

DINOSAURS



COMPILED BY HOWIE BAUM

Metro Goldwyn Mayer

TRADE

MARK



THIS IS THE FIRST OF 3 PAGES THAT HELP TO PUT THE 165 MILLION YEAR REIGN OF THE DINOSAURS, IN PERSPECTIVE.

IT IS A CALENDAR THAT IS DESIGNED SO THAT ALL OF THE TIME, SINCE THE BIG BANG HAPPENED – 13.8 BILLION YEAR AGO, UP TO THE PRESENT TIME, IS COMPRESSED INTO 1 YEAR.

Pre-December Dates

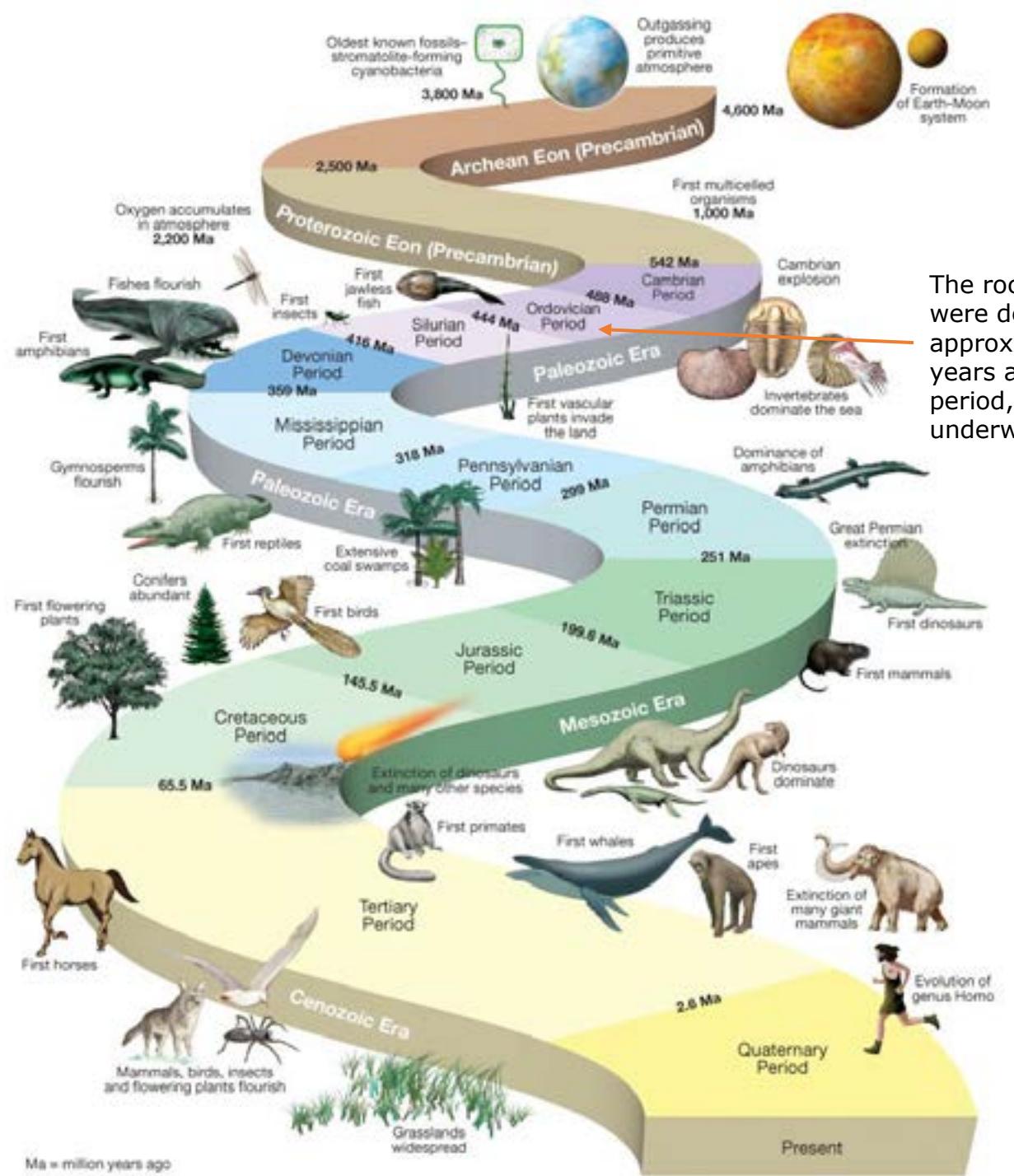
Big Bang	January 1
Origin of the Milky Way	May 1
Origin of the solar system	September 9
Formation of the Earth	September 14
Origin of life on Earth	~September 25
Formation of the oldest rocks known on Earth	October 2
Date of oldest fossils (algae/bacteria)	October 9
Invention of sex by microorganisms	~November 1
Oldest fossil photosynthetic plants	November 12
Eukaryotes (first cell with nuclei) flourish	November 15

December

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1-significant oxygen atmosphere begins to develop on Earth	2	3	4	5-Extensive volcanism and channel formation on mars	6
7	8	9	10	11	12	13
14	15	16-First worms	17-Precambrian ends. Palaeozoic Era and Cambrian Period begin. Invertebrates flourish	18-First oceanic Plankton. Trilobites flourish	19-Ordoician Period. First fish and vertebrates	20-Silurian Period. First vascular plants. Plants begin colonization of land
21-Devonian Period. First insects, animals begin colonization of land	22-First amphibians. First winged insects	23-Carboniferous Period. First trees and reptiles	24-Permian period	25-Palaeozoic Era ends. Mesozoic Era begins	26-Triassic period. First mammals First Dinosaurs	27-Jurassic Period. First birds
28-Cretaceous Period. First flowers, dinosaurs become extinct	29-Mesozoic Era ends. Cenozoic Era and Tertiary Period begin. First cetaceans. First primates	30-Early evolution of frontal lobes in the brains of primates. First hominids. Giant mammals flourish	31-End of the Pliocene Period. Quaternary Period begins. First humans.	Dinosaurs lived for 165 million years !!		

Humans have only existed for 0.004% of the age of the Earth !

Origin of <i>Proconsul</i> and <i>Ramapithecus</i> , probable ancestors of apes and men	~ 1:30 p.m.
First humans	~ 10:30 p.m.
Widespread use of stone tools	11:00 p.m.
Domestication of fire by Peking man	11:46 p.m.
Beginning of most recent glacial period	11:56 p.m.
Seafarers settle Australia	11:58 p.m.
Extensive cave painting in Europe	11:59 p.m.
Invention of agriculture	11:59:20 p.m.
Neolithic civilization; first cities	11:59:35 p.m.
First dynasties in Sumer, Ebla and Egypt; development of astronomy	11:59:50 p.m.
Invention of the alphabet; Akkadian Empire	11:59:51 p.m.
Hammurabic legal codes in Babylon; Middle Kingdom in Egypt	11:59:52 p.m.
Bronze metallurgy; Mycenaean culture; Trojan War; Olmec culture; invention of the compass	11:59:53 p.m.
Iron metallurgy; First Assyrian Empire; Kingdom of Israel; founding of Carthage by Phoenicia	11:59:54 p.m.
Asokan India; Ch'in Dynasty China; Periclean Athens; birth of Buddha	11:59:55 p.m.
Euclidean geometry; Archimedean physics; Ptolemaic astronomy; Roman Empire; birth of Christ	11:59:56 p.m.
Zero and decimals invented in Indian arithmetic; Rome falls; Birth of Islam and the Islamic Civilization	11:59:57 p.m.
Mayan civilization; Sung Dynasty China; Byzantine empire; Mongol invasion; Crusades	11:59:58 p.m.
Renaissance in Europe; voyages of discovery from Europe and from Ming Dynasty China; emergence of the experimental method in science	11:59:59 p.m.
Widespread development of science and technology; emergence of global culture; acquisition of the means of self-destruction of the human species; first steps in spacecraft planetary exploration and the search of extraterrestrial intelligence	Now: The first second of New Year's Day



The rocks of the **Cincinnatian** series were deposited between approximately 451 and 443 million years ago, during the Ordovician period, when all the land was underwater !

BASIC DINOSAUR FACTS

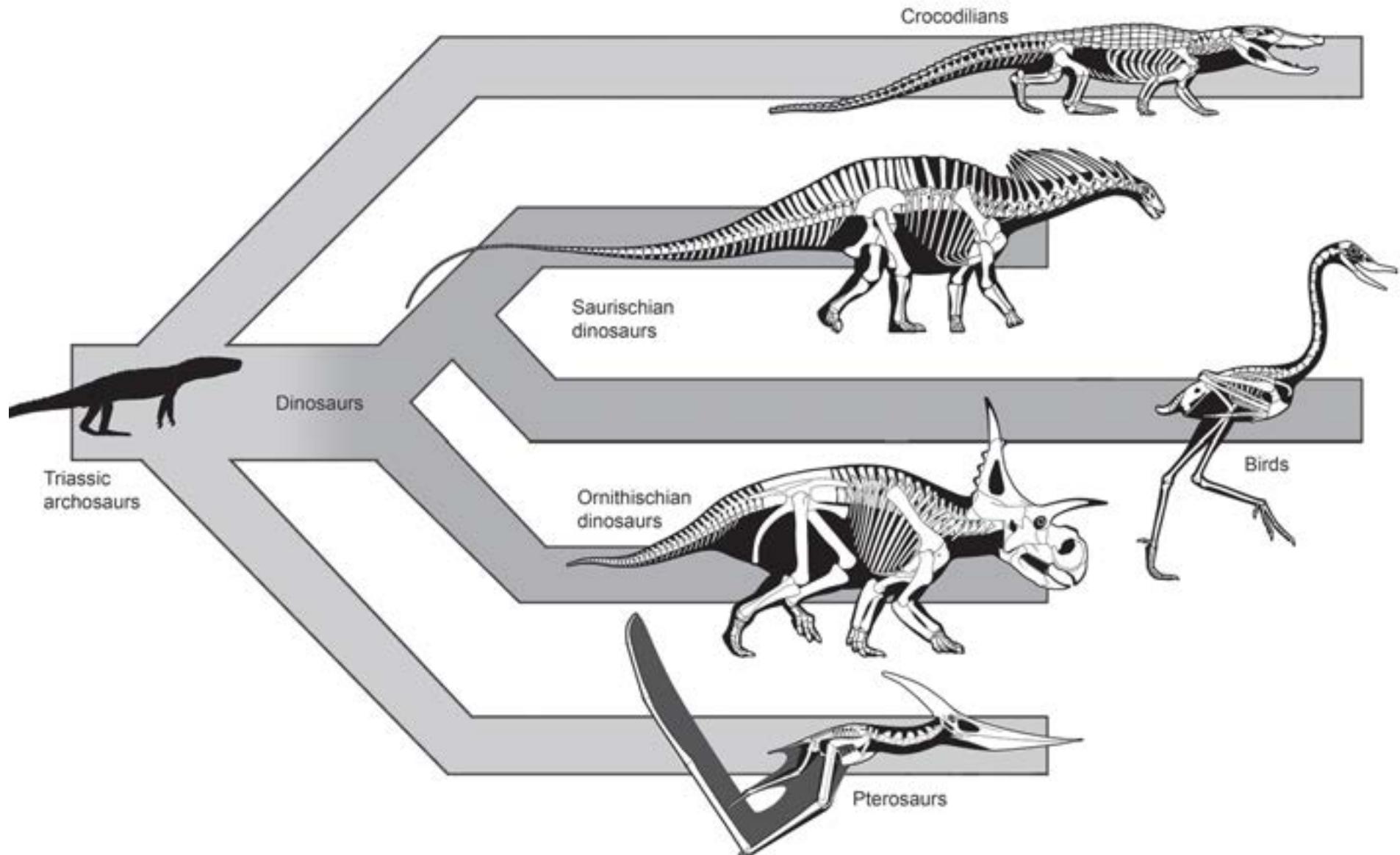
- Dinosaurs are a group of **reptiles** that have lived on Earth for about 165 million years.

About 60% of dinosaurs ate plants (herbivores) and 40% ate meat (carnivores)

- In 1842, the English naturalist Sir Richard Owen coined the term Dinosauria, derived from the Greek deinos, meaning "fearfully great," and sauros, meaning "lizard."
- Dinosaur fossils have been found on all 7 continents.
- All non-avian (non-bird) dinosaurs went extinct about 66 million years ago (MYA).**
- There are roughly 700 known species of extinct dinosaurs.
- Modern birds are a kind of dinosaur because they share a common ancestor with non-avian dinosaurs.



The **Archosaurs** consist of a diverse group of Triassic living and extinct reptiles that are subdivided into crocodiles, the 2 main types of dinosaurs, and pterosaurs.



ORNITHISCHIAN AND SAURISCHIAN DINOSAURS

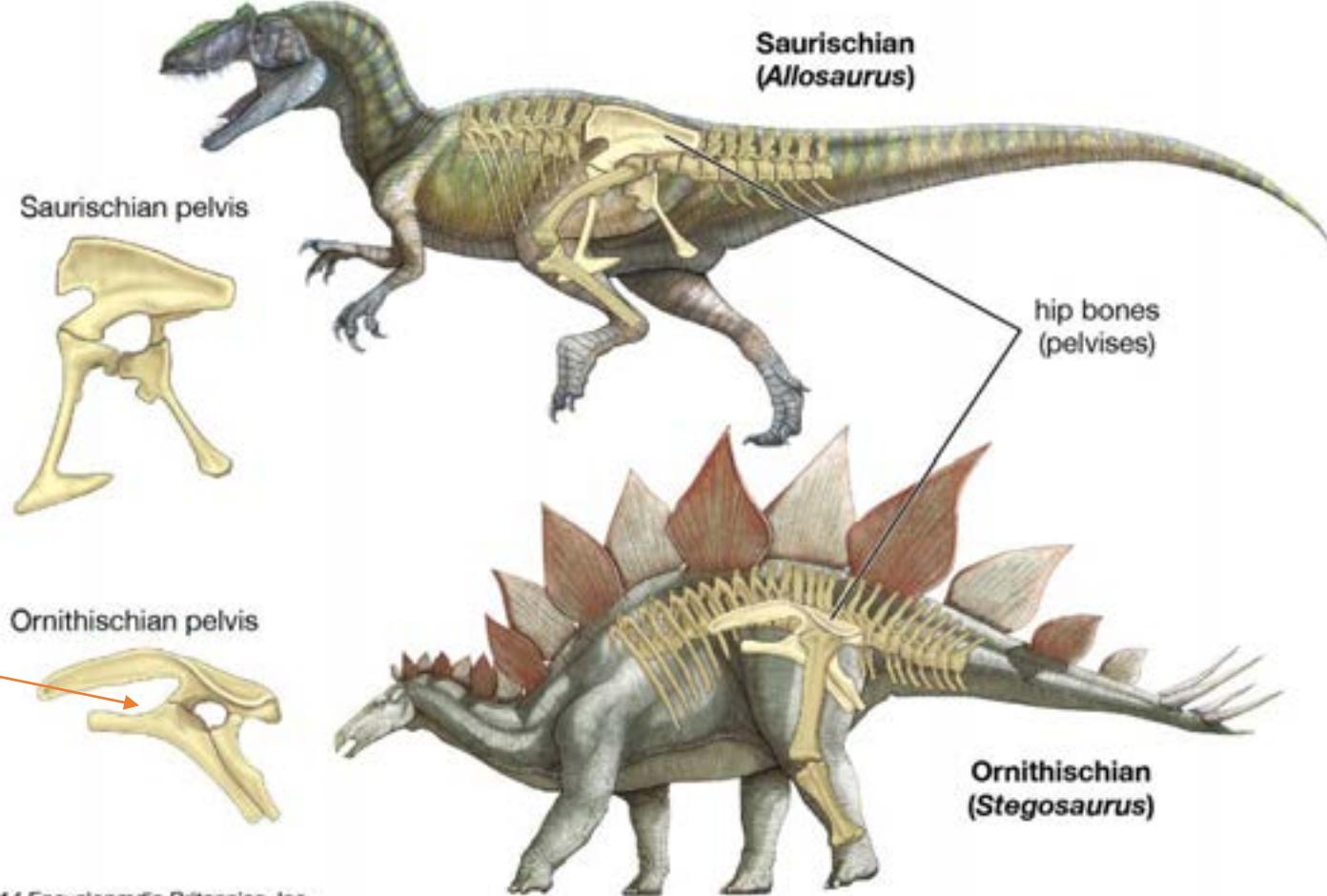
As shown on the previous diagram, there are 2 types of Dinosaurs.

Dinosaurs and reptiles have hip girdles, or *pelvises*, and all of them are composed of three bones: the ilium, ischium, and pubis.

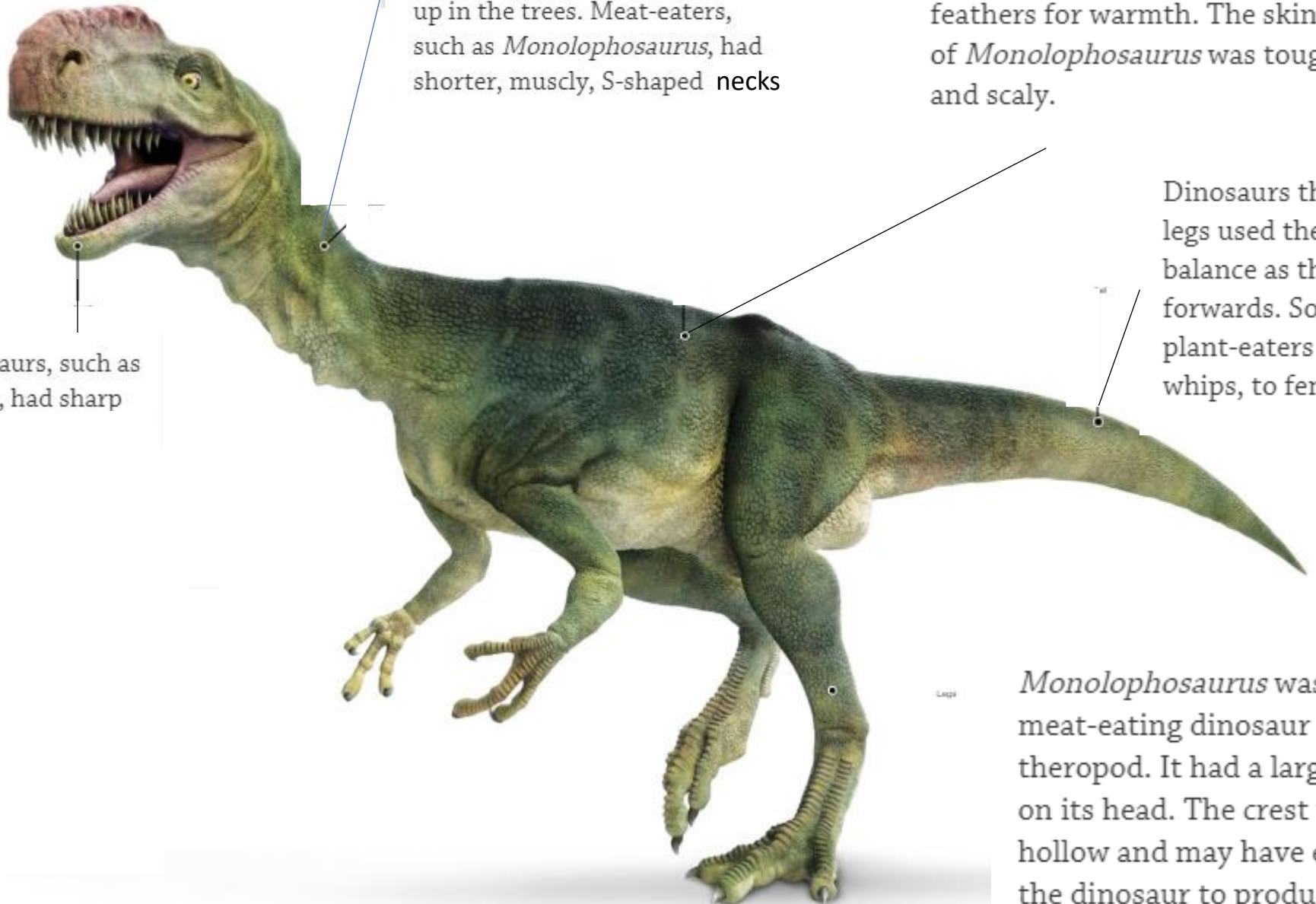
All ornithischians are united by a pubis pointing backward, running parallel with the ischium.

The name "Ornithischia" means "bird-hipped," and birds also have pelvises in which the pubis points backwards.

However, birds are more closely related to the Saurischia, or "lizard-hipped" dinosaurs, than to the ornithischian dinosaurs.



As shown above, the pubis bone in the Saurischian dinosaurs points forward.



Monolophosaurus was a type of meat-eating dinosaur called a theropod. It had a large crest on its head. The crest was hollow and may have enabled the dinosaur to produce sounds to warn off its rivals.

Dinosaur skin was covered with protective scales or a layer of feathers for warmth. The skin of *Monolophosaurus* was tough and scaly.

DINOSAURS

Dinosaurs first appeared during the Triassic period, between 243 and 233.23 million years ago.

They became the dominant terrestrial reptiles throughout the Jurassic and Cretaceous periods.

The fossil record demonstrates that birds are modern feathered dinosaurs because they evolved from ones that lived during the Late Jurassic period.

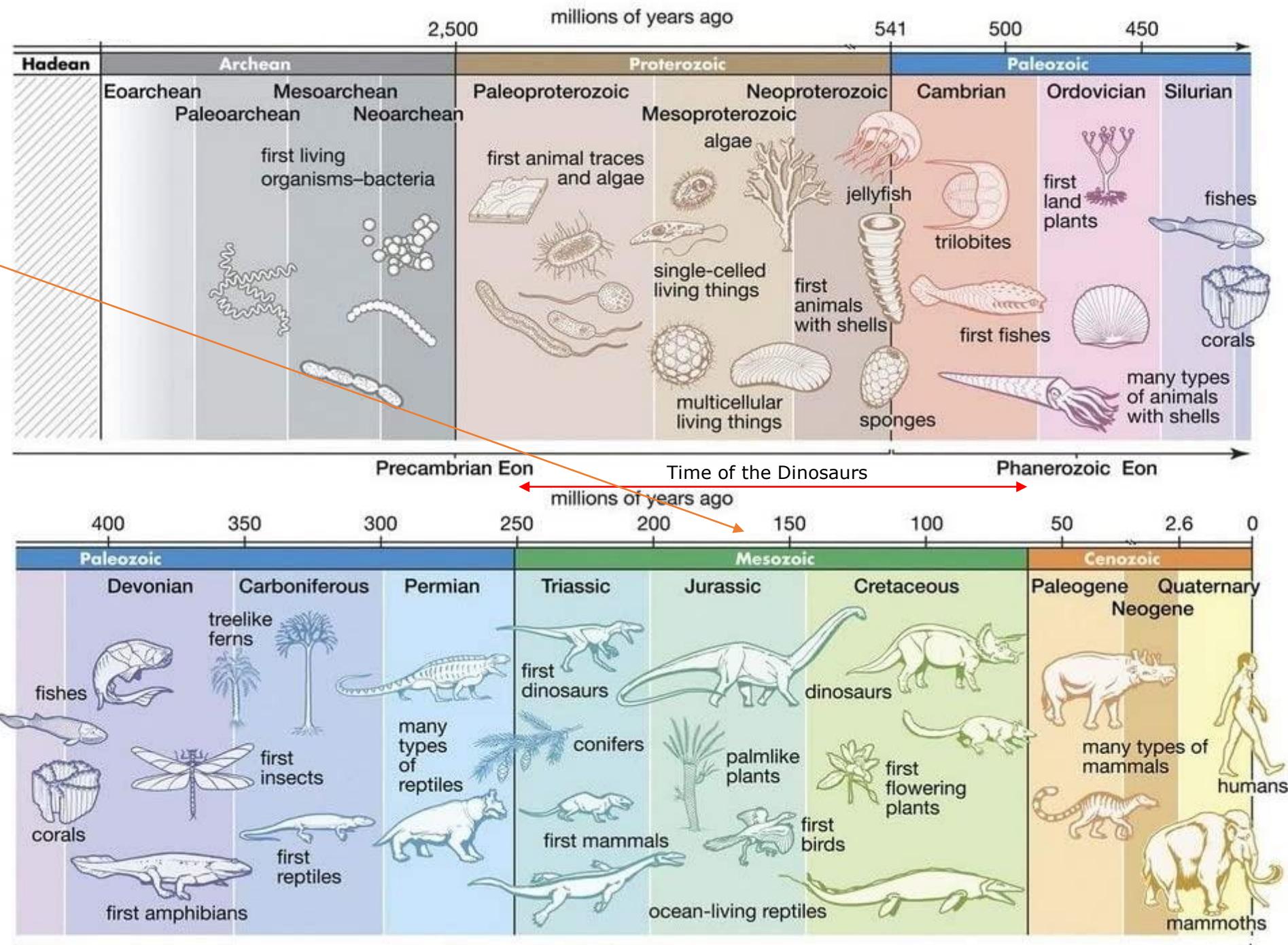
So birds were the only dinosaur lineage to survive the Cretaceous–Paleogene extinction event, approximately 66 million years ago.



Dinosaurs lived during the Mesozoic time period, for 165 million years.

This was during the Triassic, Jurassic, and Cretaceous time periods.

