big fossil libraries, where bones can be "checked out" by scientists who are doing research.



Tyrannosaurus rex skeleton on display at the Heritage Center in Bismarck, ND

Or fossils may be put on display in a museum for people to see!

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