The Mesozoic was described as the “Age of the Reptiles”

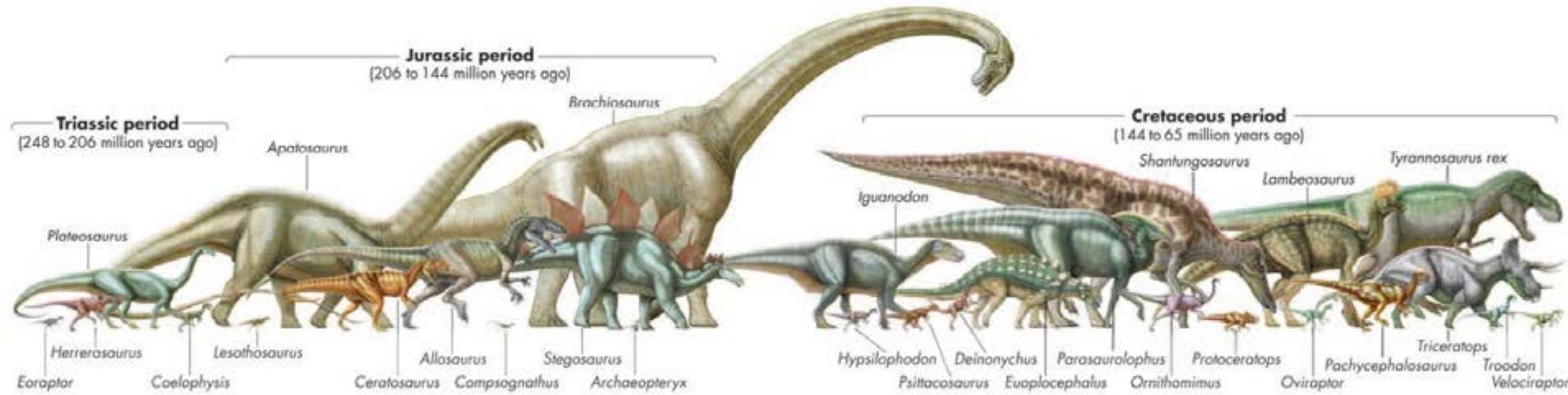


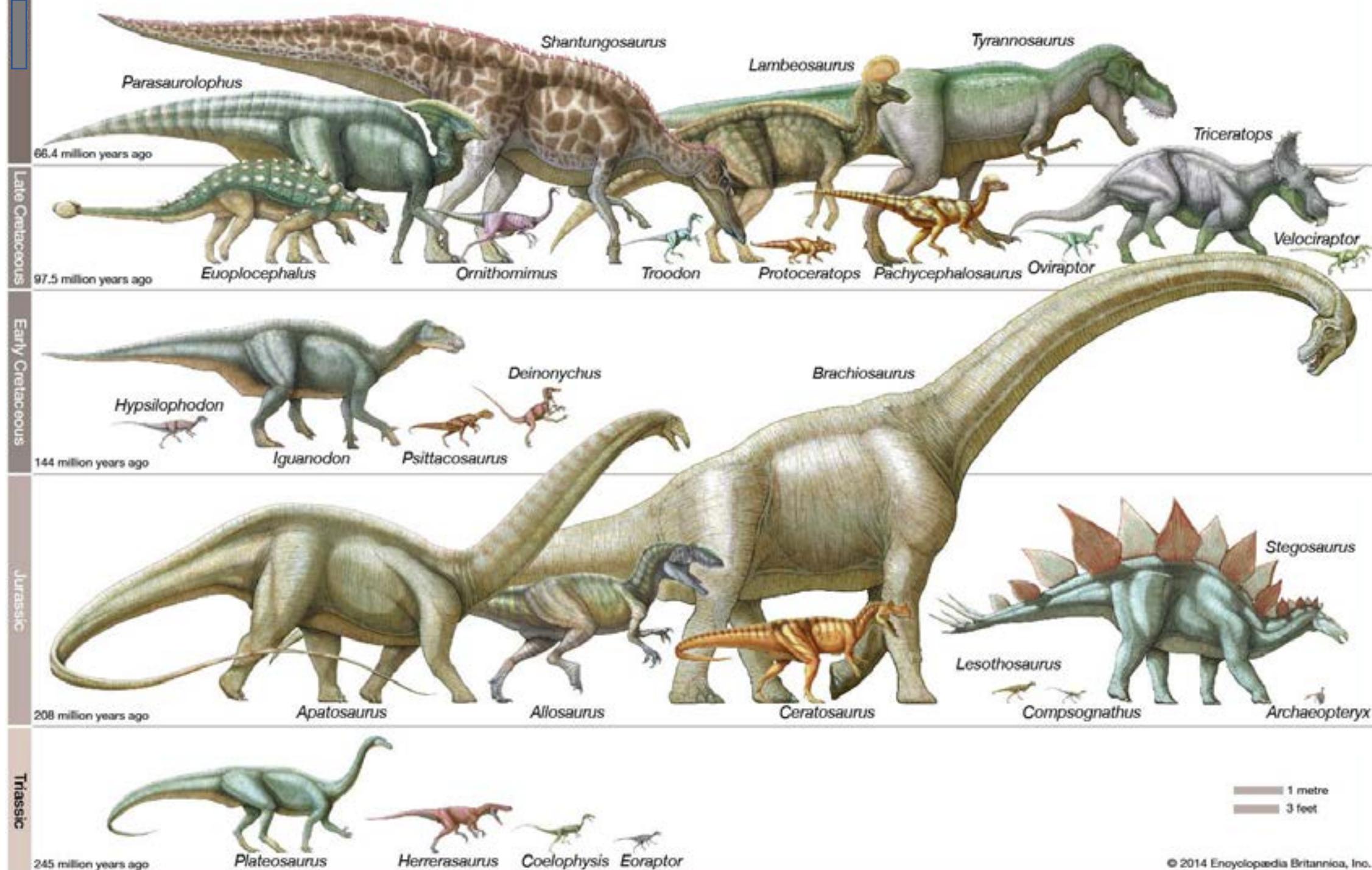
THE AGE OF REPTILES

The Mesozoic is an era that started at 252.2 million years ago to 65.5 million years ago, and is composed of the **Triassic Period, the Jurassic Period, and the Cretaceous Period.**

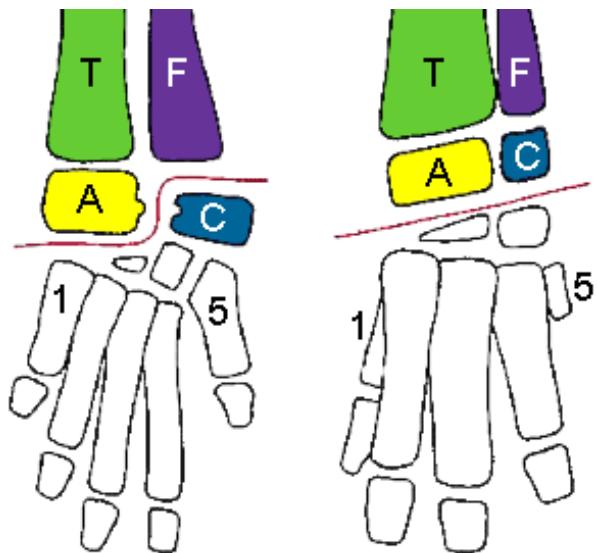
The Mesozoic was a place of giants, with dinosaurs ruling the world.

They first evolved from Archosaurs into dinosaurs during the Triassic Period, turned larger and more diverse in the Jurassic and Cretaceous periods, but got wiped out by the Cretaceous-Paleogene (K-Pg) extinction event, at the end of the Cretaceous period.





THE 2 MAIN PHYSICAL CHARACTERISTICS OF DINOSAURS



Archosaur ankles: The two major groups of archosaurs are distinguished by differences in the joint of their ankle.

The crocodiles and their relatives have an ankle joint (at left), while **dinosaurs and pterosaurs (flying reptiles) have an ankle joint (at right)**.

The red line in each image shows the plane of the ankle hinge.

! Walking tall

Unlike today's reptiles, dinosaurs could stand with their legs straight, just like mammals can.

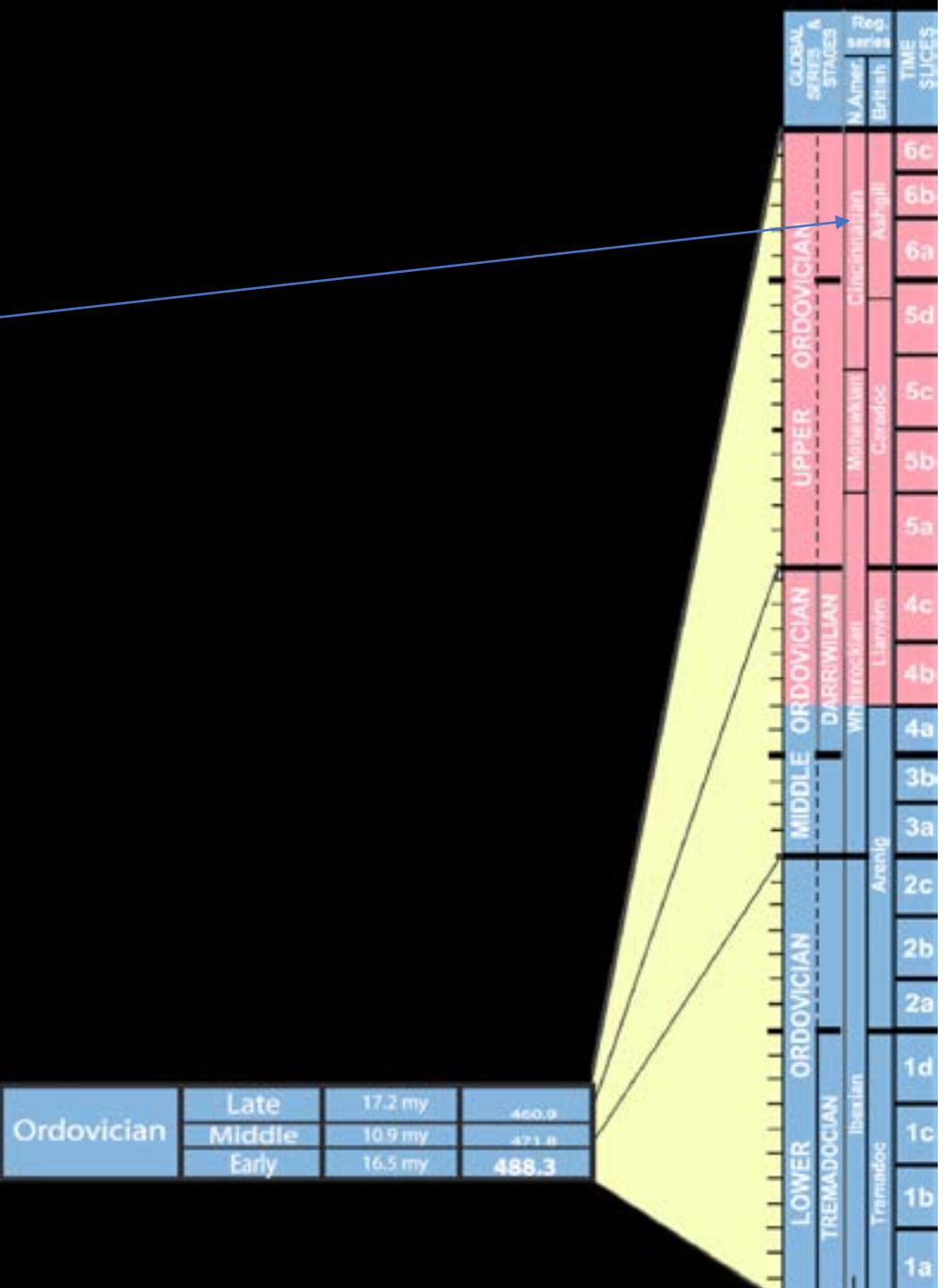
Lizards hold their legs at right angles to the body, while crocodiles walk with their knees slightly bent. The upright legs of dinosaurs fully supported their weight, which is one reason why dinosaurs could be so heavy.



THE CINCINNATIAN TIME PERIOD

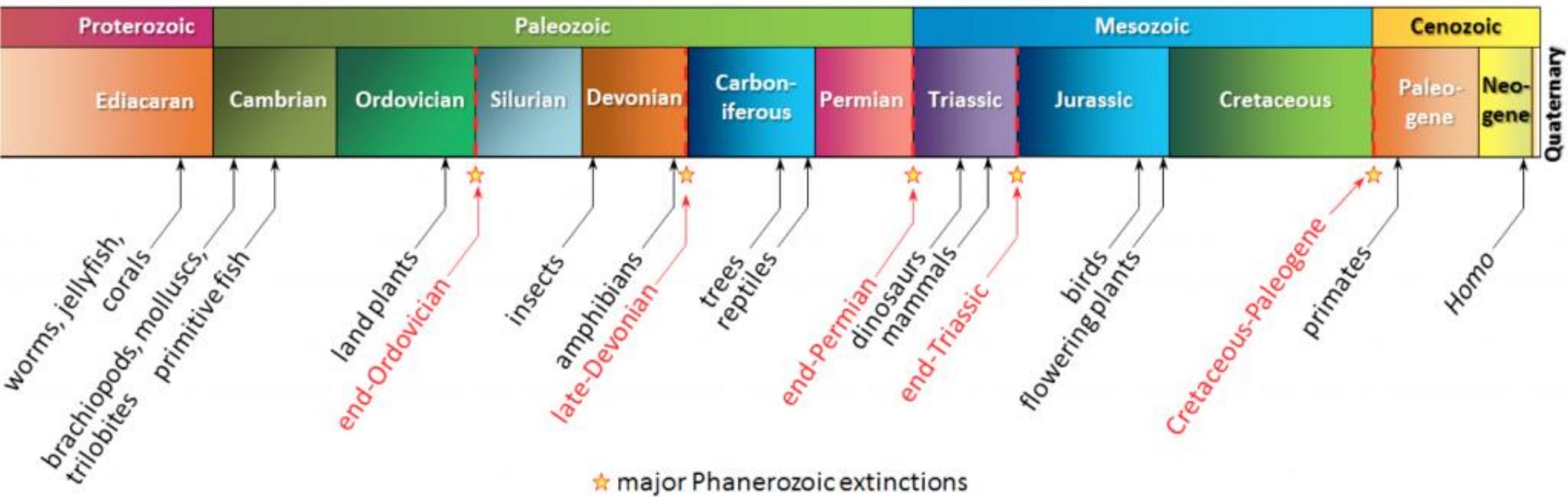
The Cincinnati area was under an inland sea for millions of years, during the Ordovician period (485 – 443 MYA) and there was all kinds of underwater life at that time but it was before there were any fish here.

The Cincinnati layer is in the Ordovician period range and was here 451 to 443 MYA. This is why it is such a good fossil hunting area.



Categories of Fossil Types

Category	Trace fossil	Molds and casts	Replacement	Petrified or permineralized	Amber	Original material
Example						
Formation	A trace fossil is any indirect evidence left by an organism. Footprints, burrows, and fossilized feces are trace fossils.	A mold is an impression of an organism. A cast is a mold filled with sediment.	The original material of an organism is replaced with mineral crystals that can leave detailed replicas of hard or soft parts.	Empty pore spaces are filled in by minerals, such as in petrified wood.	Preserved tree sap traps an entire organism. The sap hardens into amber and preserves the trapped organism.	Mummification or freezing preserves original organisms.



People who study the history of animals and fossils are called Paleontologists. As part of their training, they are asked to remember all of the names of the different time periods .

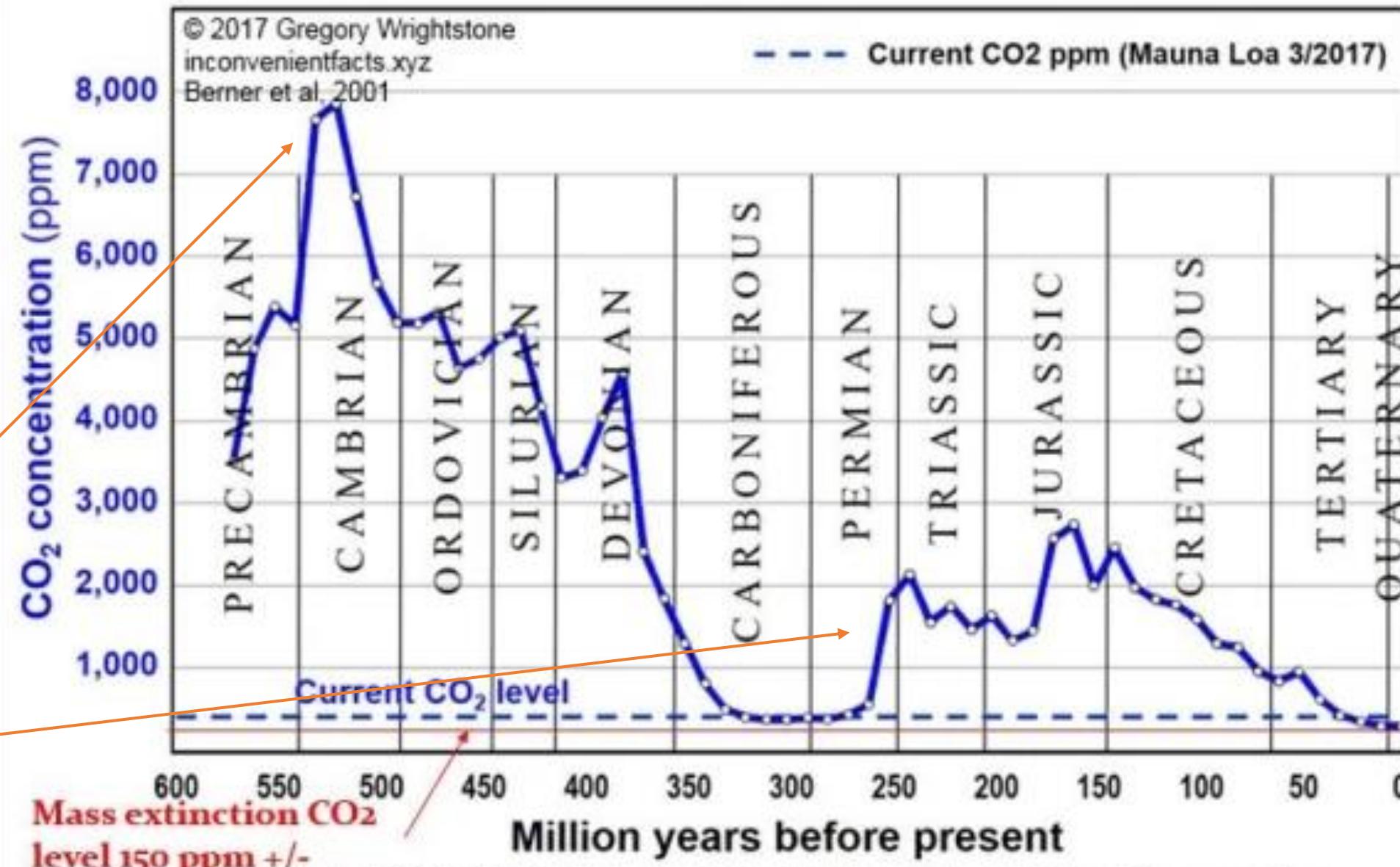
A mnemonic is a shortcut way to remember things like this and one of those used for this set, starting with the Cambrian period is:

"Cows Often Sit Down Carefully. Perhaps, Their Joints Creak? Please, No Questions"

This graph shows the changes in the Carbon Dioxide in the air, during the various time periods.

Notice that it peaked during the Cambrian period and was still somewhat high during the Triassic, Jurassic, and Cretaceous periods, when the Dinosaurs lived.

600 million years of CO₂ data reveals current CO₂ starvation

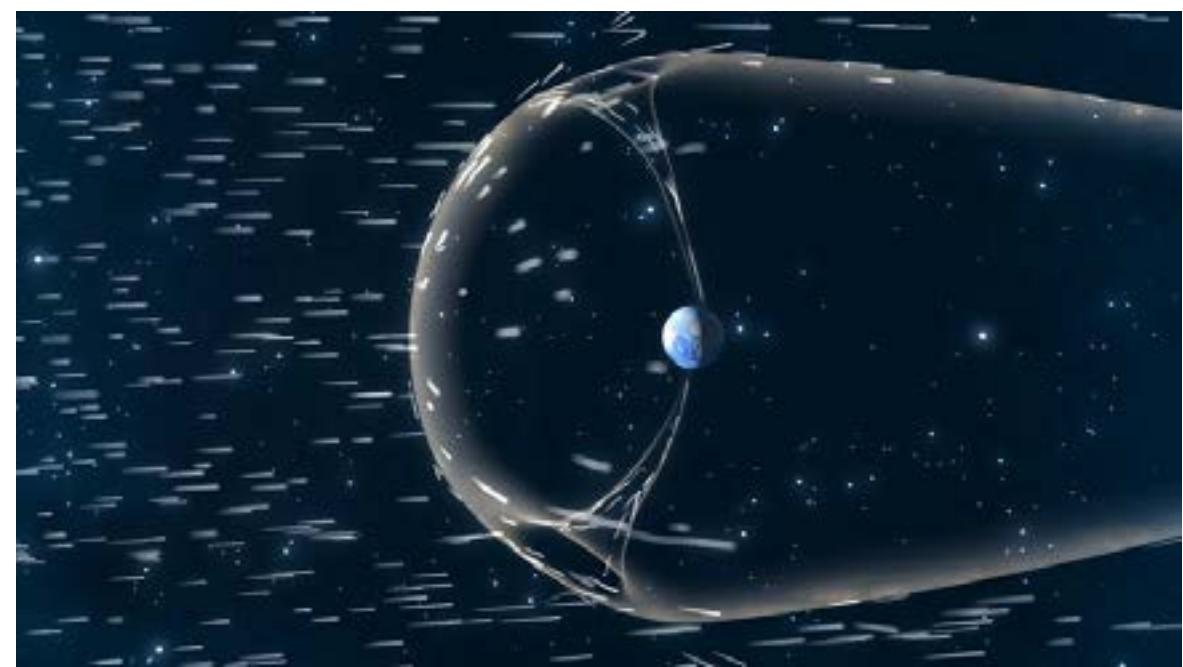
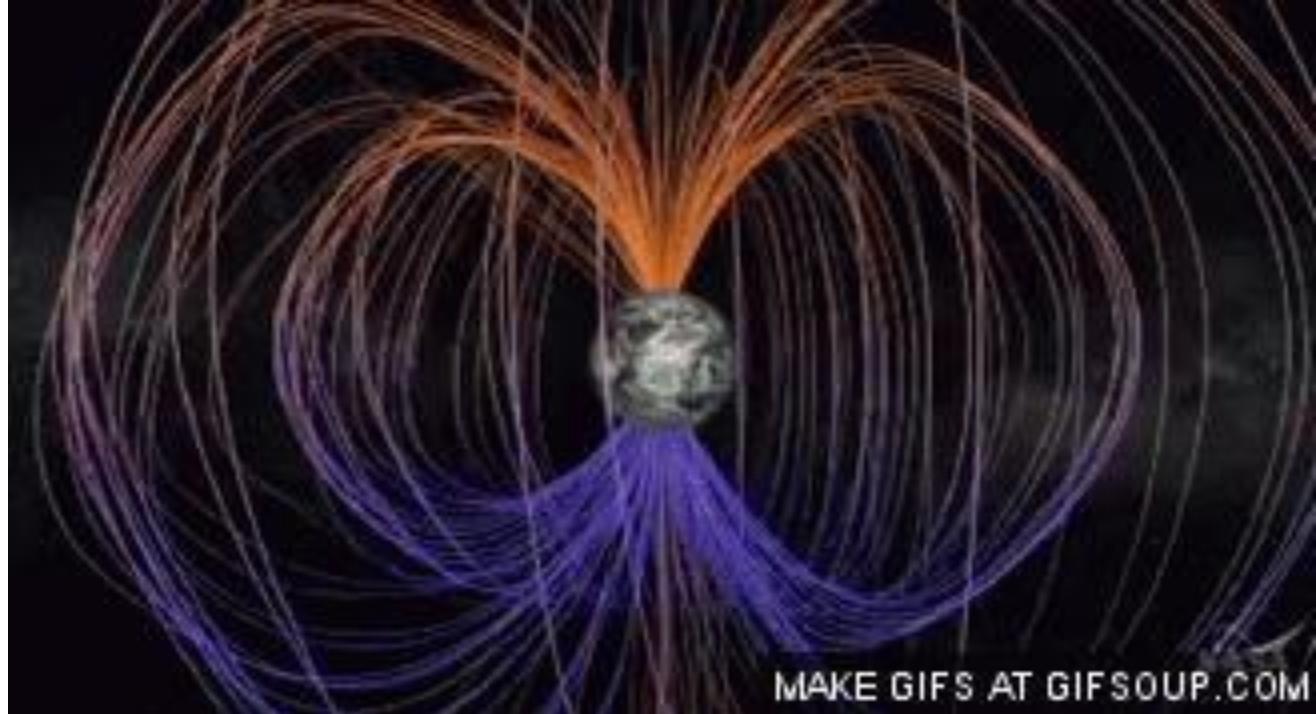


Berner RA, Kothavala Z (2001) GEOCARB III: A revised model of atmospheric CO₂ over Phanerozoic time, IGBP PAGES and World Data Center for Paleoclimatology, Data Contribution Series # 2002-051. NOAA/NGDC Paleoclimatology Program, Boulder CO, USA.

EARTH'S MAGNETOSPHERE ALLOWS US TO HAVE AN ATMOSPHERE

Life on Earth initially developed and continues to be sustained under the protection of this magnetic environment.

The magnetosphere shields our home planet from solar and cosmic particle radiation, as well as erosion of the atmosphere by the solar wind - the constant flow of charged particles streaming off the sun.



Early Earth had a low-oxygen atmosphere created by volcanic gases.

The Great Oxygenation Event (GOE) responsible for rise in Oxygen levels, which occurred nearly 2.3 billion years ago, is essential for all of the Life on Earth today.

It was the result of the growth of plants that took in Carbon Dioxide and released Oxygen.



Algae and microbial mats of plant material produce Oxygen and take in Carbon Dioxide for their growth process.

STROMATOLITES UNDER THE OCEAN

Stromatolites and microbial mats are diverse and complex ecosystems where different species of **bacteria and other microbes work together to produce oxygen.**

They have been around and growing for 3 billion years ago.

They are only found to a depth of 4 meters because some of the microbes forming them, cyanobacteria, require sunlight.

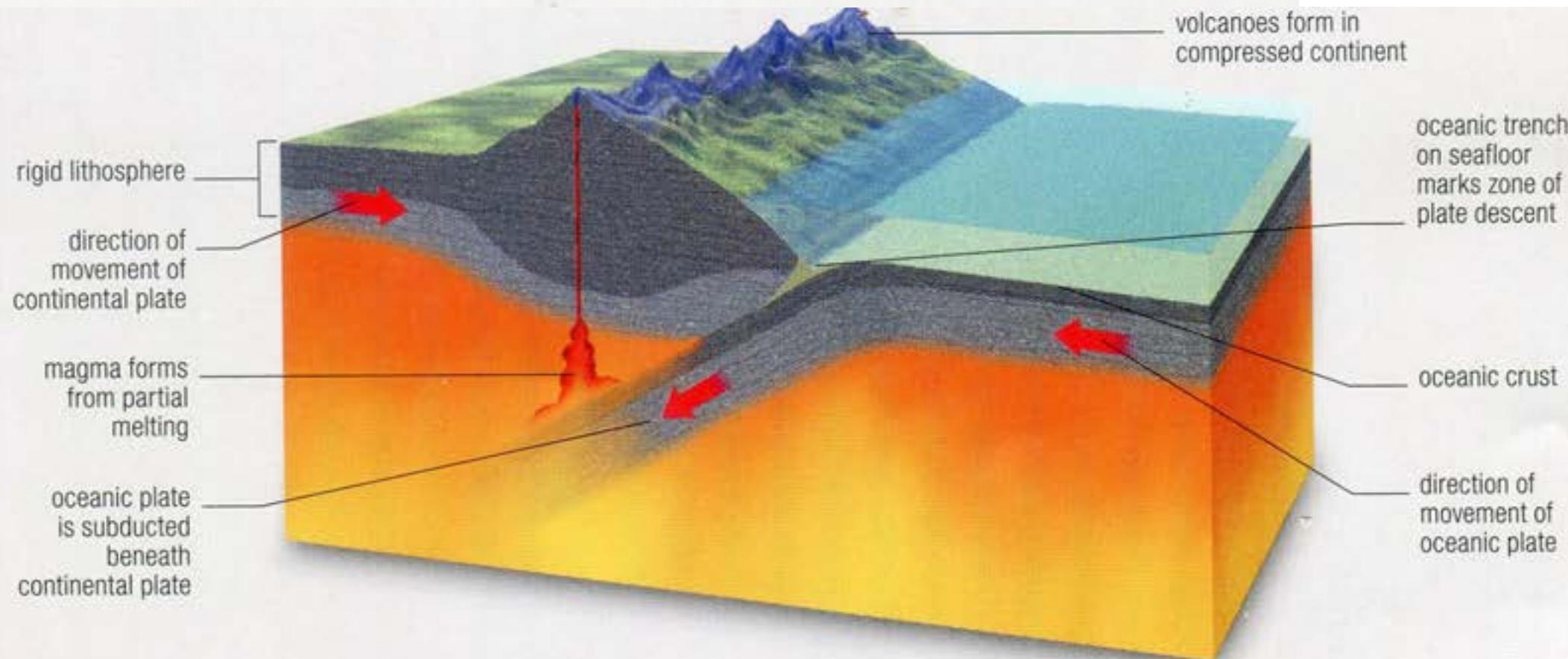


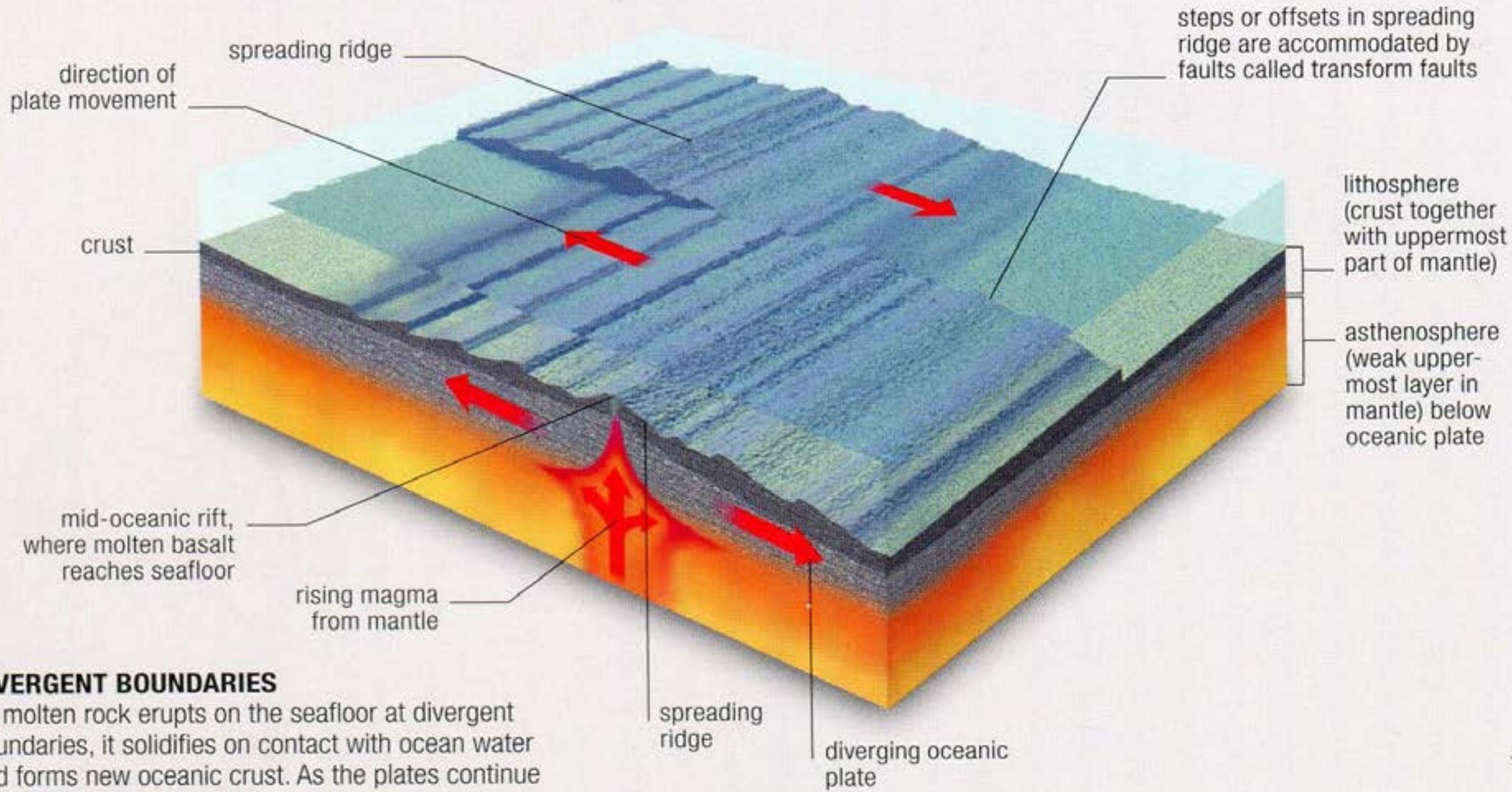
Plate Tectonics

Earth's thin outer crust and upper mantle, down to a depth of about 60–200 miles (100–300km), are divided into continent-sized plates that jostle against one another. As the plates move, oceans are created and later disappear, and volcanoes and mountain chains are formed.

OCEANIC–CONTINENTAL

Where plates of different densities converge, the denser plate is subducted below the other, descending hundreds of miles into the mantle. This usually generates earthquakes, as well as volcanic activity as water rising from the subducted slab leads to melting of the overlying mantle.





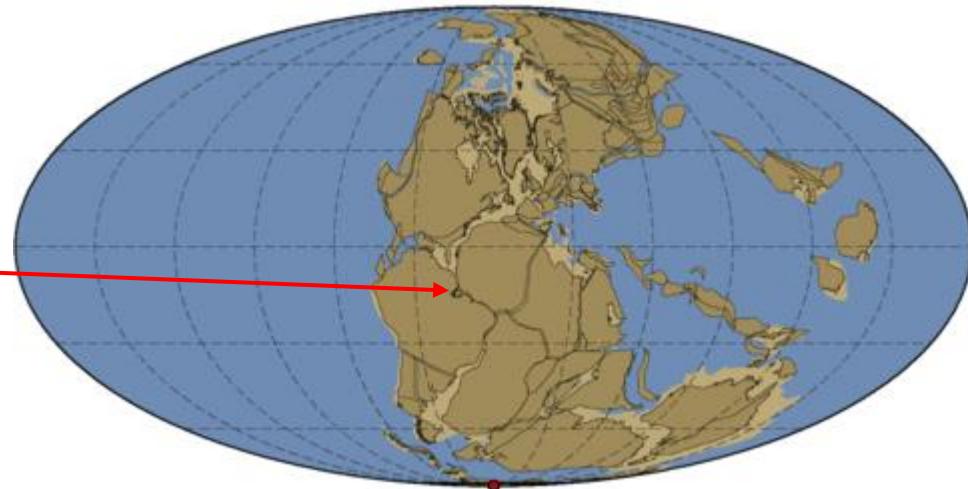
DIVERGENT BOUNDARIES

As molten rock erupts on the seafloor at divergent boundaries, it solidifies on contact with ocean water and forms new oceanic crust. As the plates continue to diverge (a process called seafloor spreading), new oceans open up over millions of years.

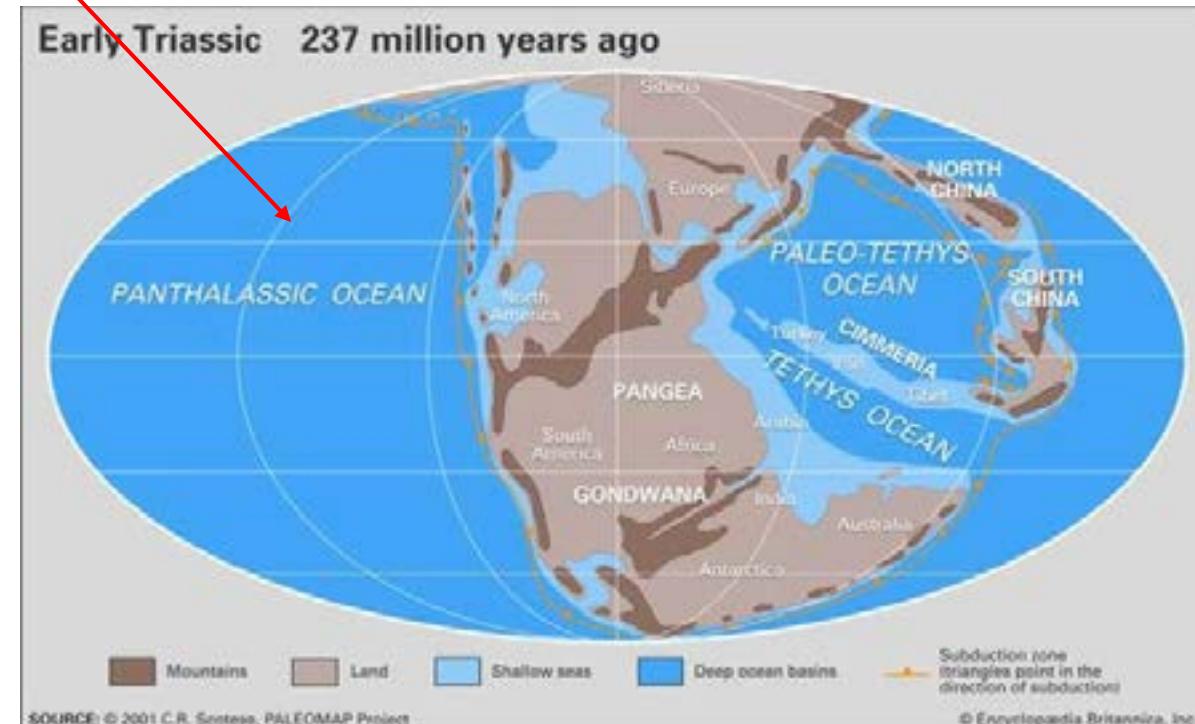
252.2 – 199.6 MILLION YEARS AGO (MYA)

THE TRIASSIC PERIOD

200 million years ago, dinosaurs roamed the supercontinent **Pangea** which extended from pole to pole, surrounded by the **Panthalassic Ocean**, the oceanic ancestor of the Pacific Ocean.

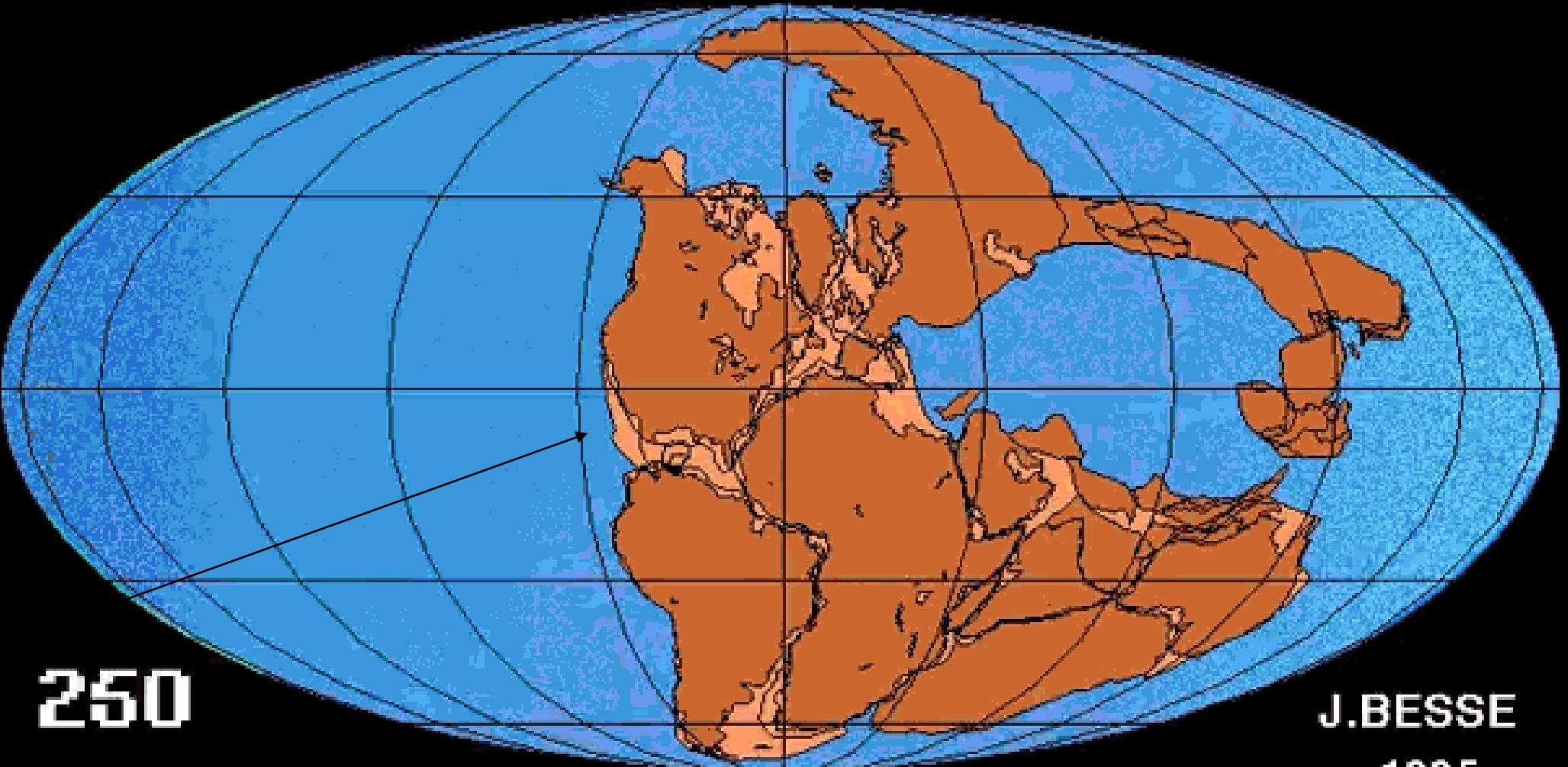


- ❖ At the end of the Triassic era, 80% of species died.
- ❖ **Pangea** supercontinent combines all major landmasses
- ❖ Panthalassa combines all oceans except Tethys
- ❖ The climate was very hot and dry with huge deserts at the center of the land mass.
- ❖ **Archosaurs wildly diversify, becoming the crocodilians, the flying Pterosaurs, and Dinosaurs.**



It is interesting to note that before Pangea started to break apart, the lower part of North America was at the Equator !!

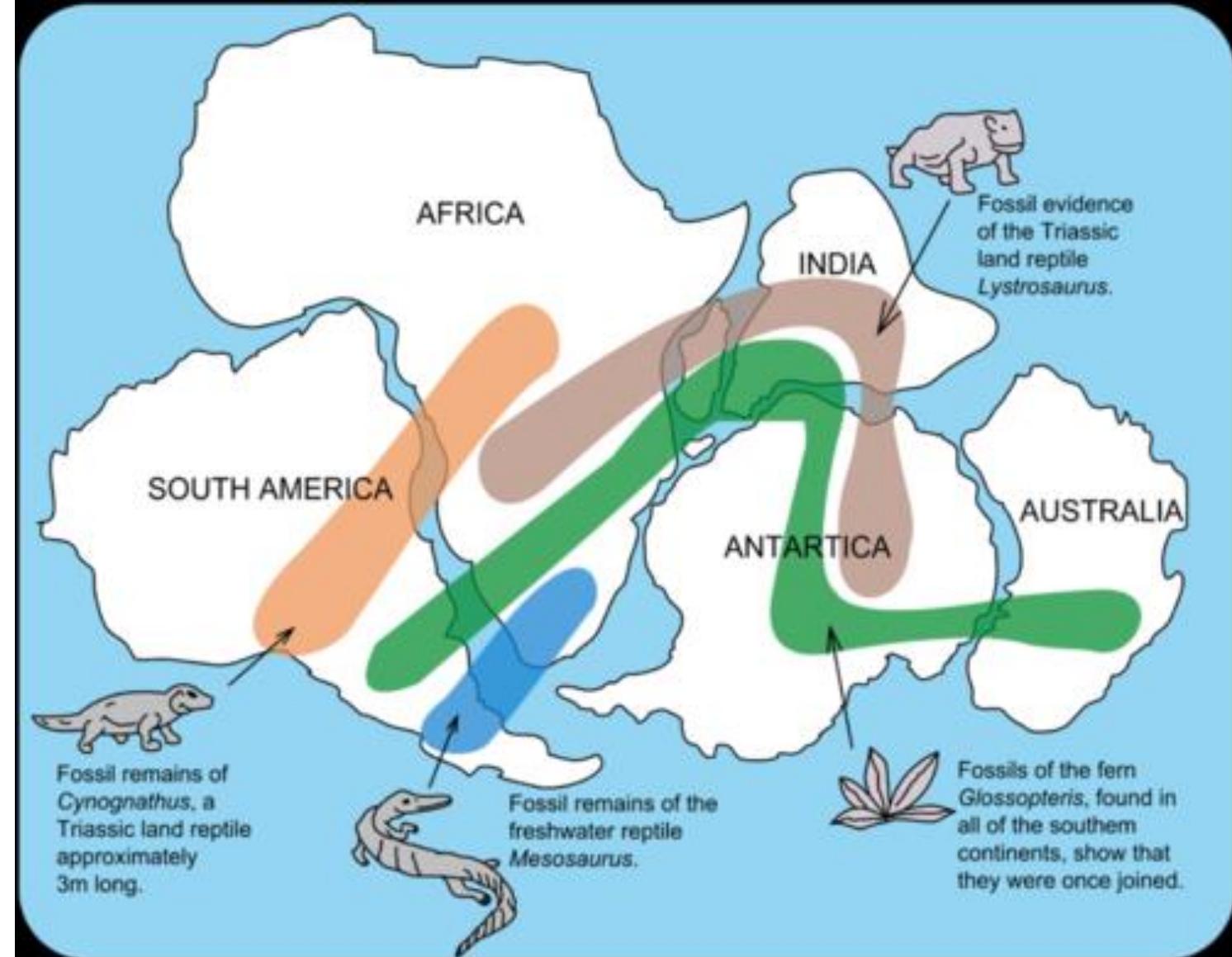
250



Ancient fossils of the same species of extinct plants and animals are found in rocks of the same age but are on continents that are now widely separated .

Alfred Wegener proposed that the organisms had lived side by side, but that the lands had moved apart after they were dead and fossilized.

He suggested that the organisms would not have been able to travel across the oceans.



Wegener used fossil evidence to support his continental drift hypothesis. The fossils of these organisms are found on lands that are now far apart.

**MATCHING ROCKS AND FOSSILS
ON DIFFERENT CONTINENTS TODAY
DID HELP TO SUPPORT THE THEORY.**

THE MESOZOIC ERA

The Mesozoic era includes the 3 main time periods when the Dinosaurs lived:

1) Triassic

2) Jurassic

3) Cretaceous.

As the Mesozoic era begins, we see the rise of the dinosaurs, during the later part of the Triassic Era which is 252-201 Million Years Ago so it lasted for 51 million years.

Pterosaurs (flying reptiles) also made their first appearance here as well as frogs, turtles, and crocodiles.

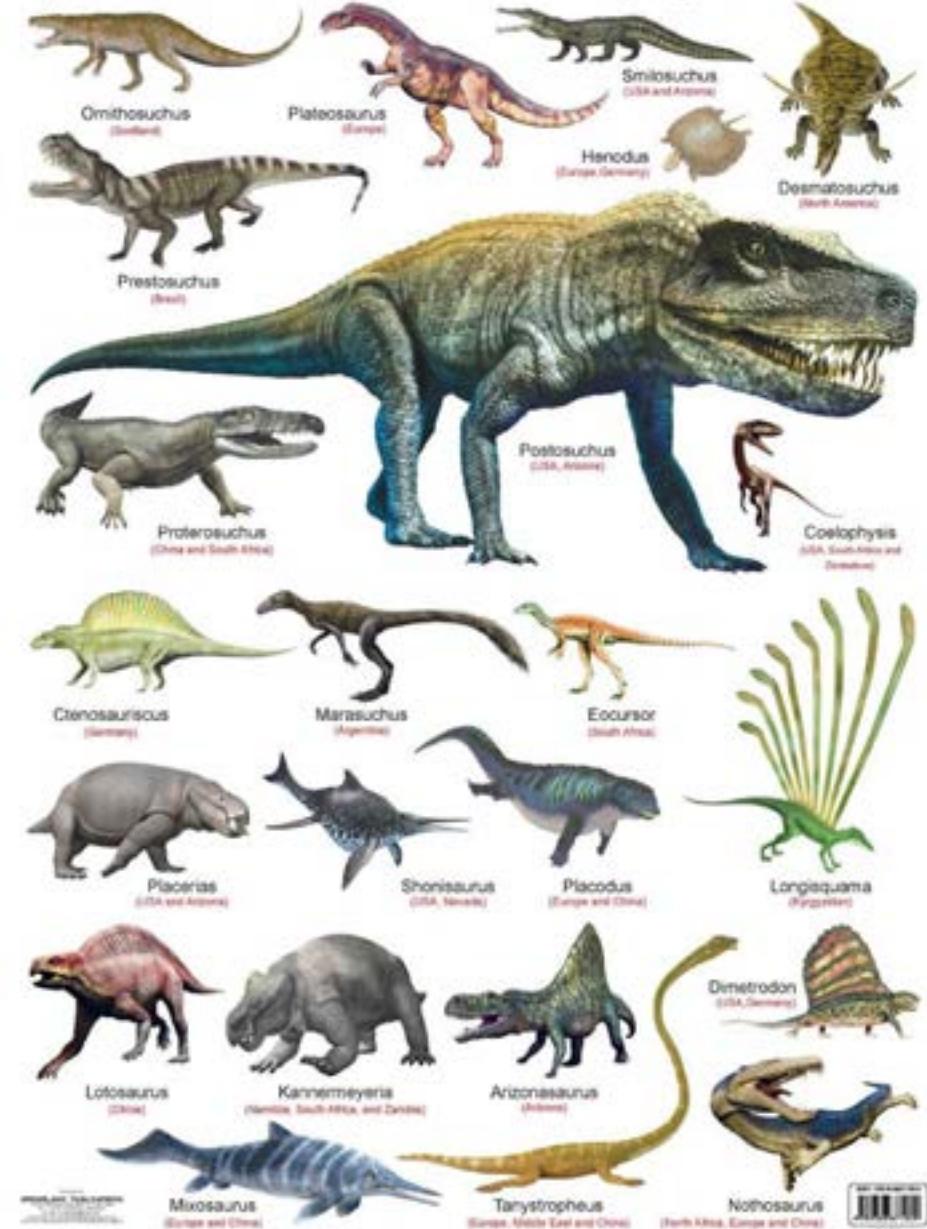
During the Late Triassic period, many small mammals also arose.

DINOSAURS OF TRIASSIC ERA

CHART

The Triassic Period, in geologic time, the first period of the Mesozoic Era. It began 252 million years ago and ended 201 million years ago. It was an era of changes. A lot happened to Earth and its life-forms. The first dinosaurs

appeared during the Triassic Period. Carnivorous mammal-like reptiles called cynodonts evolved. There were also many kinds of aquatic reptile, including tortises and turtles. Palm-like cycads grew in the Triassic Period.



THE TRIASSIC PERIOD

As mentioned, the Triassic period - spans almost 151 million years.

It began in the wake of the Permian-Triassic extinction event, which left the Earth's biosphere in bad shape.

It was well into the middle of the Triassic before life recovered its former diversity.

A specialized subgroup of archosaurs, called dinosaurs, first appeared in the Late Triassic but did not become dominant until the succeeding Jurassic Period.



PLEUROMEIA TREES

After the big Permian-Triassic extinction when most plants died out, these trees grew everywhere around the world **during the Triassic period.**

It was a smaller tree with a single, unbranched trunk topped by a tuft of grass-like leaves, with one or 2 side cones and a main one at the top.

It reproduced from spores in the cone at the top of the tree.



PLANTS THAT LIVED DURING THE TRIASSIC PERIOD

The environment was dominated by conifers (evergreen trees), ferns and a now-extinct group of plants known as the seed ferns.

Most ferns did and still reproduce with small packets of spores on the under side of their leaves.



Nyasasaurus parringtoni

This dinosaur is believed to be the one of the first ones that walked the Earth about 243 million years ago, during the **Triassic period**.

There were probably others similar to it that lived before then, but their fossils haven't been found yet.

The video of the dinosaur Troodon is shown, which is very close in size to Nyasasauruas.



COELOPHYSIS

One of the first true dinosaurs in the Triassic period was Coelophysis ("hollow form"), a carnivorous, bipedal predator that **emerged in the late Triassic, between 225 and 220 Million years ago (MYA)**.

With Hollow bones, it grew up to 10 feet in length, weighed around 60 pounds and probably fed on smaller reptiles and amphibians.

It had curved claws on its hands and a slim head crammed full of very sharp teeth.



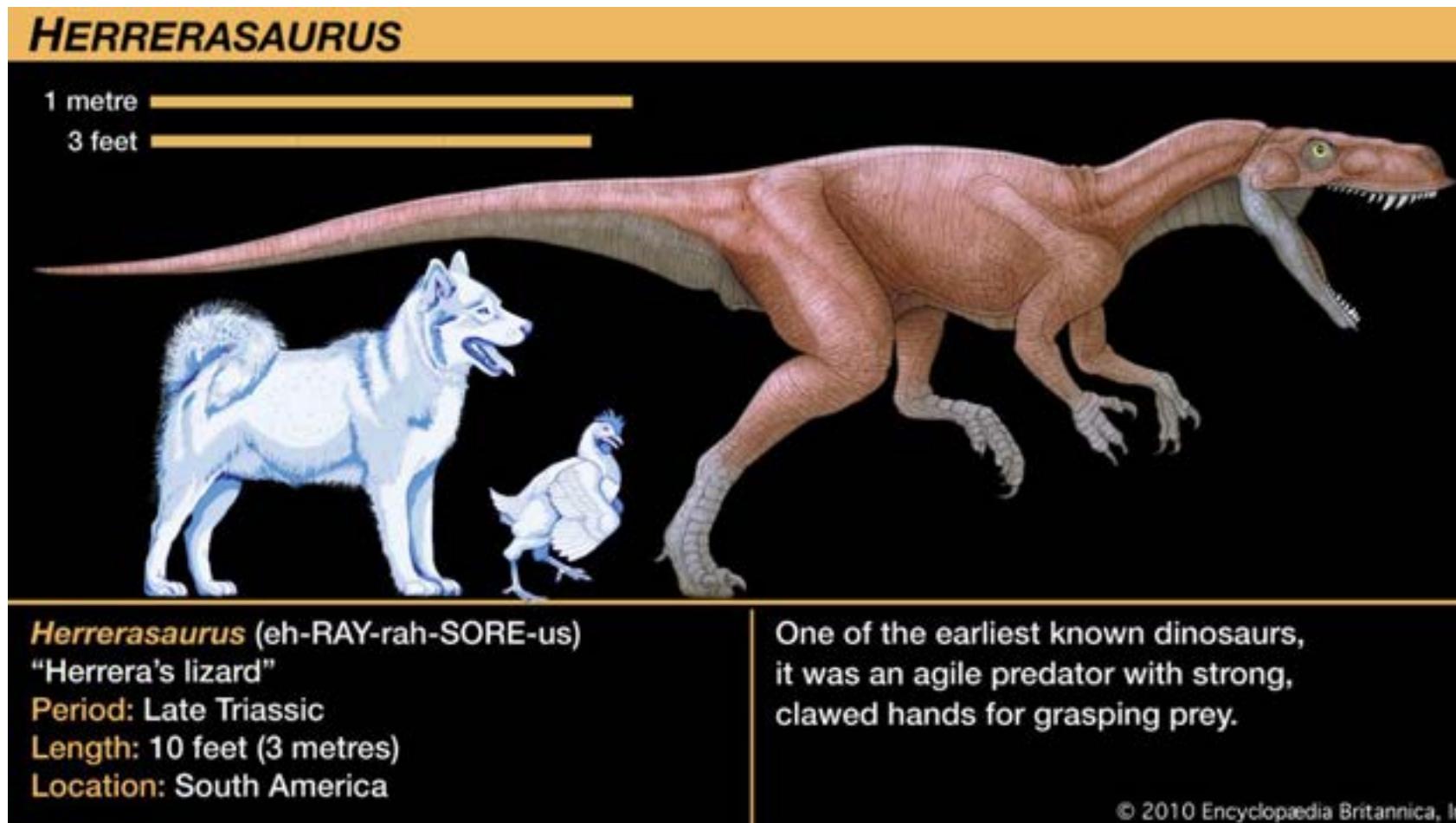
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HERRERASAURUS

Found in the late Triassic period in northwestern Argentina, Herrerasaurus is an early archosaur which is the main classification for dinosaurs.

The first specimen was found in 1958 by Victorino Herrera, for whom the fossil was named.

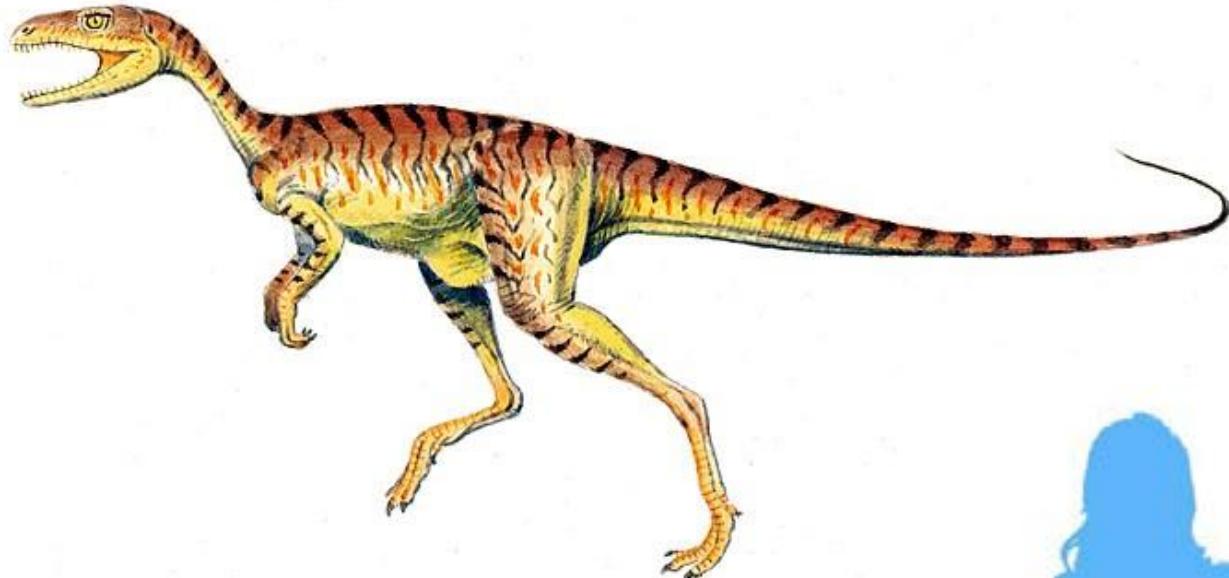
It was a large carnivore about 20 feet long and they weighed up to 770 pounds.



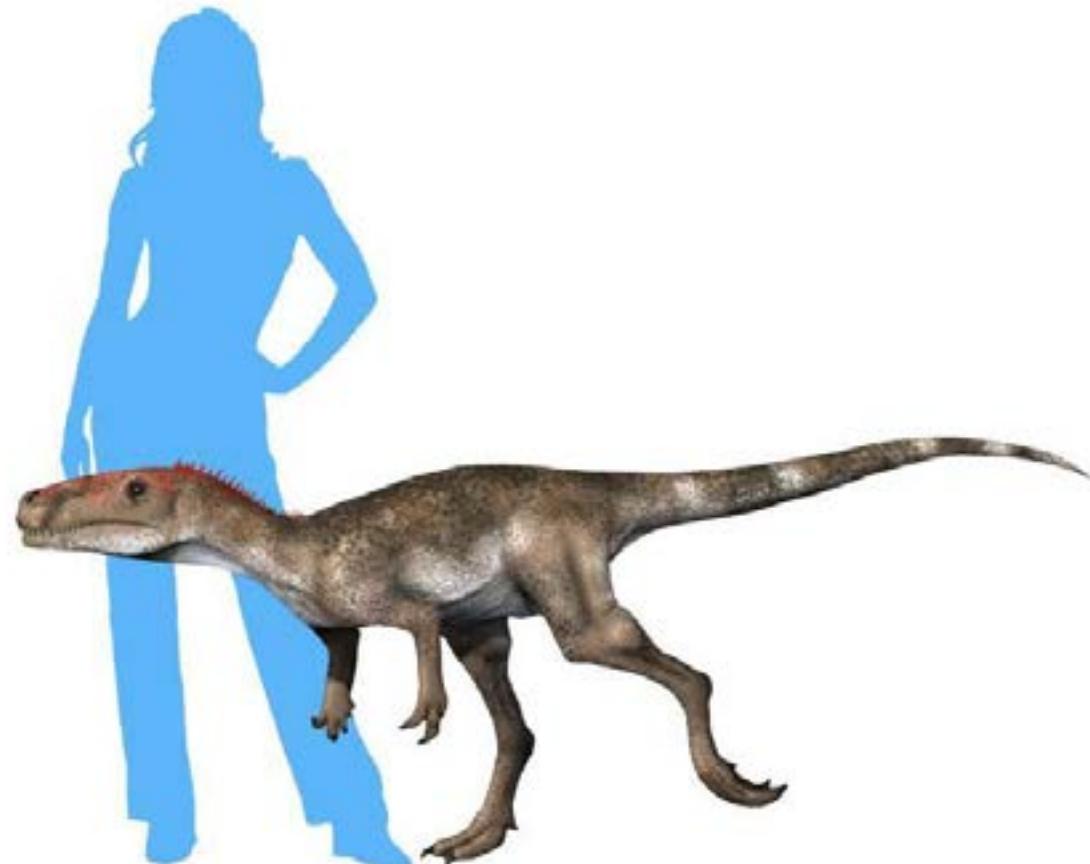
OTHER TRIASSIC DINOSAURS

As mentioned,
dinosaurs
didn't start to
appear until
the end of the
Triassic period.

These are
some others
that lived at
that time.



CHINDESAURUS



STAURIKOSAURUS



EORAPTOR



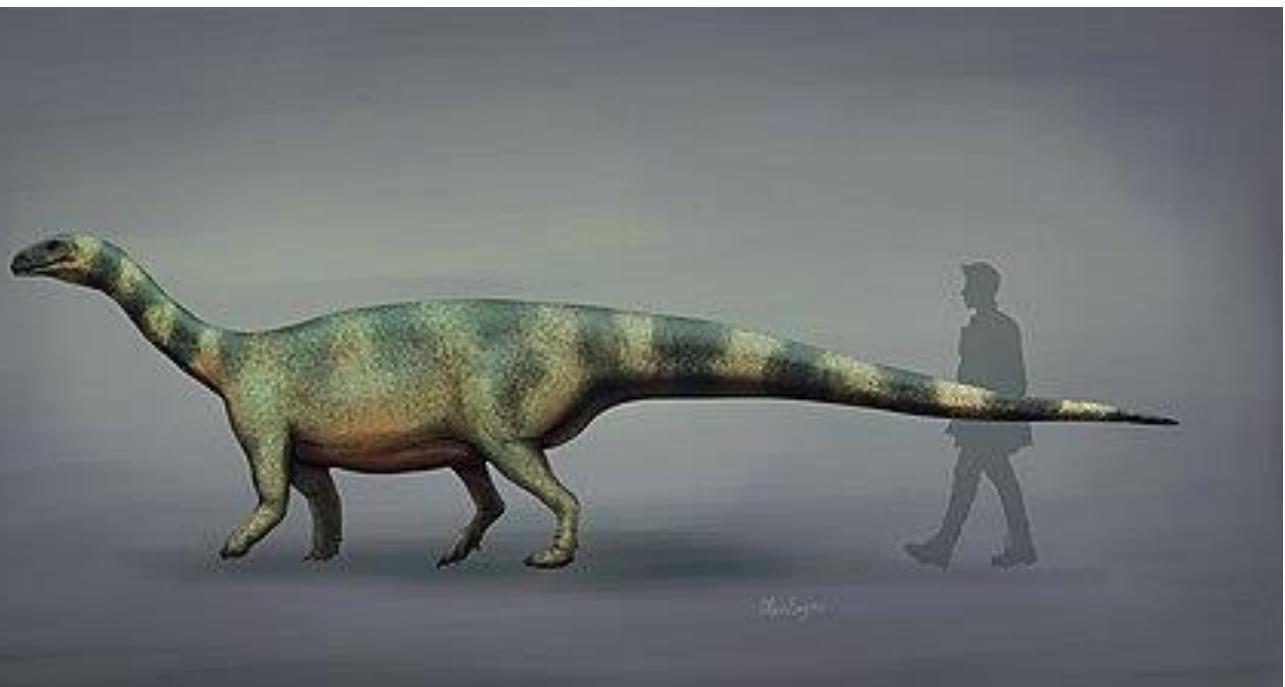
COLORADISAURUS



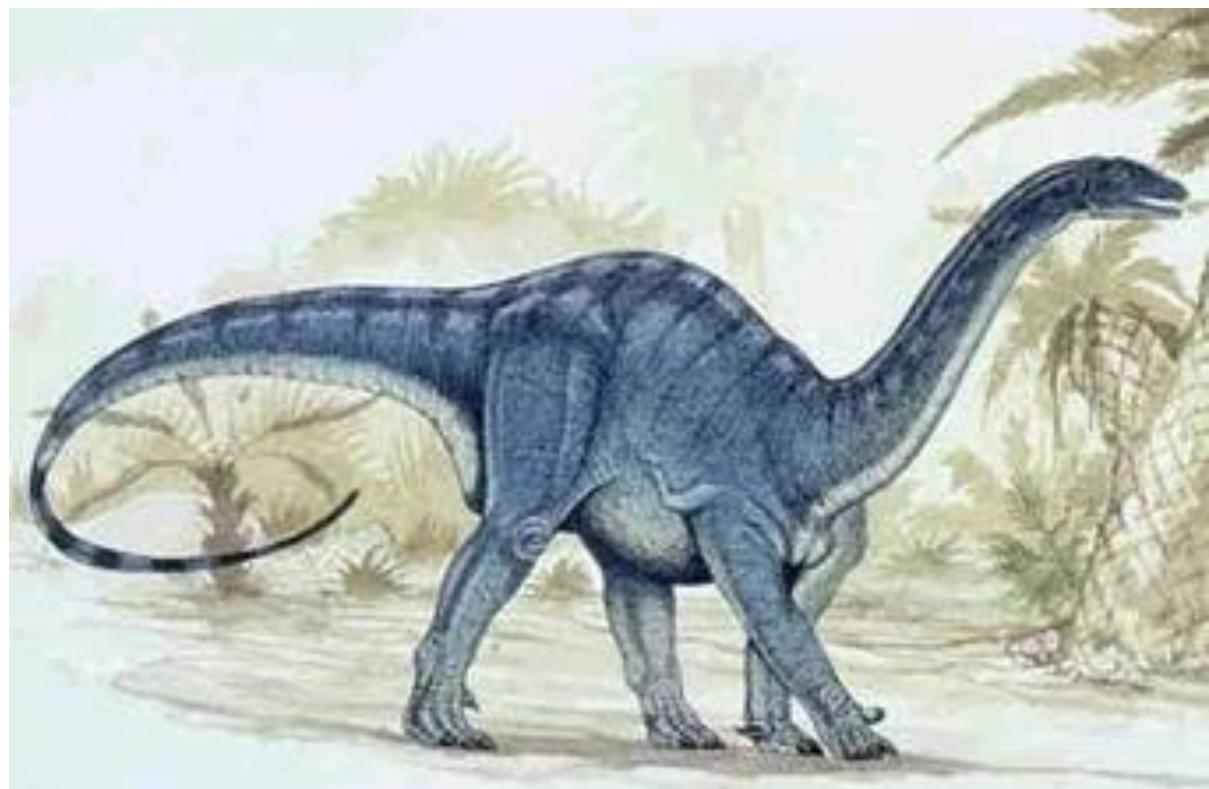
LILLIENSTERNUS



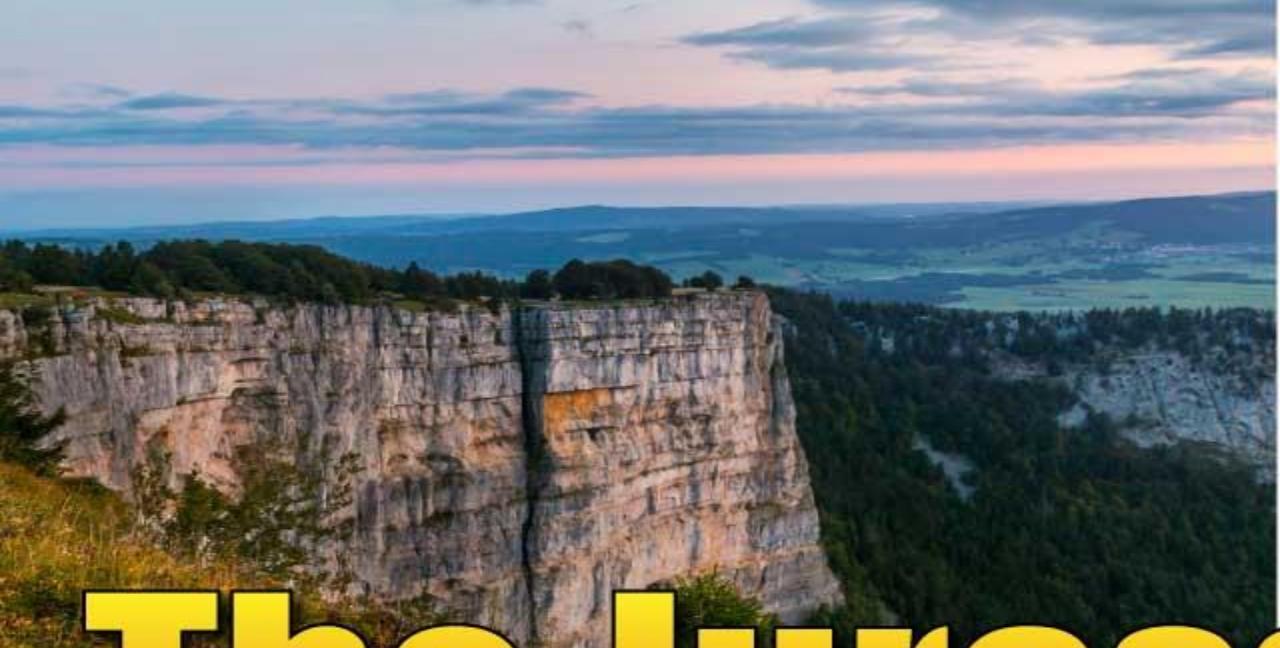
LYCORNIS



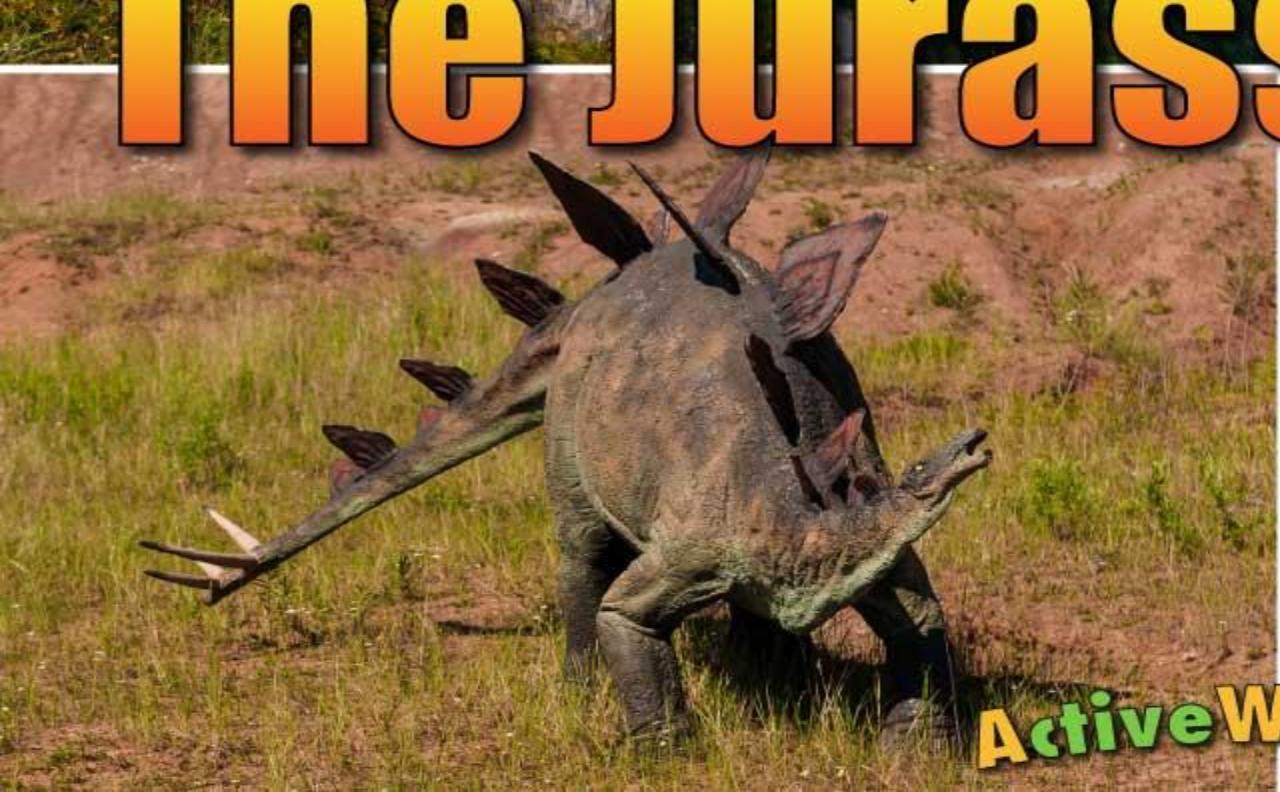
MELANOROSAURUS



MUSSAURUS



The Jurassic Period



ActiveWild.com

DINOSAURS OF JURASSIC ERA

CHART

The Jurassic was a geologic period that lasted from about 213 million years ago to about 144 million years ago. This was a golden age when the dinosaurs ruled the land. Many of the dinosaurs grew to an enormous size.

The first true bird, Archaeopteryx, evolved, and many kinds of crocodile developed. During this period, vegetation was greener and more lush. Conifers were common in the Jurassic Period.

The Jurassic period began the Age of the Ruling Reptiles, 208-144 Million Years Ago.

During this period, vegetation was greener and more abundant.

By the Late Jurassic, huge dinosaurs such as *Stegosaurus*, *Ceratosaurus*, *Brachiosaurus*, and *Allosaurus* walked the lands.

Flying reptiles ruled the skies.

The earliest known birds also appeared.



WILLIAMSONIA PLANTS

Williamsonia was a significant plant during the Jurassic time period.

It possessed a sturdy stem and had multiple fern-like leaves. The plant did not live in groups.

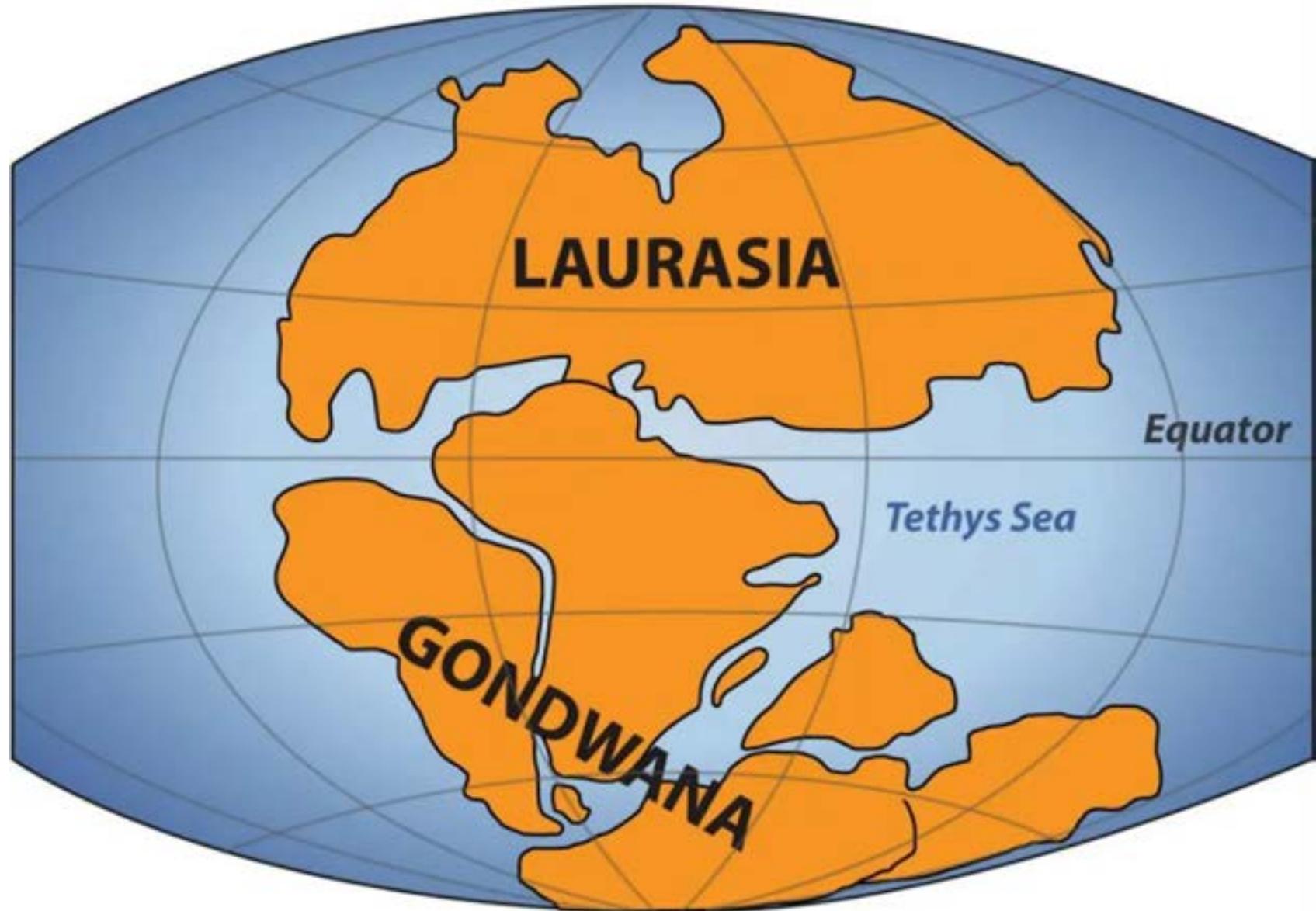
They produced flowers up to 4 inches in length.

Its stalked seeds would have grown from a central receptacle, and the entire flowers would each have been surrounded by protective coverings.



By the beginning of the Jurassic, the supercontinent Pangaea had begun dividing into 2 landmasses: Laurasia to the north, and Gondwana to the south.

This created more coastlines and shifted the continental climate from dry to humid, and many of the arid deserts of the Triassic were replaced by lush rainforests.



COMPSOGINATHUS

It was one of the smallest carnivore (meat-eating) dinosaurs. It caught and ate small animals, including insects and lizards.

It was 4.6 feet long, 10 inches tall, and weighed 6.5 pounds

It lived during the Jurassic period, about 155 to 145 years ago.



DILOPHOSAURUS

It lived in Arizona during the Early Jurassic, about 193 million years ago.

Its name means "two-crested lizard" as it had a frill collar it could expand to scare a potential enemy. It also had small feathers around its body.

It was 23 feet long and weighed about 880 pounds. The one in the video is a smaller size.

It was one of the earliest large predatory dinosaurs and the largest known land-animal in North America at the time.



DRYOSAURUS

Dryosaurus
which means
tree lizard, lived
in forests in the
Western United
States in the
late Jurassic
period.

They were 8 to
14 feet long and
weighed up to
170 to 200
pounds.

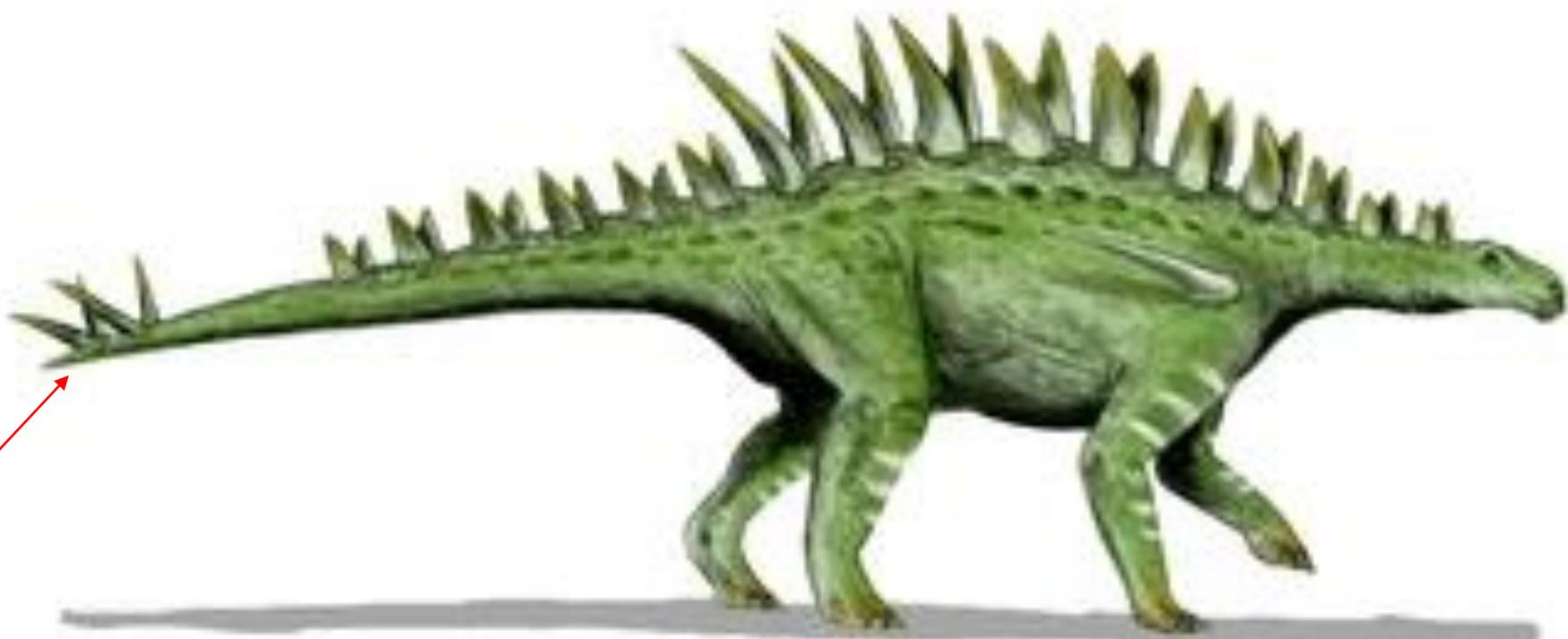


HUAYANGOSAURUS

It lived around 165 million years ago, some 20 million years before its famous relative, Stegosaurus appeared in North America.

It grew up to 15 feet long and weighed 1,000 pounds.

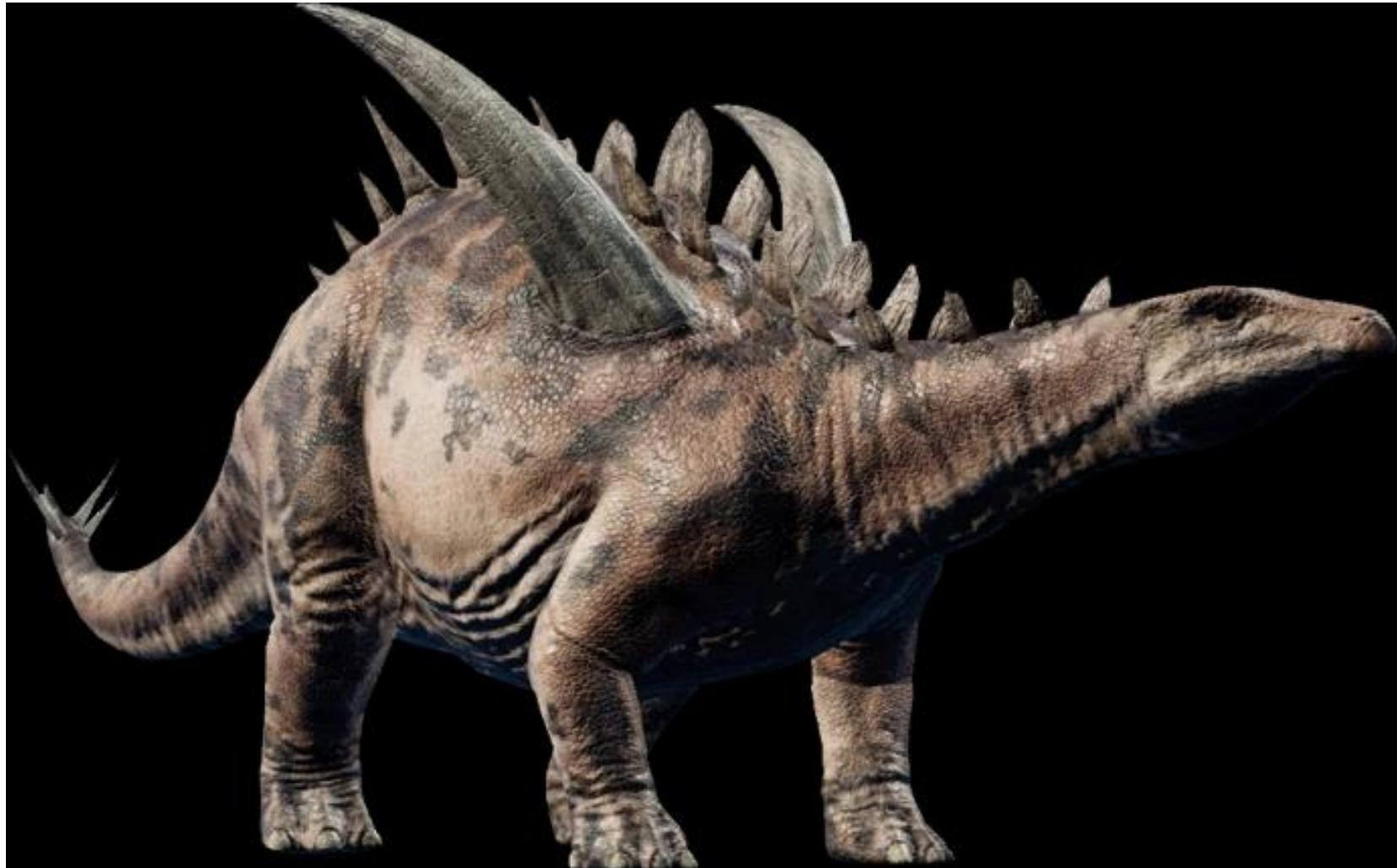
On its neck, back, and tail were two rows of paired small vertical plates and spikes. On the rear of the tail, pairs of spikes were present forming the so-called "**thagomizer**", a defensive weapon which was on all of the dinosaurs in the Stegosaur family.



GIGANTSPINOSAURUS

Gigantospinosaurus meaning "giant-spined lizard" is a herbivorous dinosaur from the Late Jurassic period.

It is another member of the Stegosaur family that was found in China.



KENTROSAURUS

They lived in the Late Jurassic period, in Tanzania, about 152 million years ago.

They grew to 15 feet long and weighed about 1.1 tons.



CHUNGKINGOSAURUS

Chungkingosaurus, meaning "Chongqing Lizard", is a herbivorous dinosaur from the Late Jurassic period, in China.

It is a member of the Stegosaurus family of dinosaurs.



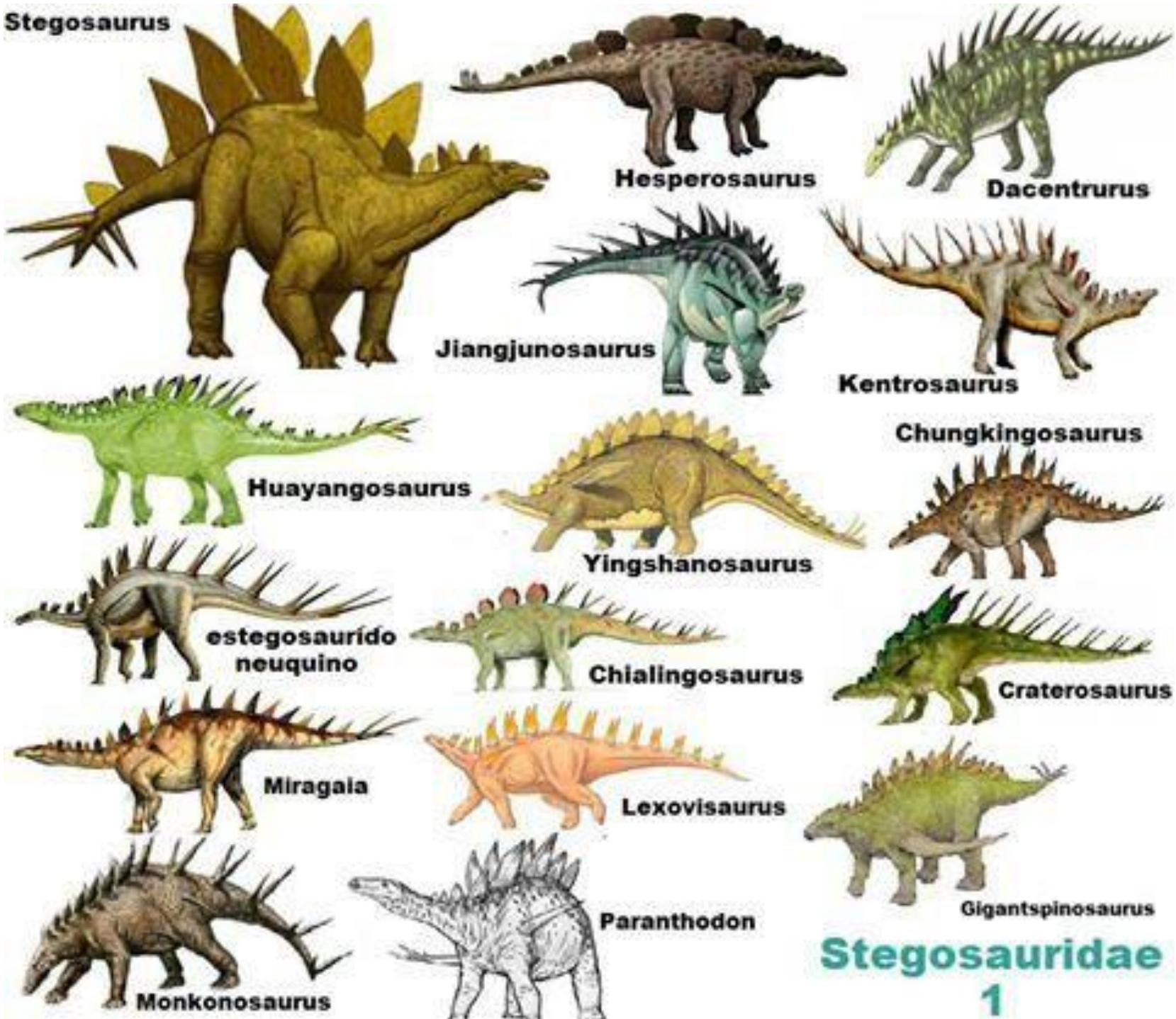
STEGOSAURUS

They lived in the late Jurassic period, between 155 and 150 million years ago, in the western United States and Portugal.

They grew up to 29.5 feet long and weighed up to 7.7 tons.

It and the 4 dinosaurs shown previously are all in the Stegosaurid family, shown on the next slide.





Stegosauridae

1

FIGHT BETWEEN A VELOCIRAPTOR AND A PROTOCERATOPS

They will remain forever locked in mortal combat. The *Velociraptor* has sunk its deadly foot claw deep into the neck of the herbivore, a boar-sized creature called *Protoceratops*.

But the *Protoceratops* fought back. It has thrown the *Velociraptor* to the ground before it, and its jaws are locked on to the predator's right arm. The bite appears to have broken the *Velociraptor*'s arm.

What happened next?

One possibility is that a sand dune collapsed on them while they were still fighting for their lives.



CERATOSAURUS

It was a carnivorous dinosaur in the Late Jurassic period and discovered in Garden Park, Colorado.

It was estimated to grow to be 23 feet long and weighed about 2.2 tons.

It had deep jaws that supported proportionally very long, blade-like teeth, a prominent, ridge-like horn on the midline of the snout, and a pair of horns over the eyes.

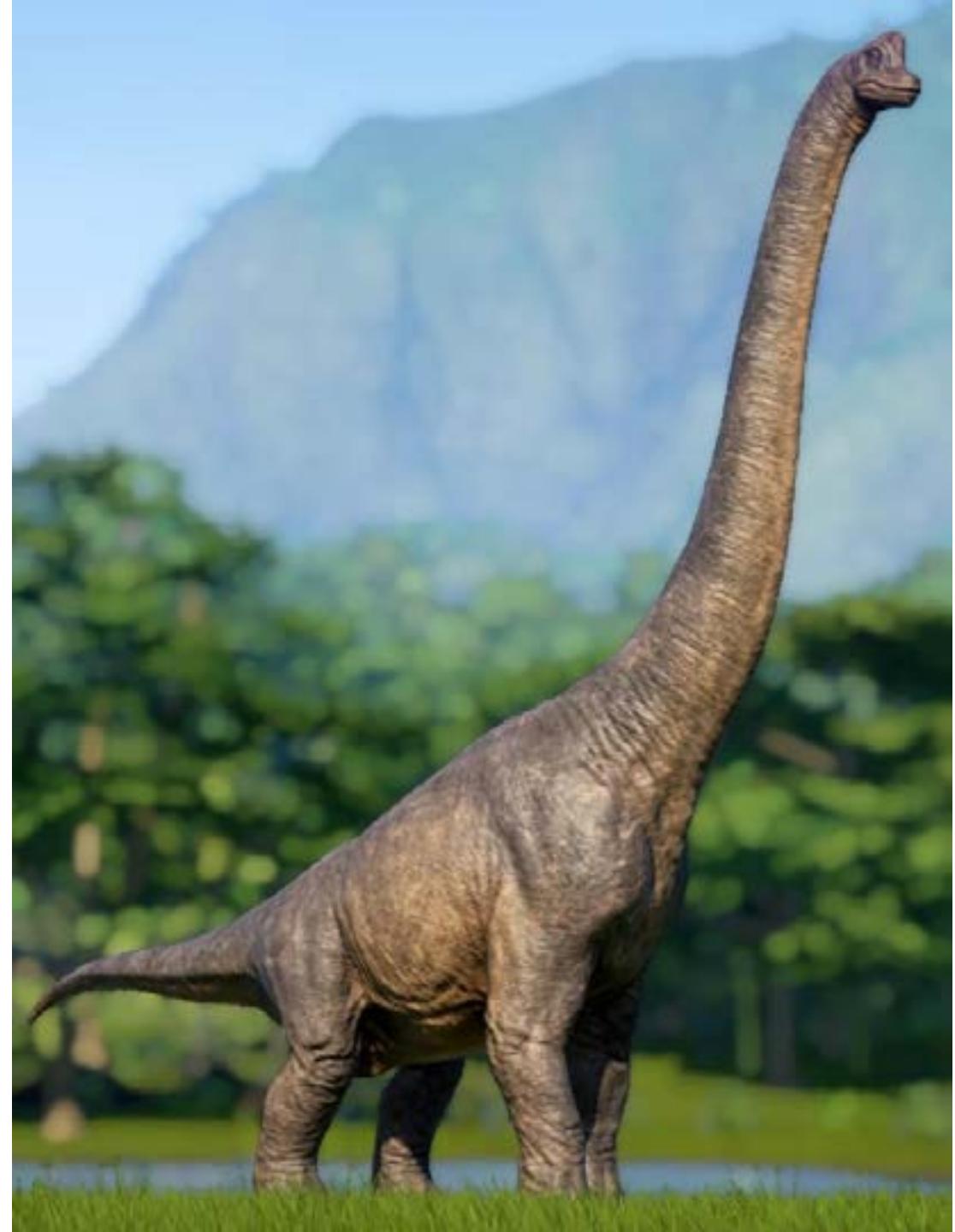


BRACHIOSAURUS

Brachiosaurus lived in North America during the Late Jurassic period, about 154–153 million years ago.

The generic name is Greek for "arm lizard", in reference to its proportionately long arms (front legs), and the specific name means "deep chest".

They were 59 to 69 feet long and weighed 31.2 to 64 tons).



APATOSARUS

Apatosaurus means "deceptive lizard" and is a herbivorous dinosaur that lived in North America during the Late Jurassic period.

They had an average length of 69–75 ft and an average weight of 18.1–24.7 tons, with some being even larger than that.

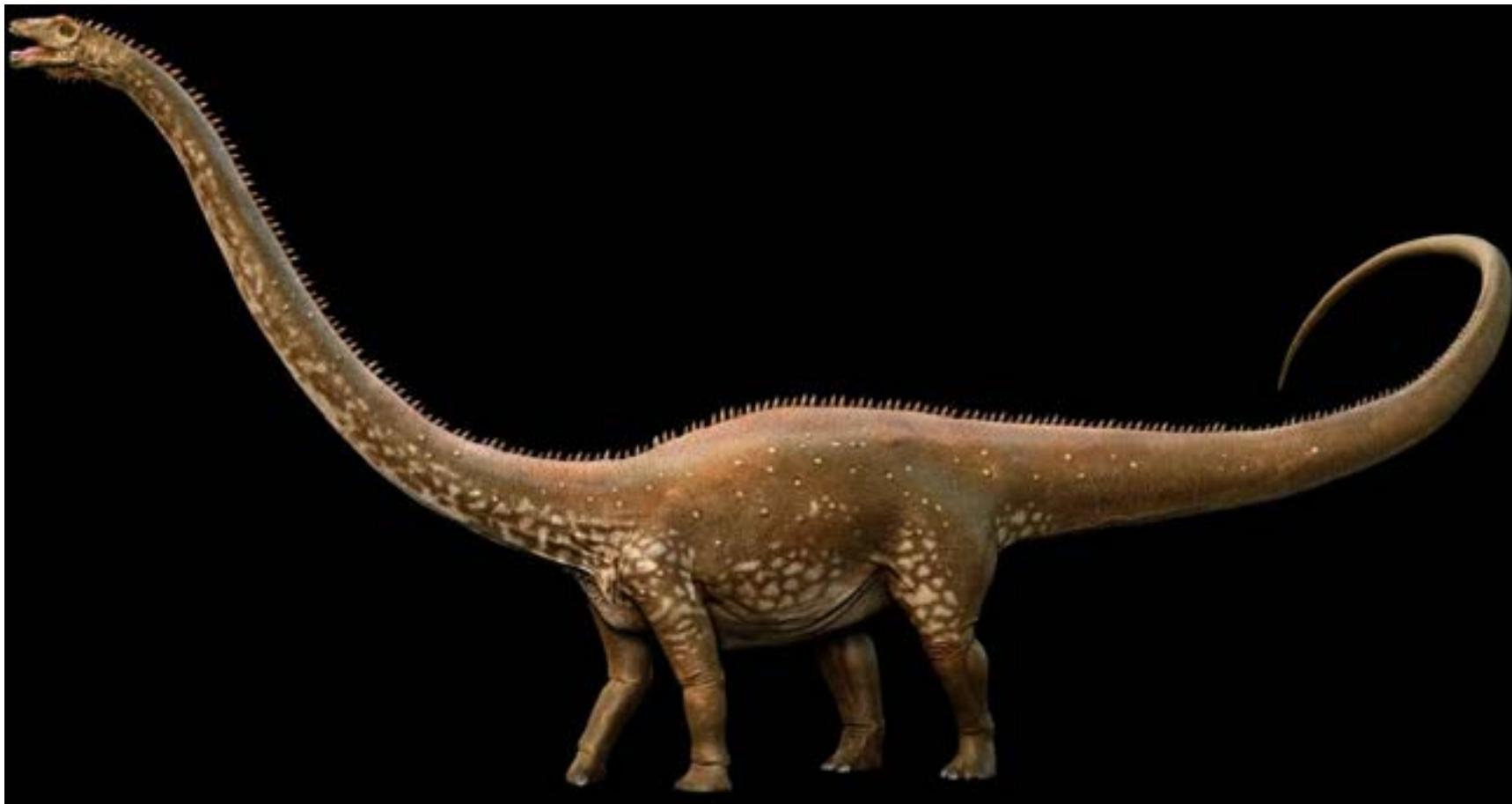


DIPLODOCUS

They lived in mid-western North America at the end of the Jurassic period.

Diplodocus is one of the more common dinosaur fossils when they lived 154 to 152 million years ago

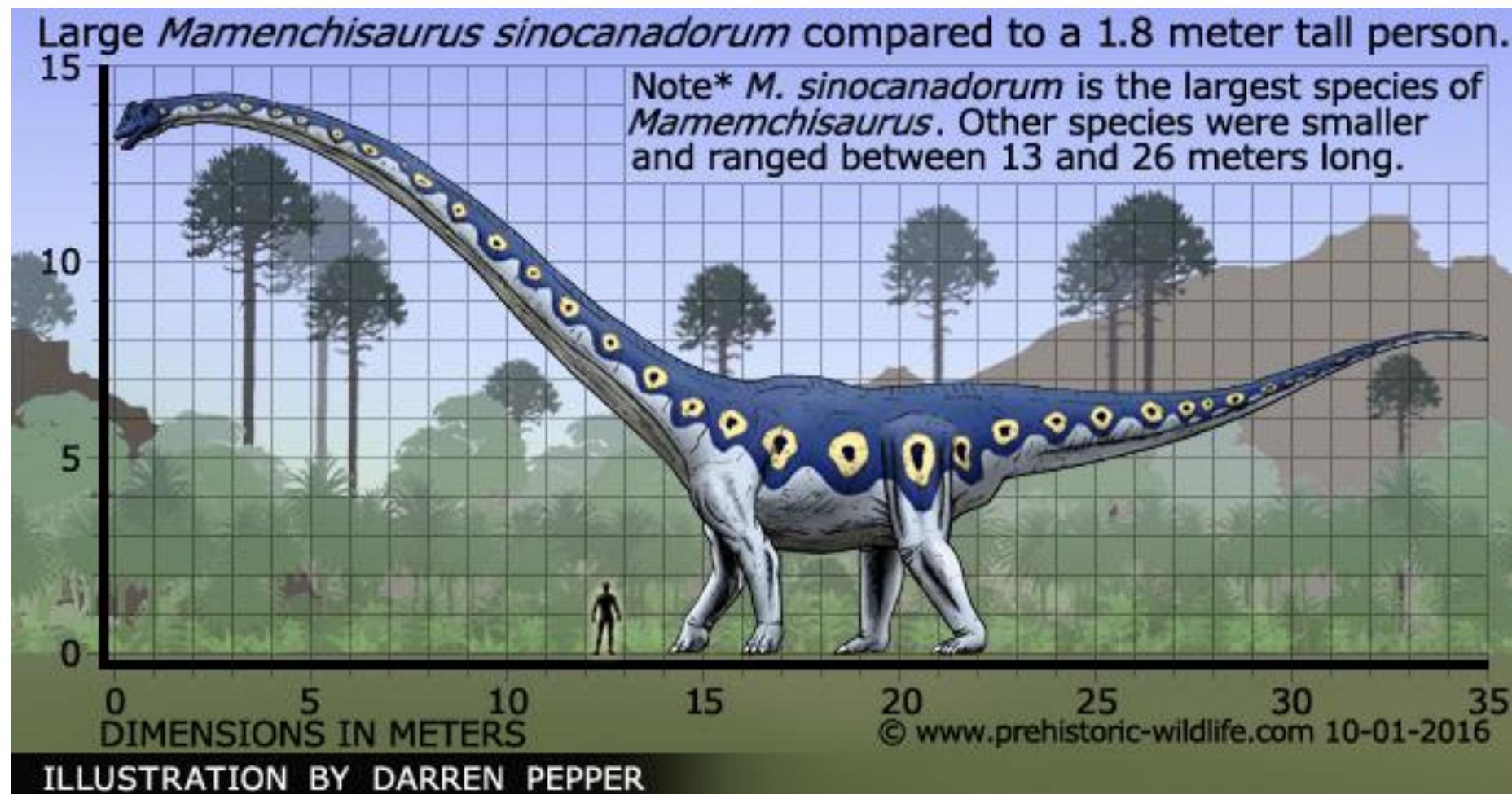
Its great size may have been a deterrent to the predators Allosaurus and Ceratosaurus

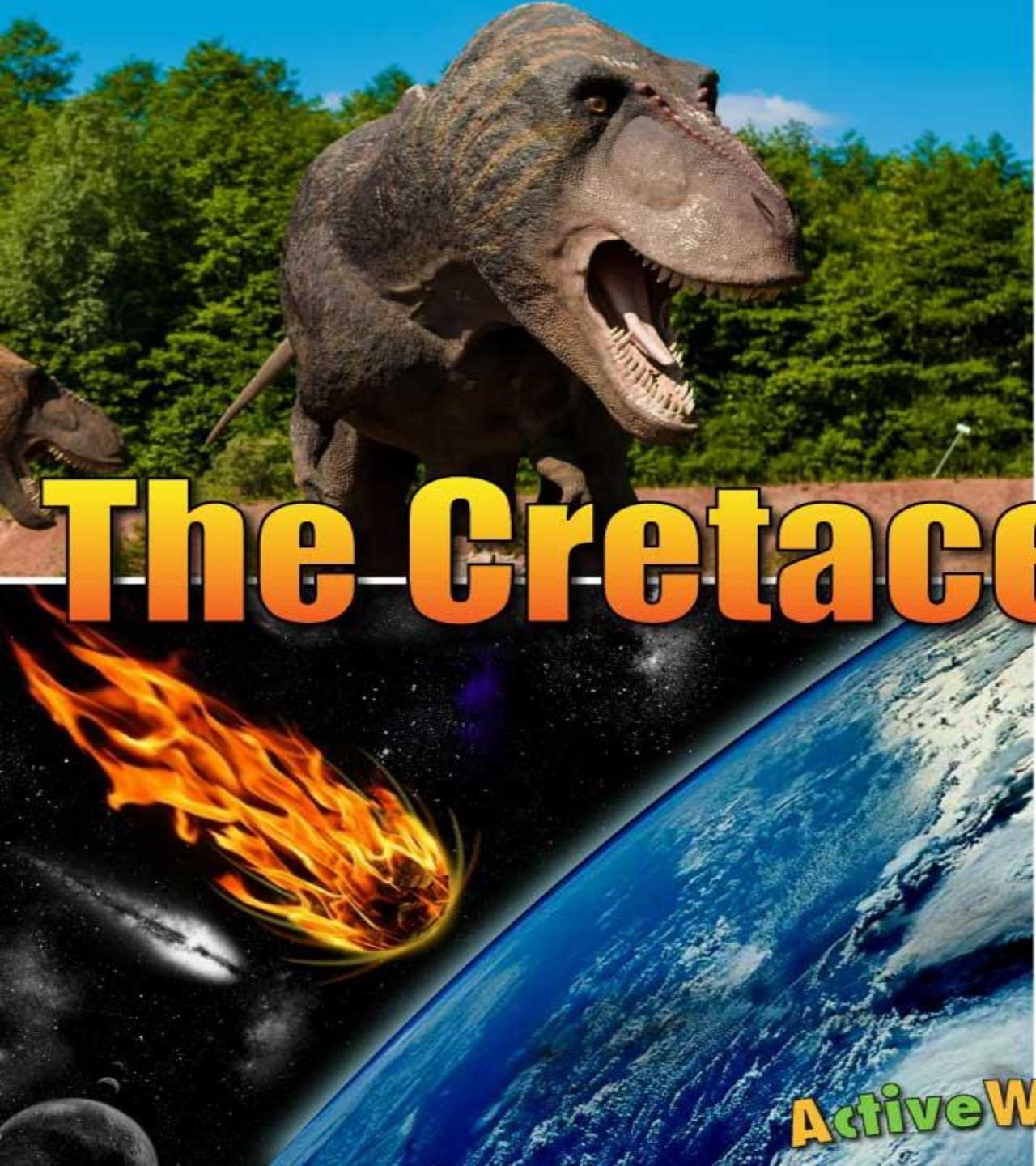


Mamenchisaurus was also one of the biggest sauropod dinosaurs, known for their remarkably long necks which made up half the total body length.

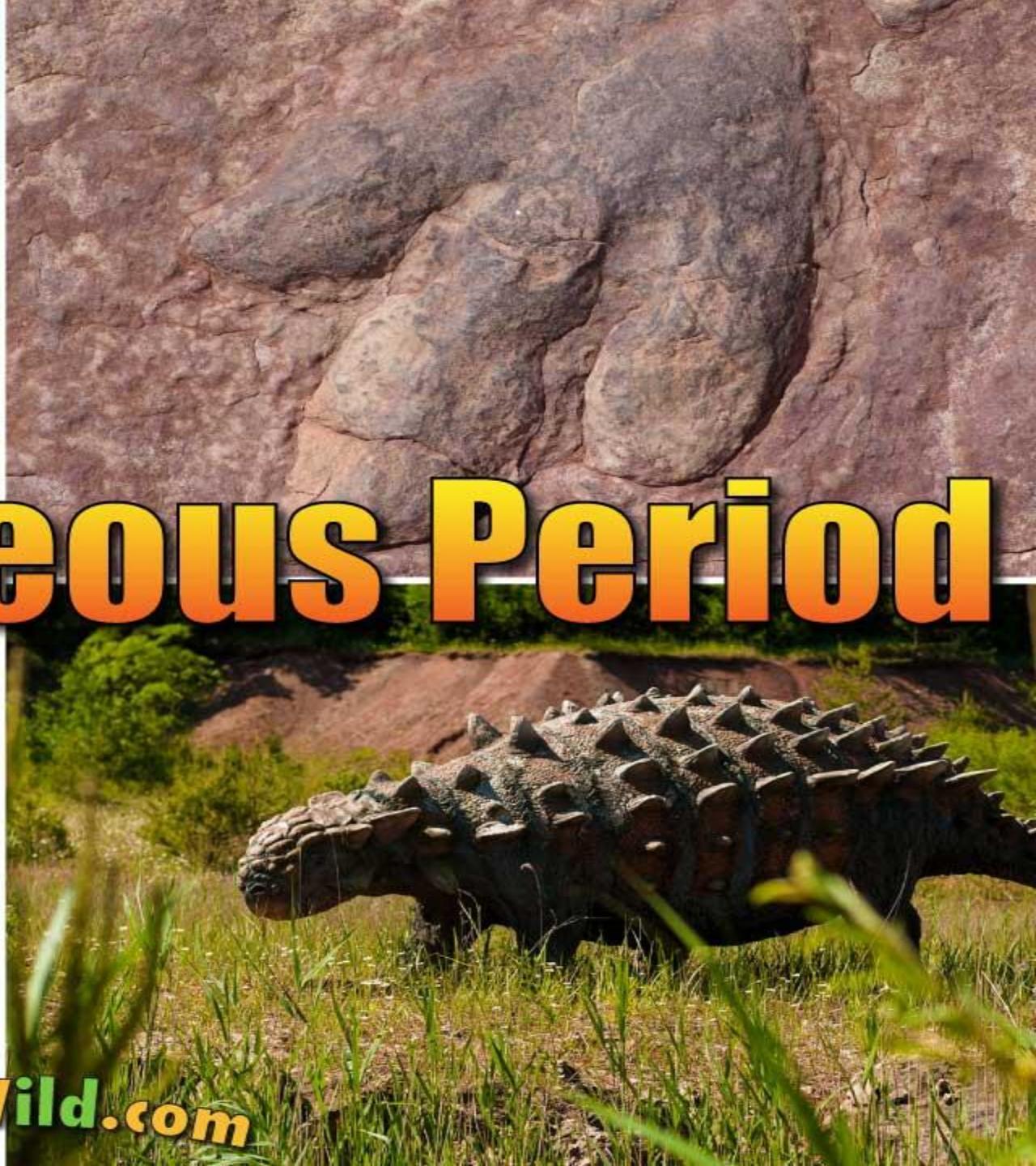
It lived from 160 to 145 million years ago of **the late Jurassic Period in China**.

The largest species may have reached 115 ft in length and possibly weighed 66-88 tons).





The Cretaceous Period



The Cretaceous period of the Mesozoic era may have seen more dinosaurs than ever before and went from **144-65 Million Years Ago.**

The horned Cretaceous dinosaurs appeared, like the Triceratops and Centrosaurus.

The armored Ankylosaurus, duckbilled Parasaurolophus, and large carnivore Tyrannosaurus Rex were a few of the quickly evolving dinosaurs.

Birds became increasingly numerous & flowering plants were emerging.

By the end of the Cretaceous period, 65 – 66 million years ago, all large and small ruling reptiles, except some crocodiles and birds went extinct.

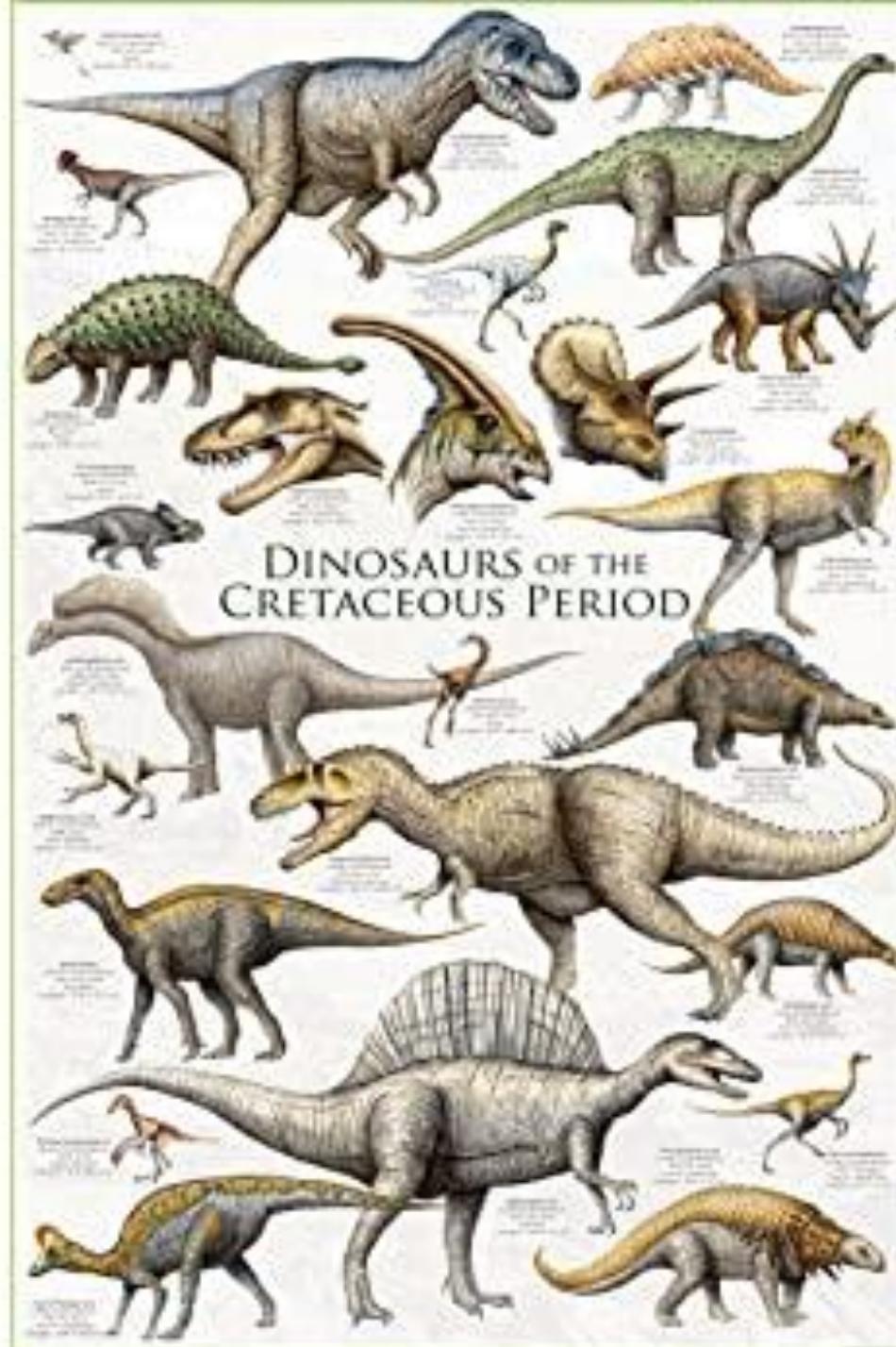
DINOSAURS OF CRETACEOUS ERA

CHART

The Cretaceous Period was a time in geological history that lasted from about 144 million years ago to about 65 million years ago. Many huge dinosaurs and flying reptiles lived in the Cretaceous Period. Placental mammals first appeared at

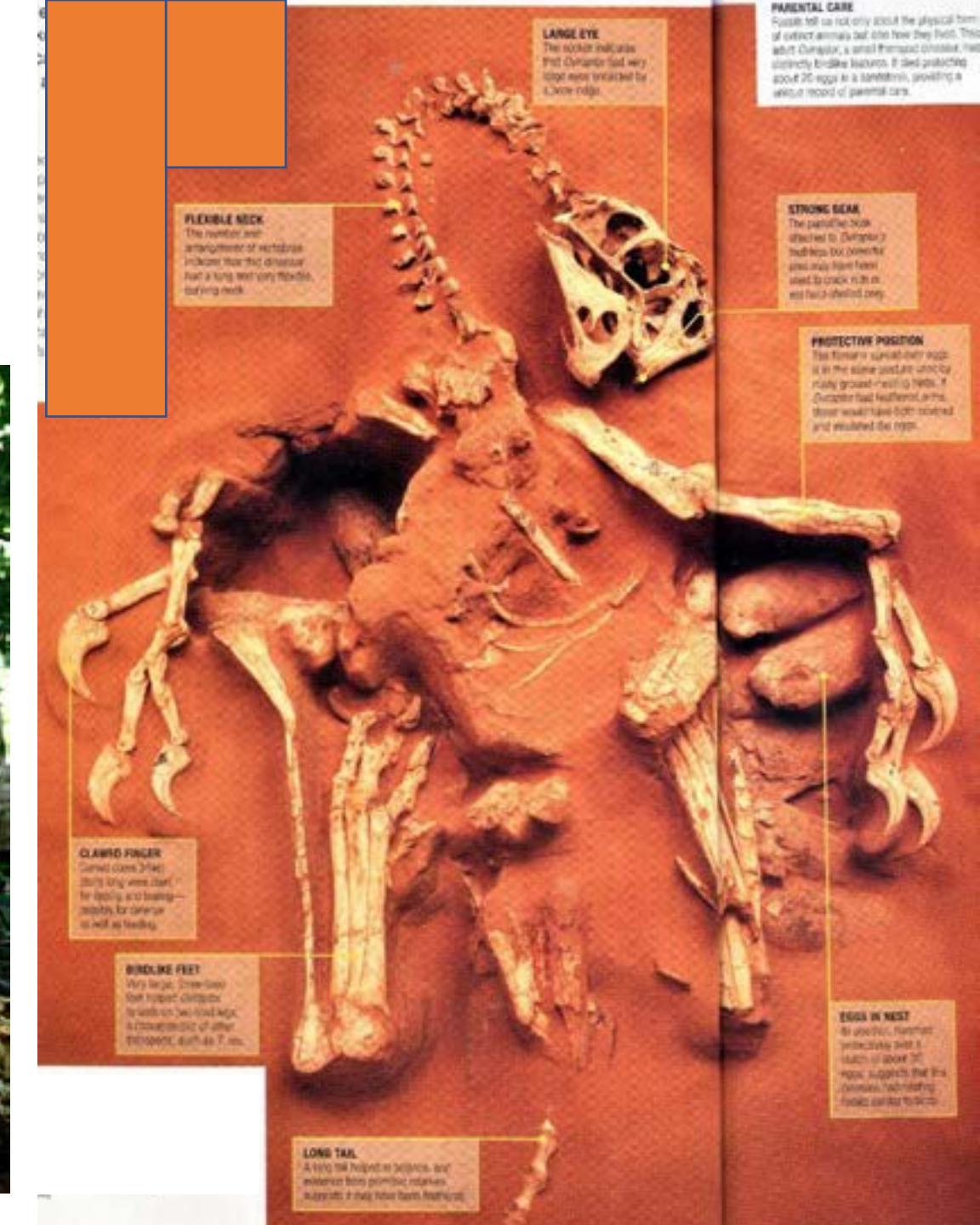
this time. At the end of the Cretaceous Period, the dinosaurs became extinct and the period marked the end of the age of dinosaurs what is known as the Great Extinction. Mammals and plants started to evolve in different forms.





An **Oviraptor** sitting on the eggs in its nest to protect them until they hatch. Most dinosaurs did this.

Oviraptor lived in the late Cretaceous period, about 75 million years ago.



ARCAEORNITHOMIMUS

Archaeornithomimus (meaning "ancient bird mimic") is a dinosaur that lived in Asia during the Late Cretaceous period, around 96 million years ago.

It was medium sized, reaching 11 feet long with a weight ranging from 99 to 201 pounds

Solid evidence show that it was a feathered animal.



PACHYCEPHALOSAURUS

Pachycephalosaurus
meaning "thick-headed
lizard lived during the Late
Cretaceous Period of what
is now North America.

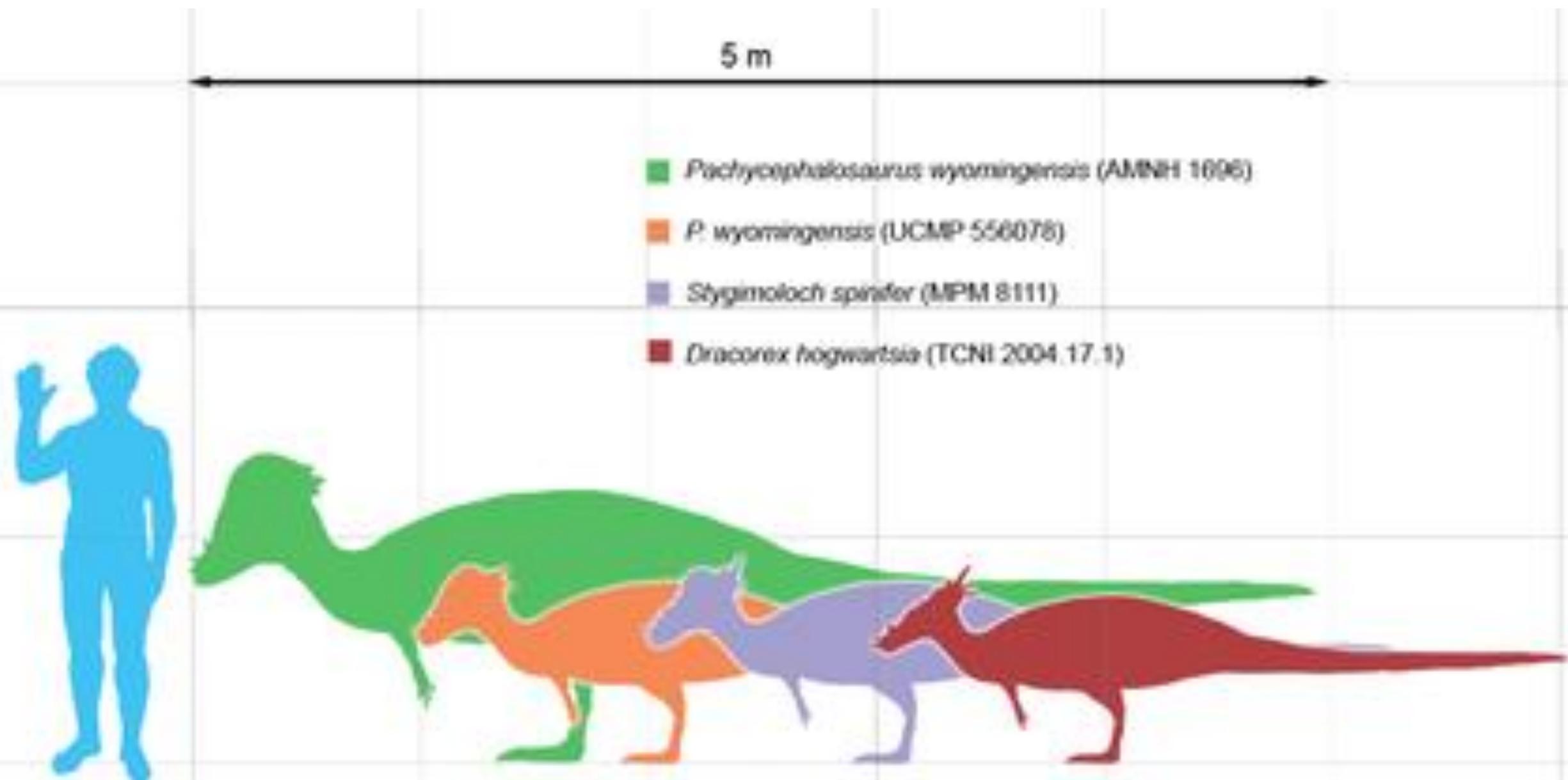
Remains have been
excavated in Montana,
South Dakota, Wyoming,
Alaska, and Alberta.

It was the largest of the
bone-headed dinosaurs
and was about 14.8 ft long
and weighed about
990 pounds.

The image on the next
page shows the 4 types in
the Family.



SAURIAN
DINOSAURS & OTHER PREHISTORIC CREATURES



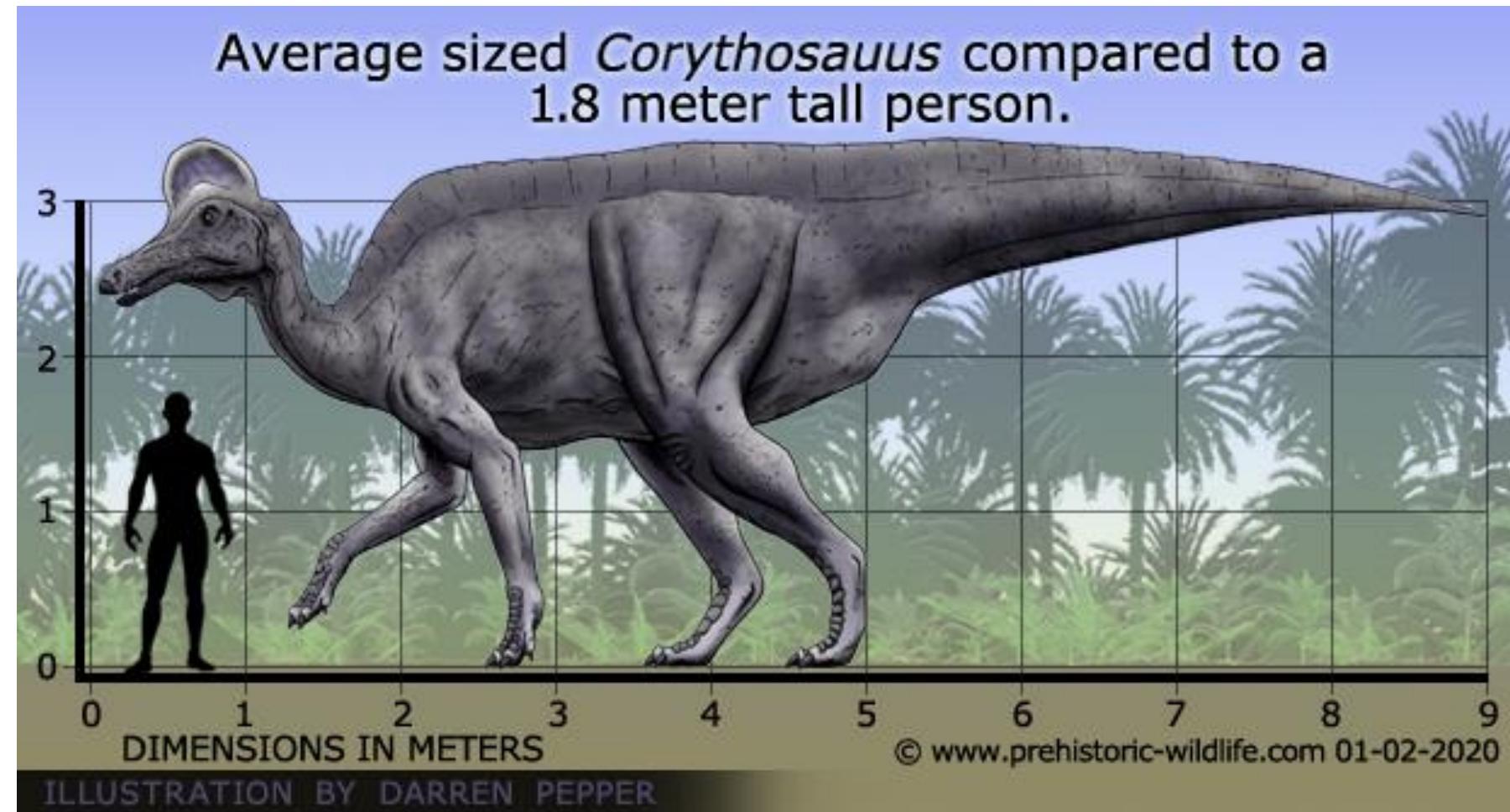
CORYTHOSAURUS

It is a hadrosaurid "duck-billed" dinosaur from the Upper Cretaceous Period, about 77–75.7 million years ago.

It lived in North America.

Its name means "helmet lizard."

It grew to 30 feet long and had a skull, including the crest, that is 28 inches tall.



OLORITAN

Olorotitan was a duckbilled dinosaur from the Late Cretaceous, whose remains were found in far Eastern Russia.

They grew up to 26 feet long and weighed 3.4 tons.

It was one of the last non-avian dinosaurs and it went extinct during the Cretaceous-Paleogene extinction event.



MUTTABURRASA URUS

Muttaburrasaurus was a herbivorous dinosaur, which lived in what is now northeastern Australia sometime between 105 and 103 million years ago during the early Cretaceous Period.

It was about 26 feet long and weighed around 3.1 tons.



MAIASAURA

Maiasaura means "good mother reptile" and is a large herbivorous "duck-billed" dinosaur that lived in the area currently covered by the state of Montana in the Upper Cretaceous Period, about 76.7 million years ago.

It was about 30 feet long and weighed up to 4 tons.



EDMONTOSAURUS

It is type of duck-billed dinosaur and has 2 known species found in western North America, from the late Cretaceous Period, 73 million years ago

It was 39 feet long and weighed up to 4.4 tons.

It and the **Parasaurolophus** on the next page are part of the Hadrosaurid family.



PARASAUROLOPHUS

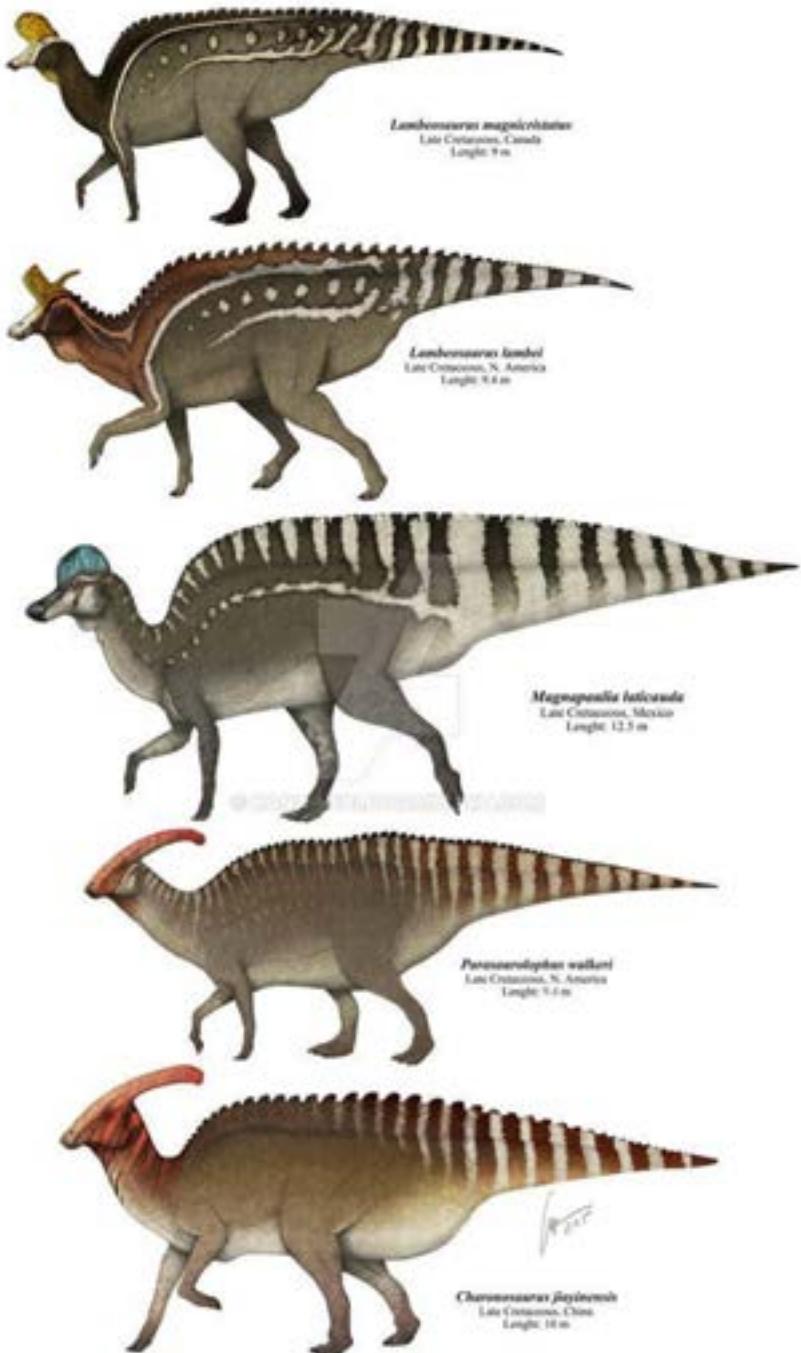
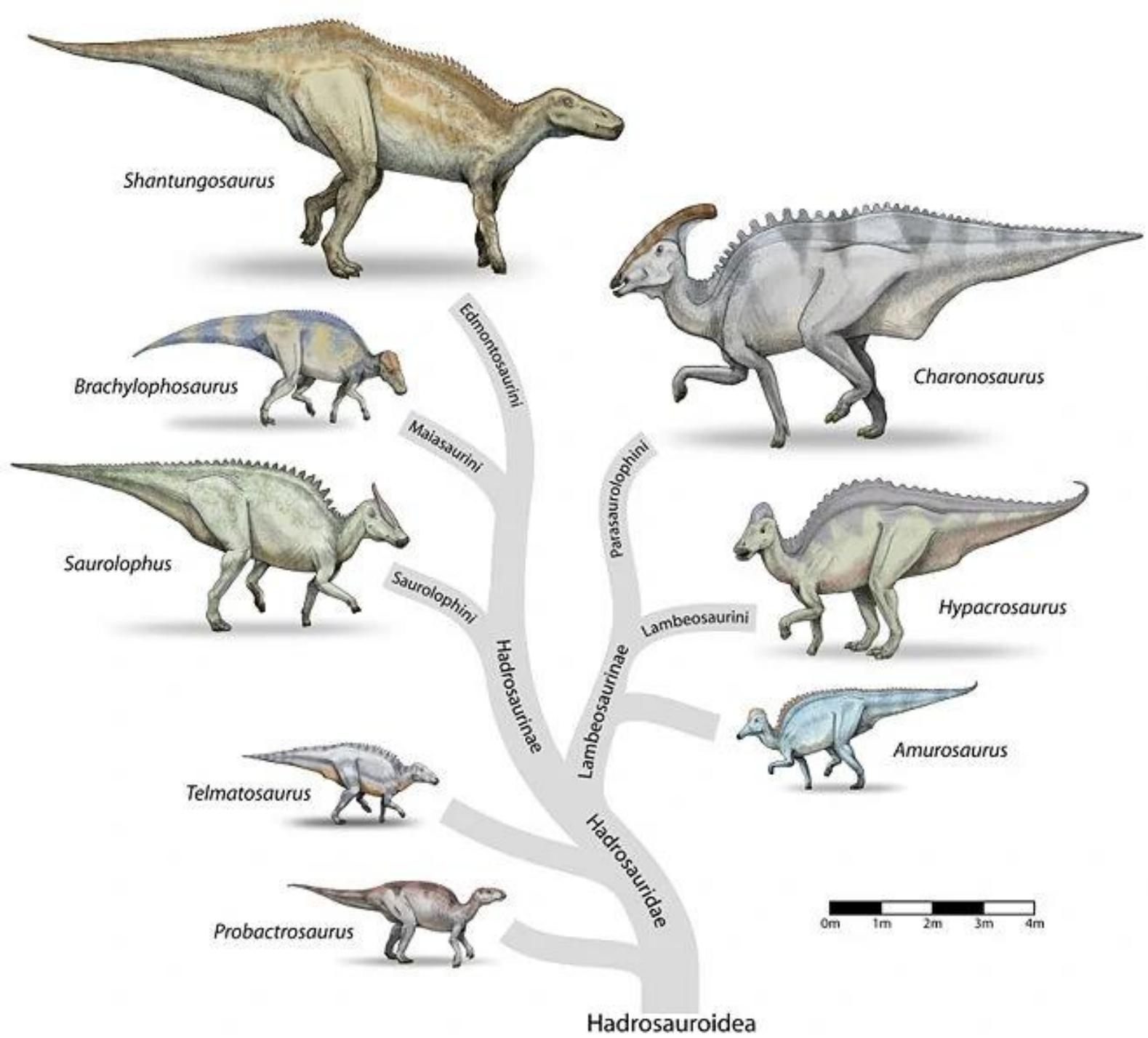
It is a herbivorous dinosaur that lived in what is now North America and possibly Asia during the Late Cretaceous Period, about 76.5–73 million years ago.

It has a large, elaborate cranial crest, which at its largest forms a long curved tube projecting upwards and back from the skull.

The purpose of the crest may be for visual recognition, a mating attraction, sound resonance, or heat regulation.

Other members of its family are shown in the 2 images on the next slide.





SAUROPELTA

Sauropelta means 'lizard shield') and lived in the Early Cretaceous Period of North America 108.5 million years ago.

Fossilized remains were recovered in Wyoming, Montana, and Utah.

It measured 17 feet long with a very long tail which made up about half of its body length.

It weighed about 3,300 pounds (1.65 tons), with the extra weight largely due to its extensive covering of bony armor, including the characteristically large spines projecting from its neck.



NODOSAURUS

It lived in the Late Cretaceous period and lived in North America.

It grew to a length of 20 feet and weighed 3.85 tons.



ANKYLOSAURUS

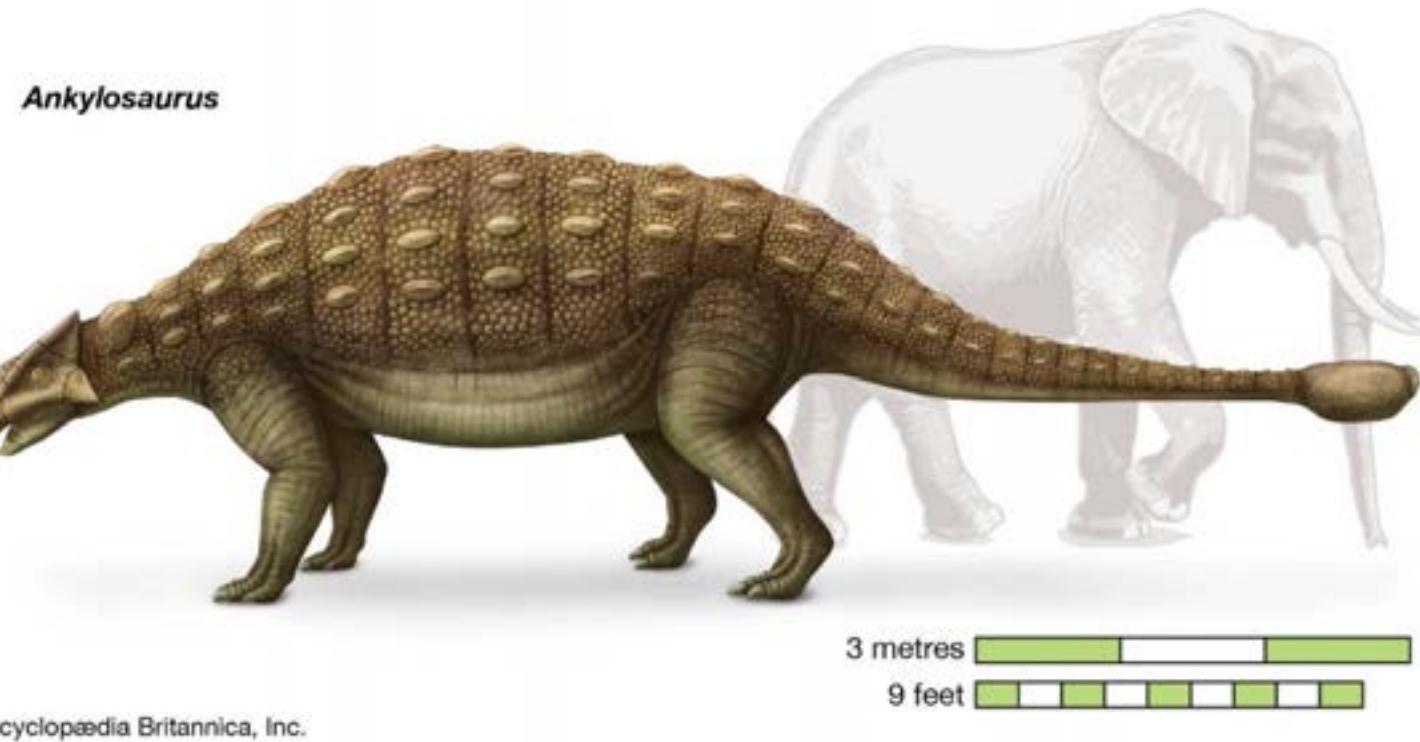
Ankylosaurus an armored dinosaur that lived at the very end of the Cretaceous Period, about 68–66 million years ago, in western North America.

It was one of the last non-avian dinosaurs when the Cretaceous period ended.

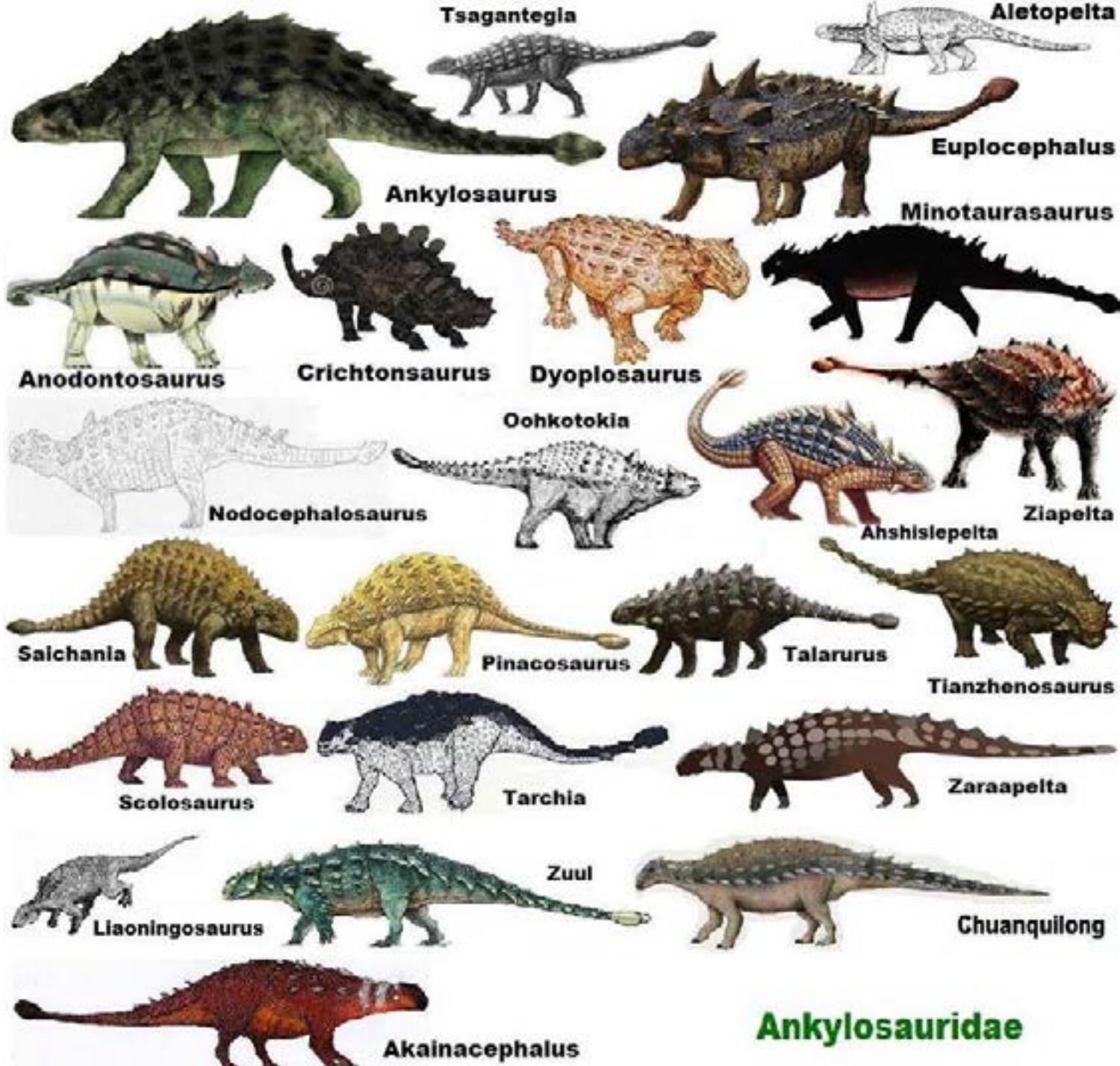
Possibly the largest-known ankylosaurid, it is estimated to have been between 20 and 26 feet long and weighed between 4.8 and 8 tons).

It was covered in armor plates and had a large club on the end of its tail that could be swung at anything trying to attack it.

Other members of the same Family are shown on the next slide.



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Ankylosauridae

When persons were digging in a coal mine, they found an exquisitely preserved fossil of an armored dinosaur ever discovered – a species of ankylosaur that in 2017 would be named **Borealopelta markmitchelli.**

After being unearthed, the 110-million-year-old fossil ended up at the Royal Tyrrell Museum of Paleontology in Drumheller, Alberta, where **technicians spent 7,000 hours over the next six years chiseling away the rock around it.**

Its another example of an animal that showed what color it had been and that it had the property called countershading.



COUNTERSHADING

As example was found that *Psittacosaurus*, an early relative of the famed horned dinosaur *Triceratops*, was light on its underside and darker on top.

This color pattern, known as countershading, is a common form of camouflage in modern animals



It was dark smears that caught the attention of University of Bristol palaeo-biologist and fossil color expert, Dr Jakob Vinther.

Analysis of the smears revealed traces of a reddish pigment, indicating the dinosaur's skin color.

Borealopelta had entered the select group of dinosaurs to have their true colors revealed.

Today, animals use color for camouflage, communication, attracting mates and warding off predators.

Dinosaurs almost certainly did, too.



SINOCERATOPS

It is a Ceratopsian dinosaur that lived approximately 73 million years ago during the latter part of the Cretaceous Period in what is now Shandong province in China.

It was a medium-sized, herbivore and could grow up to 19.7 feet long and 6.6 feet high. It weighed up to 2.2 tons.



CHASMOSAURUS

Its name means
'opening lizard',
referring to the large
areas in its front frill.

It grew to a length of
15.7 feet and weighed
up to 2.2 tons



PENTACERATOPS

It lived in the late Cretaceous Period, in North America.

They lived around 76–73 million years ago, in New Mexico.

They grew to 20 feet long and weighed up to 5.5 tons.



TRICERATOPS

They first appeared during the late Cretaceous period, about 68 million years ago, in North America.

They grew to 29.5 feet long and weighed up to 13.2 tons !!

It was one of the last known dinosaurs and became extinct in the Cretaceous–Paleogene extinction event, 66 million years ago.

The name Triceratops, means "three-horned face".

Other members of this horned dinosaur family are shown on the next page.





Eotriceratops



Ojoceratops



Eoceratops



Regaliceratops



Agujaceratops



Titanoceratops



Judiceratops



Spiclypeus



Bravoceratops



Tatankaceratops



Utahceratops



Nedoceratops



Vagaceratops



Arrhinoceratops



Coahuilaceratops



Kosmoceratops



Mercuriceratops



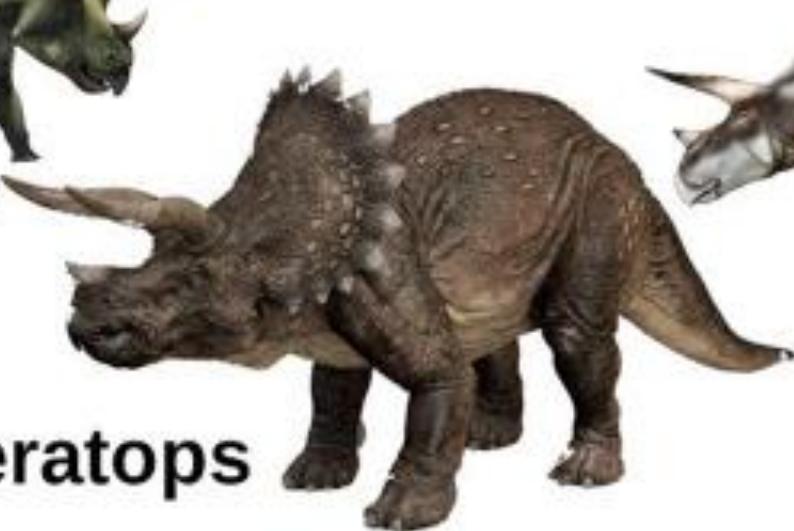
Anchiceratops



Mojoceratops



Pentaceratops



Triceratops



Torosaurus



Chasmosaurus

MAJUNGASAURAUS

It lived in Madagascar from 70 to 66 million years ago making it one of the last known non-avian dinosaurs that went extinct during the Cretaceous-Paleogene extinction event.

It was medium-sized at 26.2 feet long and weighed 3,300 pounds (1.65 tons).



BARYONYX

It lived in the early Cretaceous period, about 130–125 million years ago, in Surrey, England.

Its name means "heavy claw" which refers to the animal's very large claw on the first finger.

It has a very long snout with lots of teeth as it mostly caught and ate fish.

Baryonyx is estimated to have been between 25 and 33 feet long and to have weighed between 1.3 and 2.1 tons.



NIGERSAURAUS

It is a dinosaur that lived during the middle Cretaceous period, about 115 to 105 million years ago and discovered in the Republic of Niger.

It was 30 feet long, which is small for a sauropod, and had a short neck.

It weighed around 4 tons, comparable to a modern elephant.



IGUANODON

They lived in Belgium, Spain, Germany, England, Portugal and possibly elsewhere in Europe, between about 126 and 122 million years ago.

They were large, bulky herbivores.

They weighed up to 3.4 tons and measured up to 43 feet long

Distinctive features include large thumb spikes, which were possibly used for defense against predators, combined with long prehensile fifth fingers able to forage for food.



CARNOTAURUS

It was a large theropod dinosaur that lived in South America during the Late Cretaceous period, between 72 and 69.9 million years ago.

It was a lightly built, predator, measuring 24.6 to 29.5 ft long and weighed up to 3.3 tons).

It had thick horns above the eyes, a feature unseen in all other carnivorous dinosaurs, and a very deep skull sitting on a muscular neck.

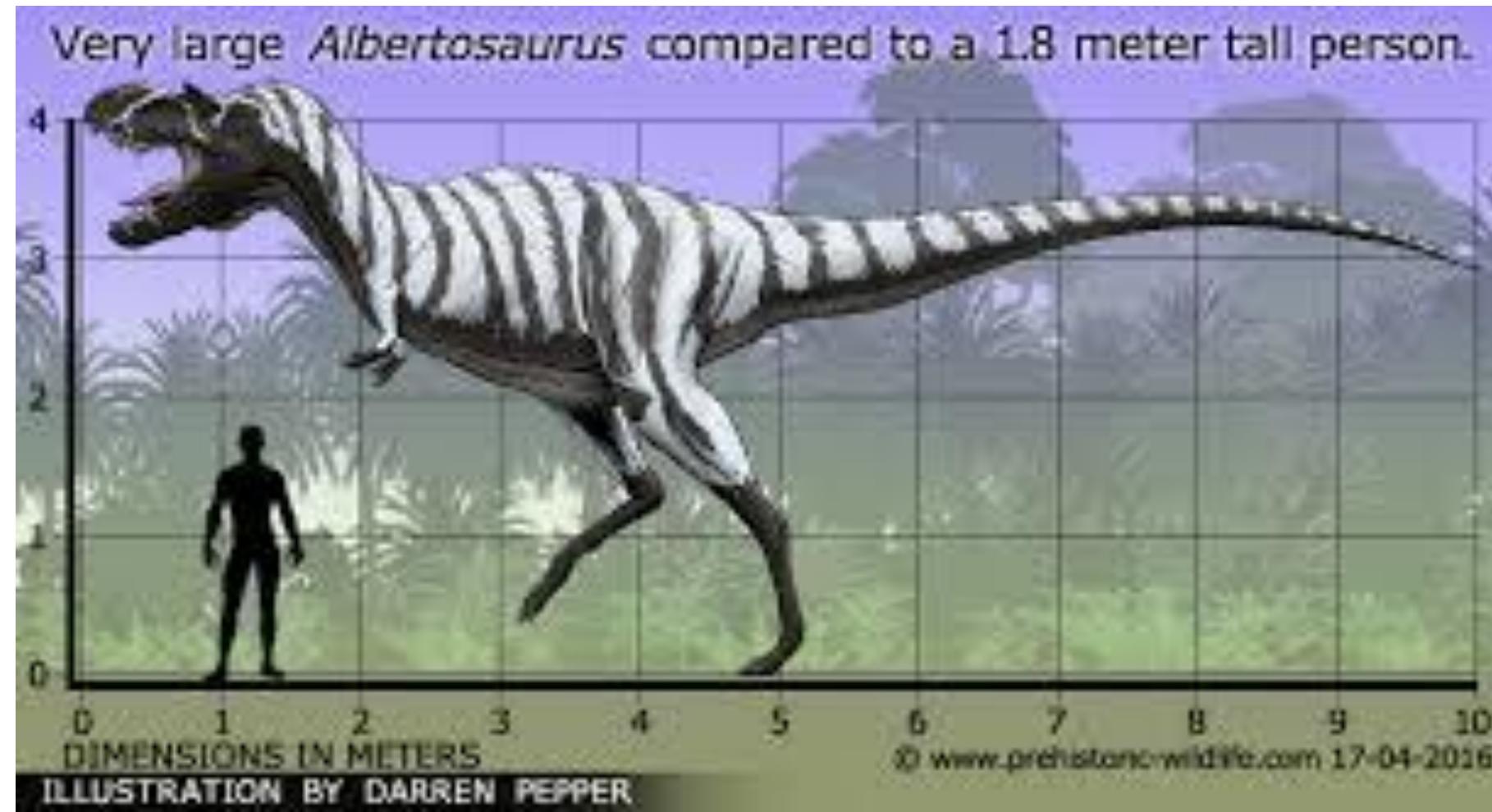


ALBERTOSAURUS

It is a tyrannosaurid dinosaur that lived in western North America and an area in Mexico, during the Late Cretaceous Period, about 70 million years ago.

It was smaller than Tyrannosaurus Rex and measured up to 30 feet long

An adult weighed from 3 to 4.4 tons.

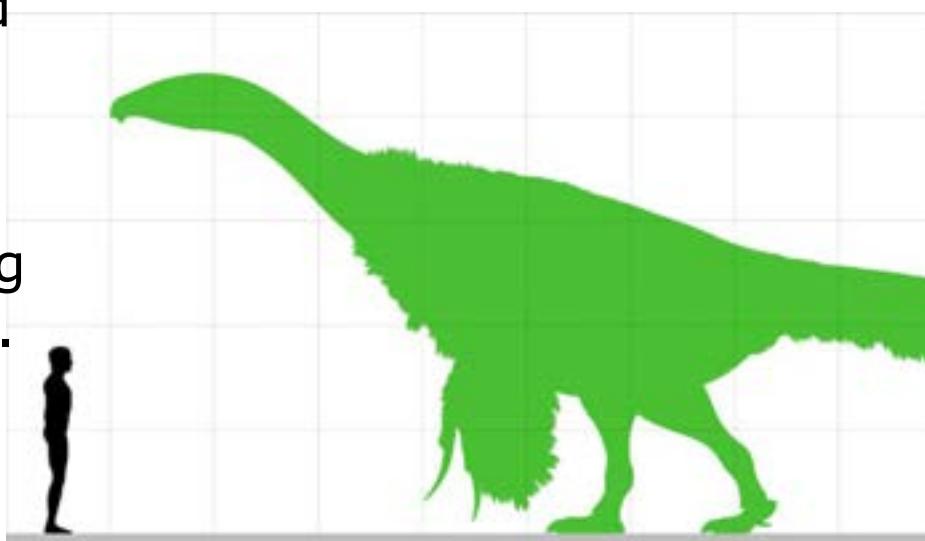


THERIZINOSAURUS

The name means "scythe lizard" and they were a very large herbivorous dinosaurs that lived in Asia during the Late Cretaceous period, around 70 million to 68 million years ago.

Even though they ate plants, they had the longest hand claws – up to 3.3 feet long, of any land animal, to protect themselves.

They grew to 33 feet long and weighed over 5 tons.



SUCHOMIMUS

Its name means "crocodile mimic" and it is a type of spinosaurid dinosaur that lived between 125 and 112 million years ago in what is now Niger, in West Africa.

It was 31 to 36 feet long and weighed up to 5.7 tons.



CARCHARODONT OSAURUS

It was a carnivorous dinosaur that existed during the mid-Cretaceous Period in Northern Africa.

It is nearly as large as or even larger than Tyrannosaurus, Giganotosaurus and Spinosaurus. at 33 feet long and weighing 4.4 tons.



ACROCANTHOSAURUS

It lived in North America during the early Cretaceous period.

It is best known for the high neural spines on many of its vertebrae, which most likely supported a ridge of muscle over the animal's neck, back, and hips.

It was one of the largest dinosaurs, reaching 38 feet in length and weighing up to 6.8 tons.



TYRANOSAURUS REX

It lived in western North America during the early Cretaceous period, 68 to 66 million years ago.

They grew to be 40 feet long and adults weighed 15.4 tons.

It was the last known member of the tyrannosaurids, and among the last non-avian dinosaurs to exist before the Cretaceous–Paleogene extinction event.



GIGANOTOSAURUS

It was a dinosaur that lived in what is now Argentina, during the late Cretaceous period, approximately 98 million years ago.

It was 39 to 43 feet long and the adults weighed 15.2 tons.

Giganotosaurus carolinii

Keenan Taylor's
Illustrated Menagerie



SPINOSAURUS

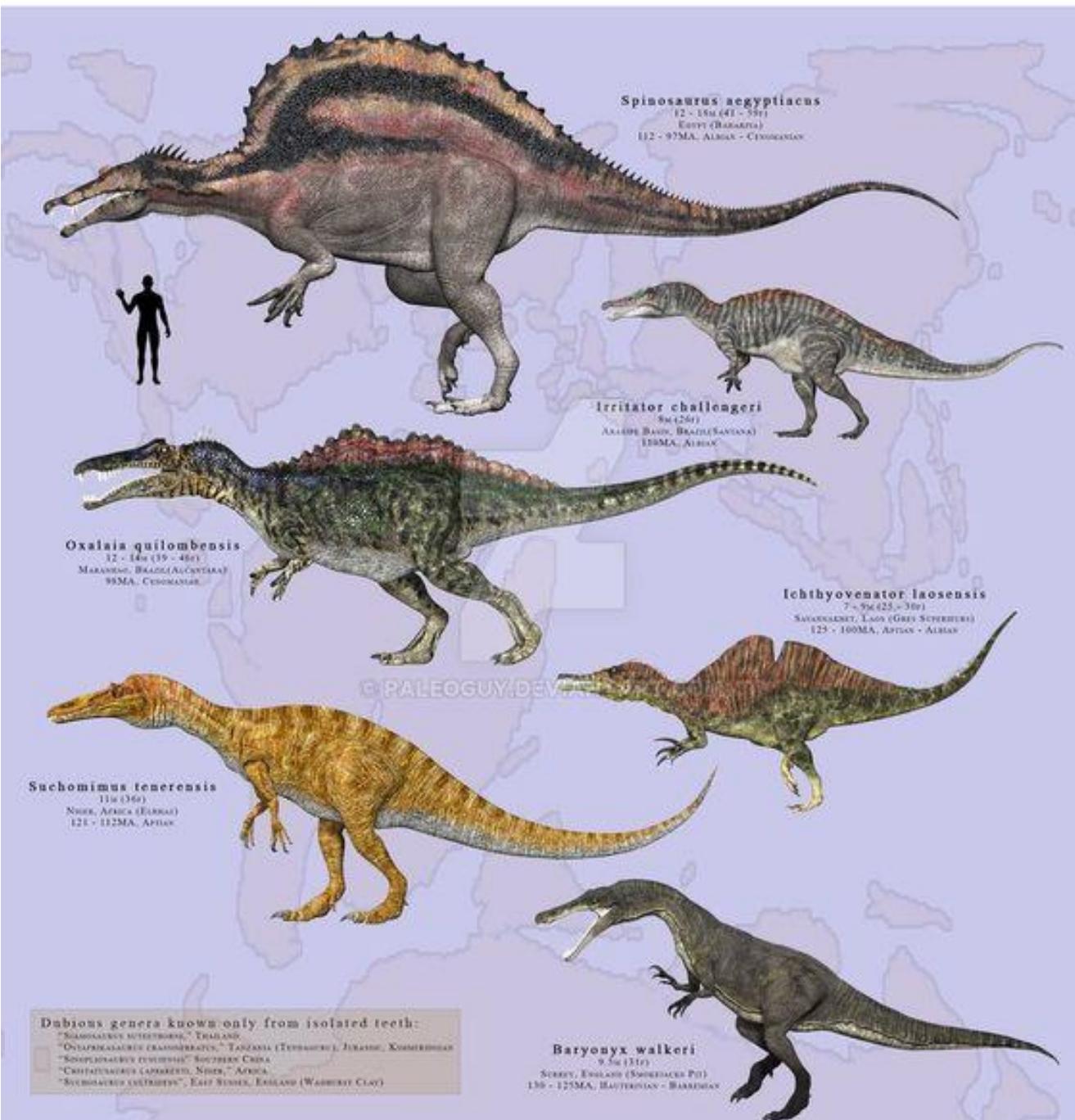
It lived in what now is North Africa during the Cretaceous period, about 112 to 93.5 million years ago.

Its length ranged from 49–52 feet and it weighed 7.1–8.3 tons.

It mostly caught and ate big fish that its mouth was designed for.



WORLDWIDE SPINOSAURS



DREADNOUGHTUS

It is a sauropod dinosaur discovered in the early Cretaceous period - 99–94 Million Years ago (MYA), found in Argentina.

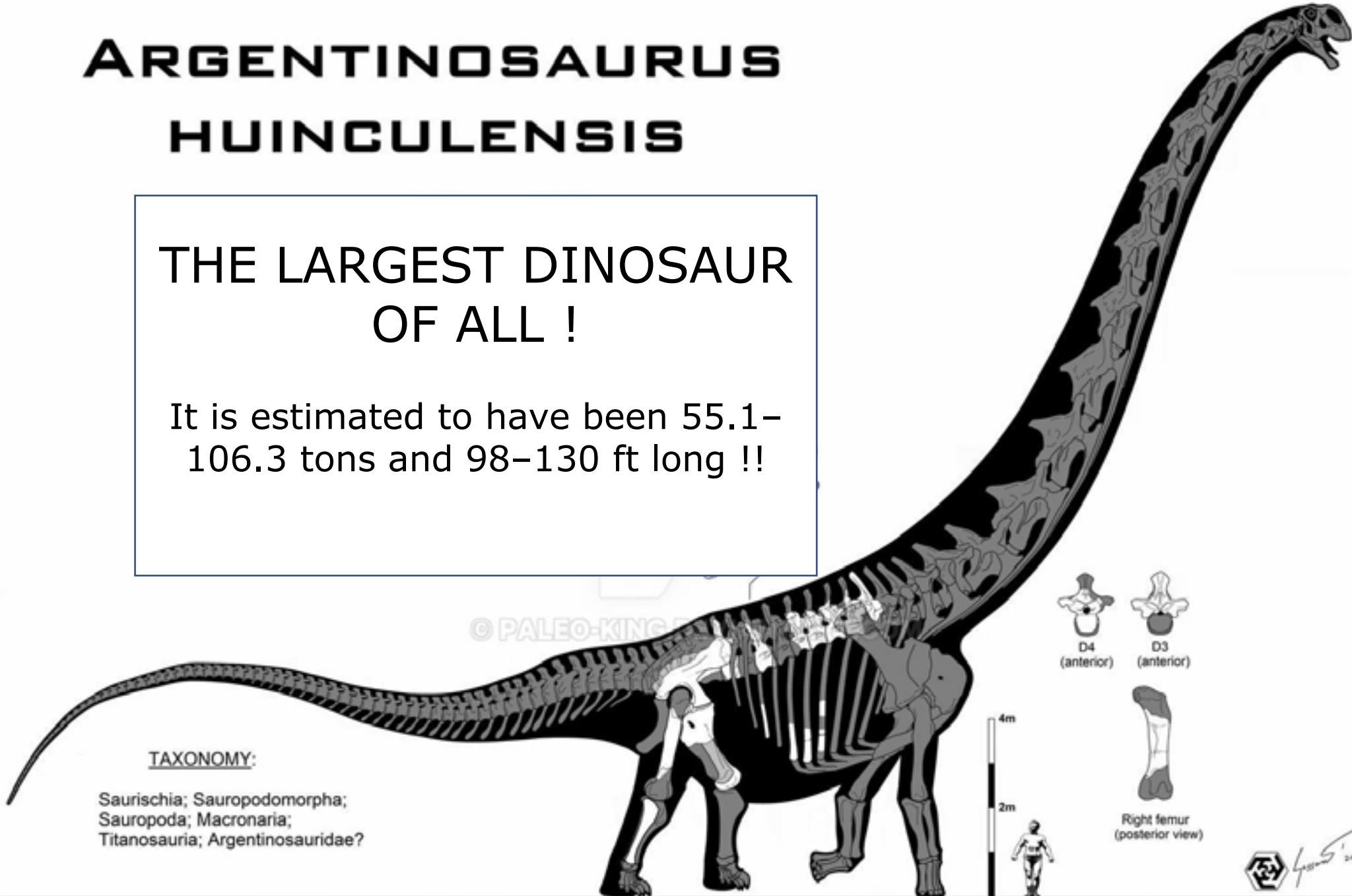
It is one of the largest of all known terrestrial vertebrates, possessing the greatest mass of any land animal that can be calculated with reasonable certainty, weighing in about 42 tons and 85 feet long !



ARGENTINOSAURUS HUINCULENSIS

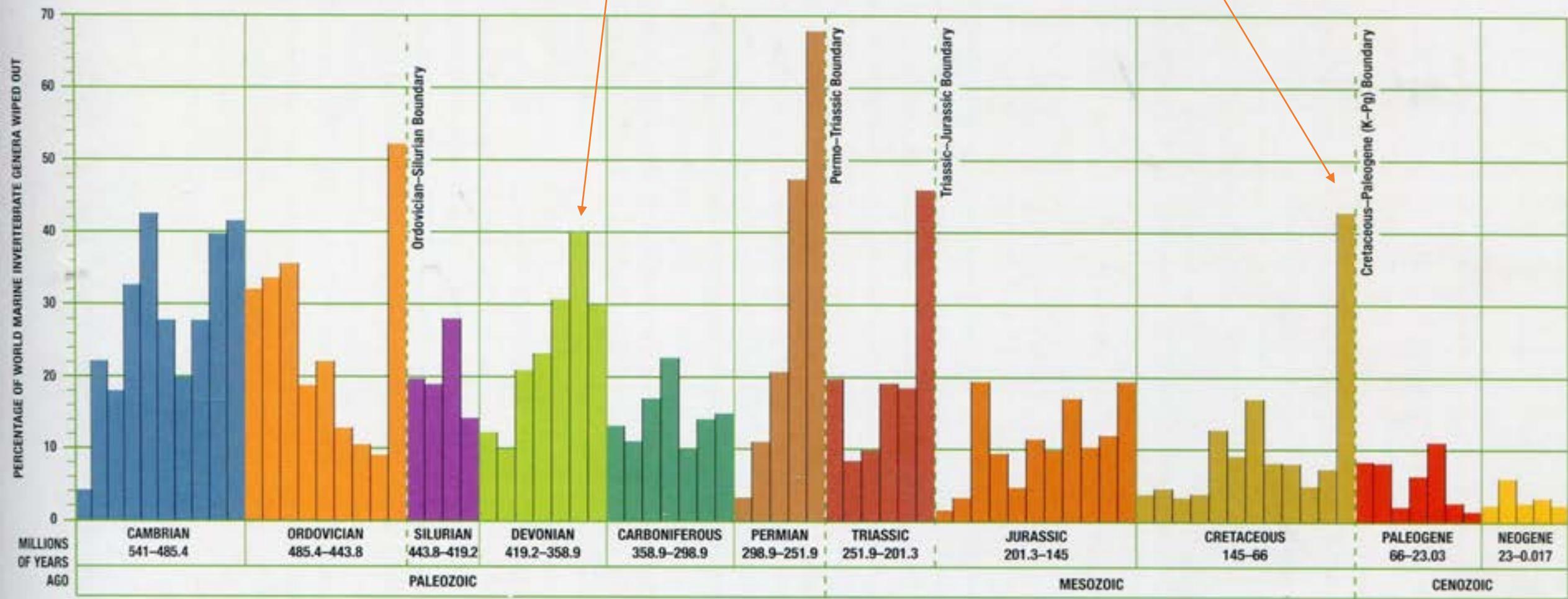
THE LARGEST DINOSAUR
OF ALL !

It is estimated to have been 55.1–
106.3 tons and 98–130 ft long !!



MASS EXTINCTIONS

There have been at least 5 major extinctions of Life over the last 540 million years. They happened at the end of the Ordovician era, Devonian, Permian, Triassic, and Cretaceous-Tertiary (or the K-T) Mass Extinction.



MASS EXTINCTIONS:

The biggest disasters in history

ORDOVICIAN

Death Rate:



Time: 445 million years ago

Likely Causes:

- Rapid global cooling
- Falling sea levels

Results:

- Coastal areas destroyed
- Chemical reactions affected by cold



DEVONIAN

Death Rate:



Time: 340 million years ago

Likely Causes:

- Asteroid impact(s)
- Rapid global cooling

Results:

- Local destruction from debris
- Ocean life affected by temperature



PERMIAN

Death Rate:



Time: 250 million years ago

Likely Causes:

- Volcanic activity
- Increase in Methane and CO₂
- Rapid global warming

Results:

- Oxygen removed from oceans
- Desertification of land



TRIASSIC

Death Rate:



Time: 200 million years ago

Likely Causes:

- Increase in Methane and CO₂
- Rapid global warming

Results:

- Desertification of land
- Frequent heat waves



K-T

Death Rate:



Time: 65 million years ago

Likely Causes:

- Asteroid impact
- Volcanic activity
- Falling sea levels

Results:

- Widespread fires
- Plants disrupted by global ash cloud
- "Nuclear winter"



PERMIAN-TRASSIC EXTINCTION

Just before the beginning of the Triassic period, at the end of the Permian period, Earth experienced its largest mass extinction.

It is called the “**Great Dying**”.

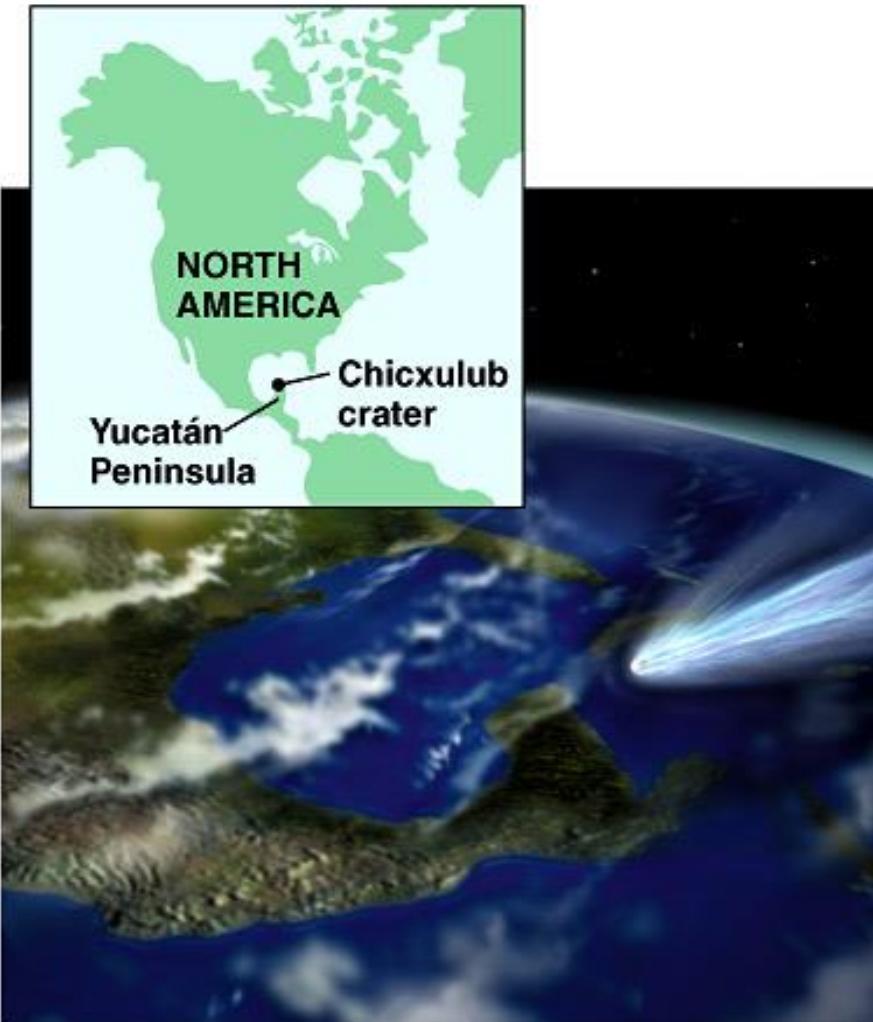
90 percent of all marine life, and 70 percent of all land animals were wiped out when the temperature soared, the oceans acidified, and there was large-scale volcanic activity.

Even though it was sad that so many creatures died, it did contribute to the rise of the dinosaurs, towards the end of the Triassic period.



There have been 5 major extinction events that eliminated a large percent of the animals and plants living at each of those times.

One of the main events was when a large asteroid hit the earth in the Yucatan peninsula, 65 million years ago, which is believed to have wiped out the dinosaurs.



THE IRIDIUM METAL LAYER

Iridium is one of the rarest metals in the Earth's crust.

Most scientists today believe that a giant asteroid crashed into earth in the Gulf of Mexico, creating a nuclear-winter type of event that killed most animals and plants living at that time.

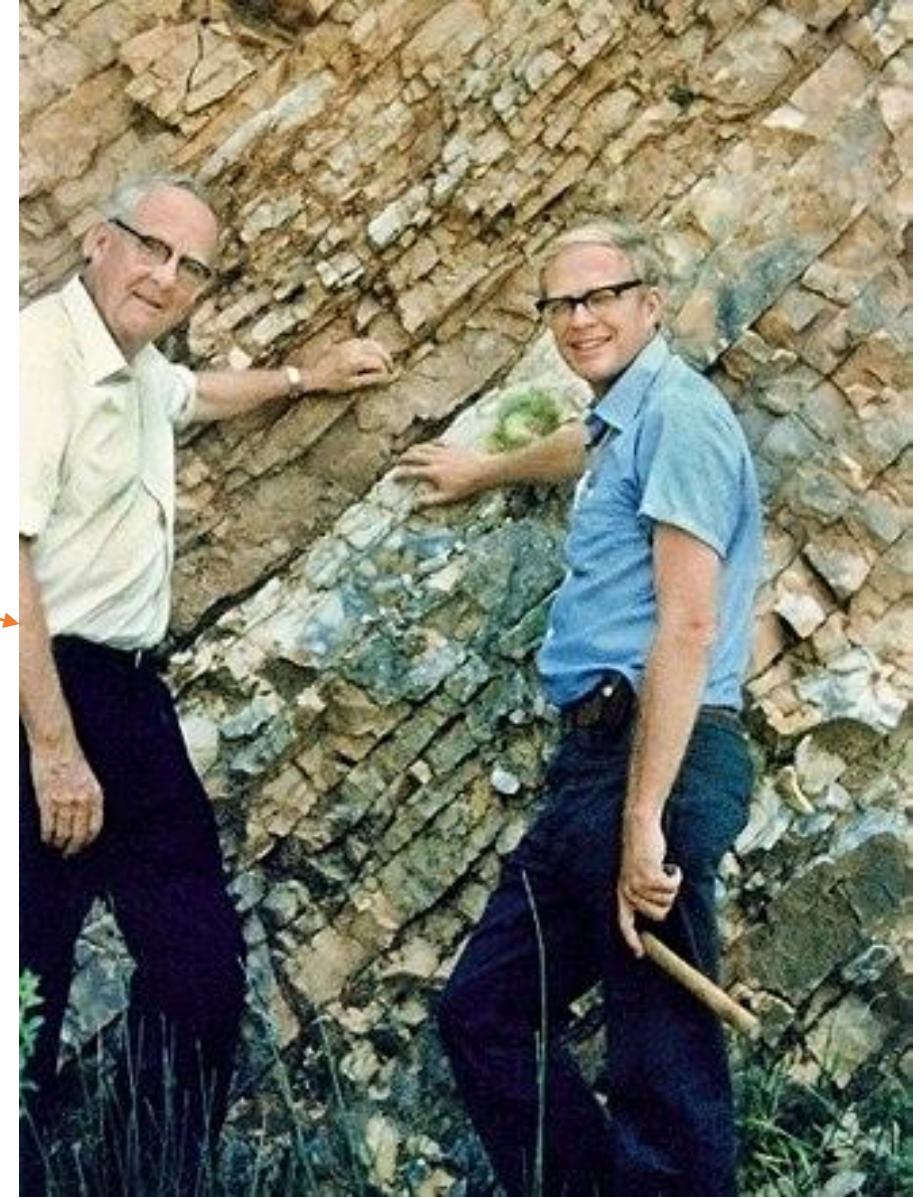
This belief is based on the presence of a thin layer of iridium metal , shocked quartz and microtektites (small melted glass balls) found in the sedimentary layer dating to 65 million years ago and found in about 100 places, all around the world.



Iridium is found in meteorites in much higher abundance than in the Earth's crust.

For this reason, the unusually high abundance of iridium in the clay layer at the Cretaceous–Paleogene boundary gave rise to the Alvarez hypothesis that the impact of a massive extraterrestrial object caused the extinction of dinosaurs and many other species 66 million years ago.

This layer is termed the K-T layer (Cretaceous-Tertiary layer). The initial "K" is used because the abbreviation for the German term for Cretaceous is Kreide which also means chalk as there was a thick layer of it laid down before that.



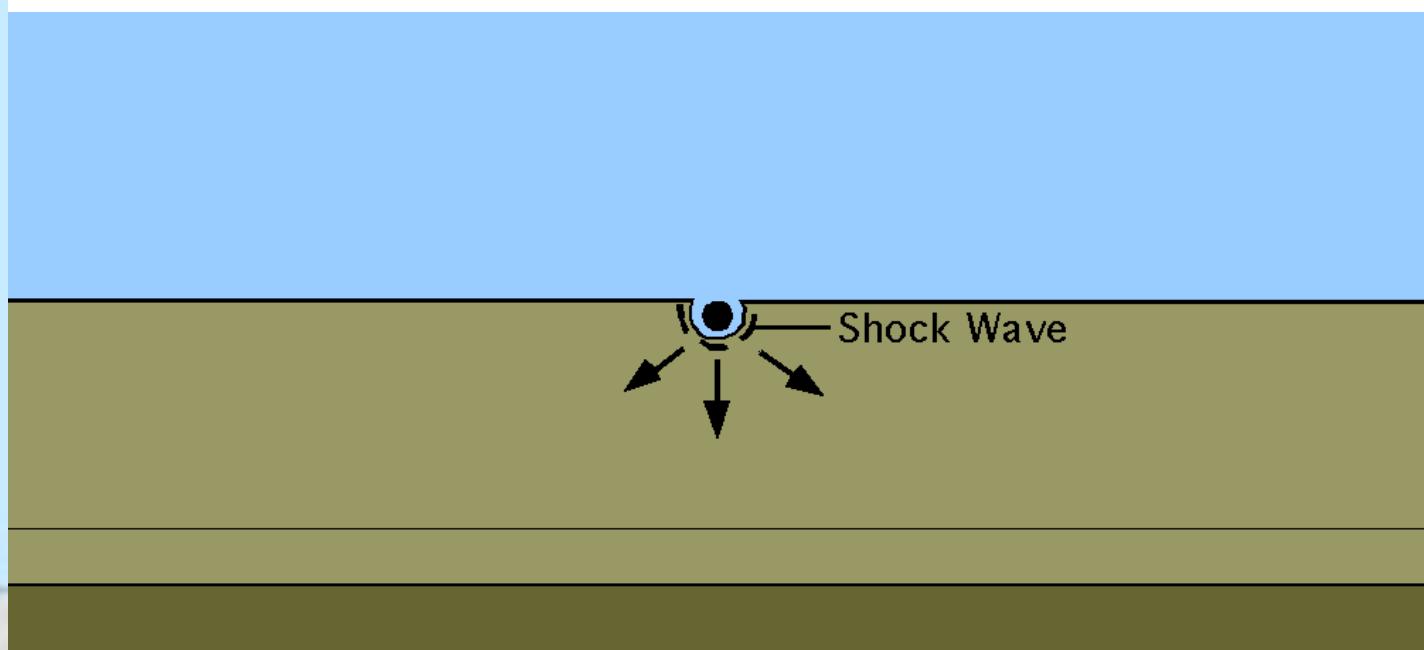
Luis, left, and his son Walter Alvarez, right, at the K-T Boundary in Gubbio, Italy, 1981



Location of the Chicxulub crater in the Yucatan peninsula, Mexico

The crater is estimated to be 93 miles in diameter and 12 miles deep.

Below is an animation of the impact.



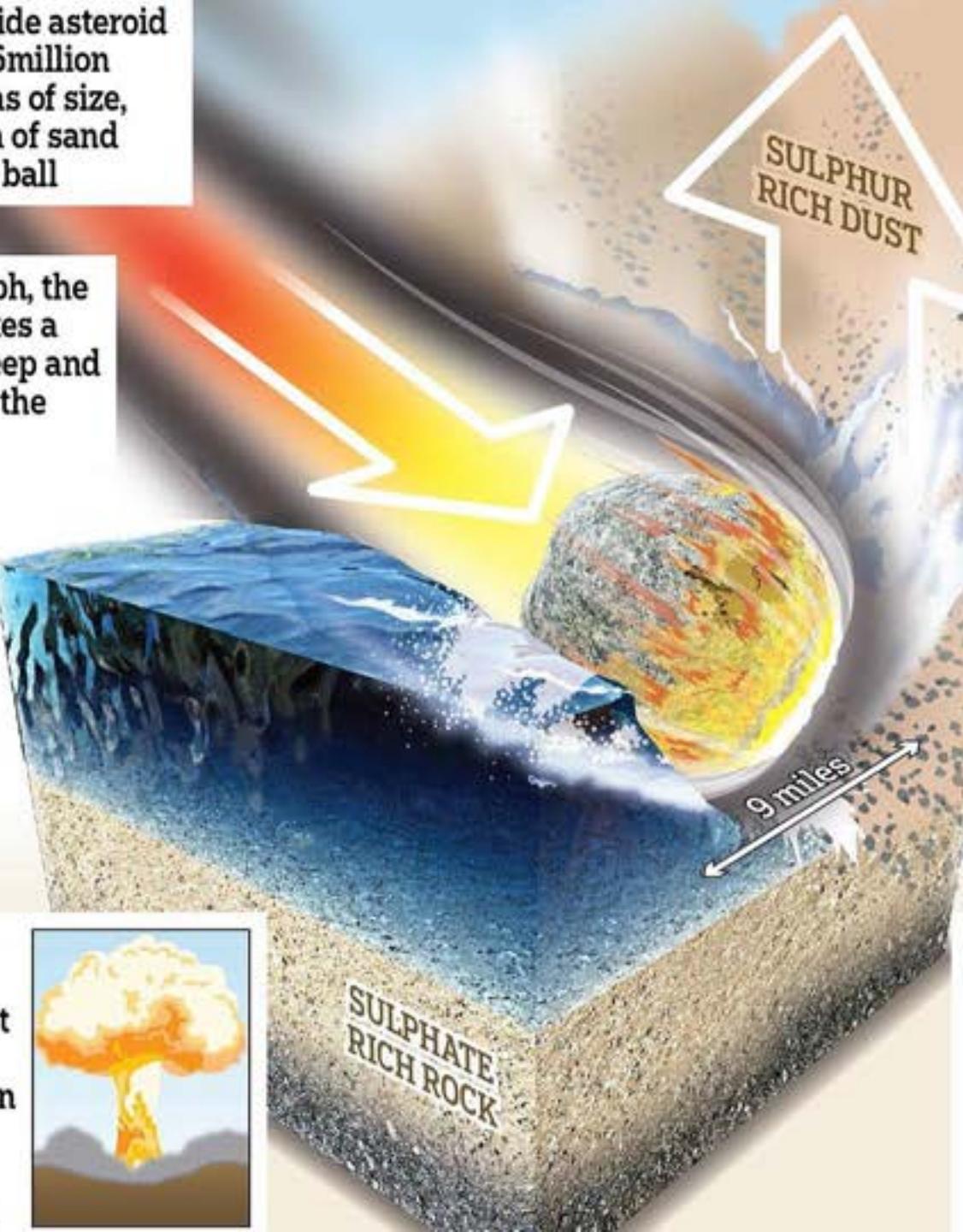
An animation showing the impact, and subsequent crater formation
(University of Arizona, Space Imagery Center)

1 Nine-mile wide asteroid hits Earth 66million years ago. In terms of size, this is like a grain of sand hitting a bowling ball

2 At 40,000mph, the impact creates a crater 20 miles deep and 111 miles wide off the coast of Mexico

3 Instead of landing in the ocean, as it might have done 30 seconds earlier or later, it hits rocks rich in sulphur compounds

4 100billion tons of sulphate-rich dust are thrown into the air, creating an effect similar to a catastrophic volcanic eruption



5 As a result, the sun is blocked out and global temperatures plummet by 26C (47F), killing 75 per cent of all species





DINOSAURS THAT EVOLVED INTO BIRDS

It began in the 1960s with the revolutionary discovery of **Deinonychus**, another small predatory dinosaur that lived about 115 million years ago, that had light feathers on it.

It not only showed unique similarities to birds, but also appeared to be an intelligent, fast-moving pack hunter, rather than a slow, plodding reptile.



WHAT IS THE SMALLEST DINOSAUR?



Anchiornis huxleyi was a tiny, long-legged, winged dinosaur. Covered in feathers, it is seen by many as an evolutionary link between dinosaurs and birds. **It lived in what is now China, in the late Jurassic period, around 167.7 million years ago.**

With long feathers found on both fore and hind limbs, it may have been a better glider than it was a flyer – if it left the ground at all!

One of the smallest dinosaurs yet discovered, it weighed between 3.9 and 24.7 oz. and was between 13 and 16 inches, in length.

HOW SOME DINOSAURS BECAME BIRDS

Some dinosaurs grew very large.

As others realized that safety and food could be found in the air and trees, they morphed into birds, shrank dramatically and adopted a more baby-like skull shape and also had feathers.

Shown left to right:

Velociraptor, a dinosaur of the class that gave rise to birds

Archaeopteryx, often called the first bird

A modern **chicken**

A **pigeon**.



Credit: Katherine Taylor for Quanta Magazine

A painting of Archaeopteryx by Maurice Wilson.

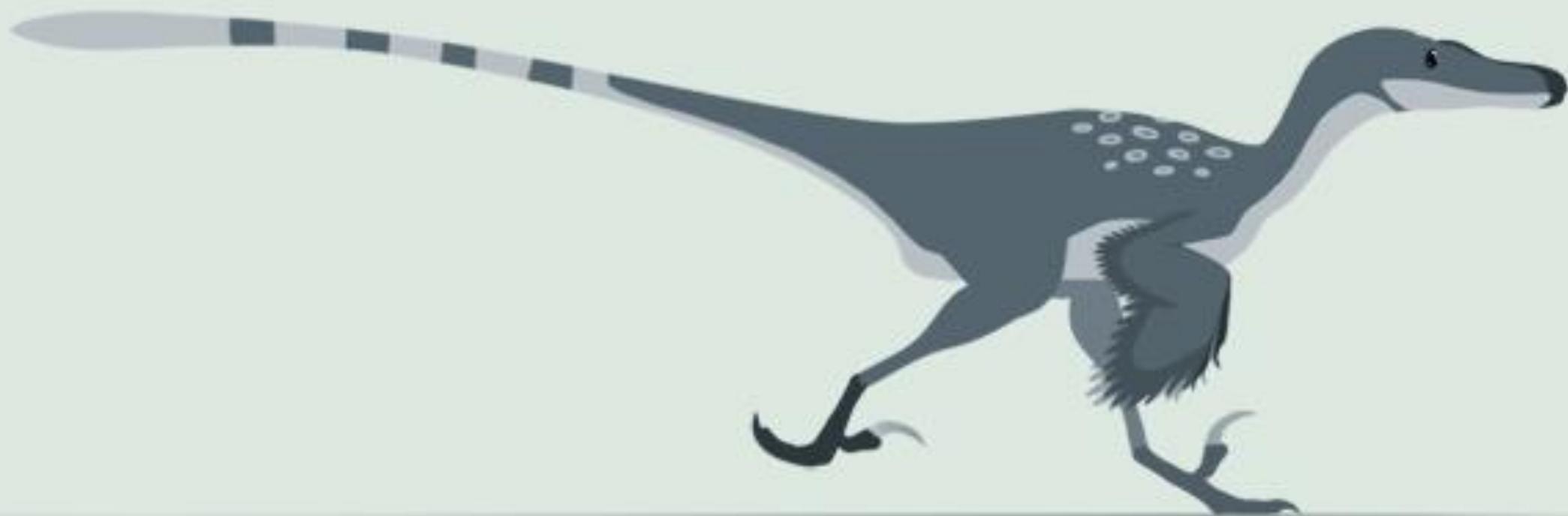
At the right is a fossil of the 'earliest bird' which was the first time that feathers could be seen on a prehistoric bird.



ARCHAEOPTERYX



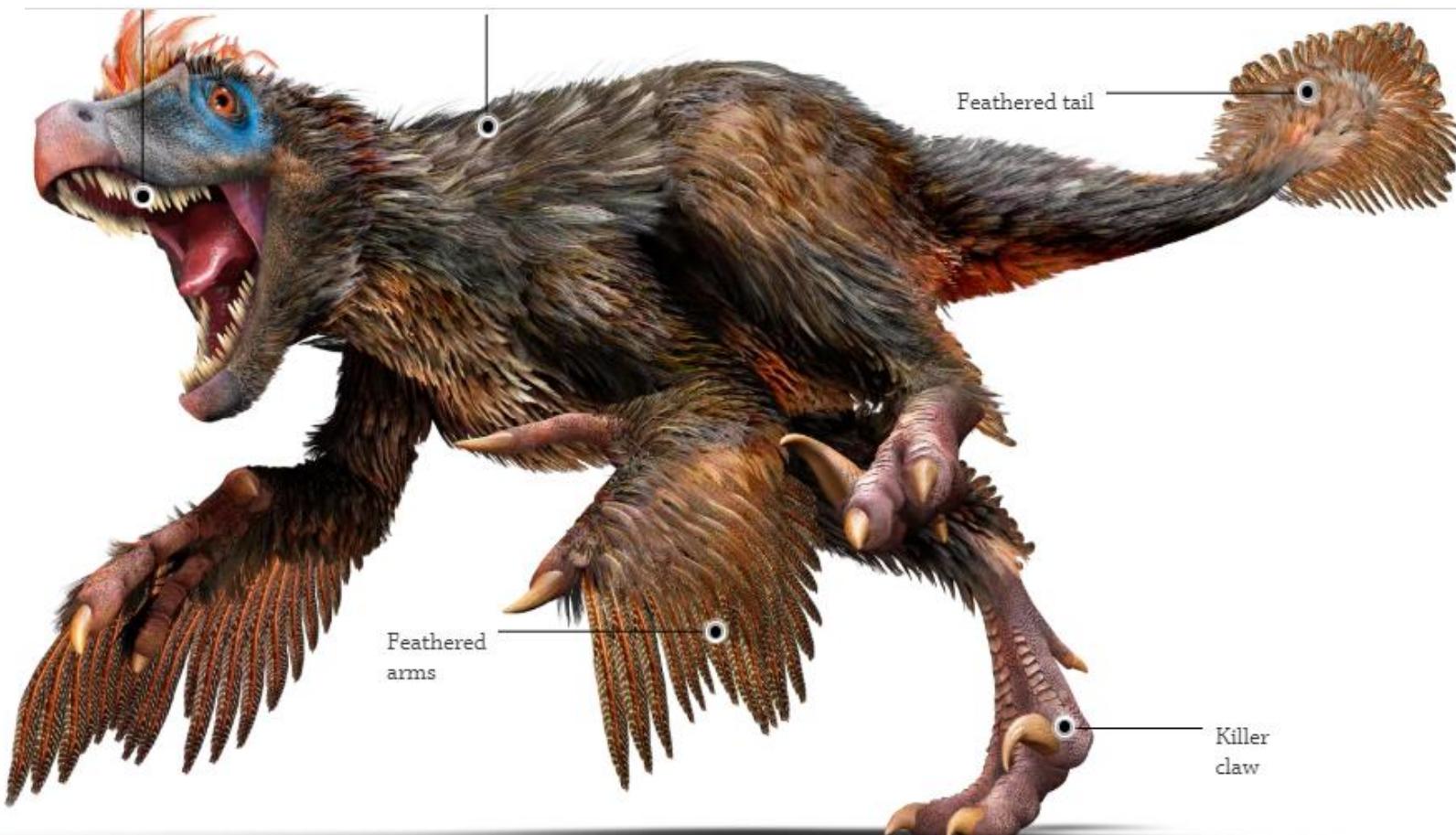
VELOCIRAPTOR



ChrisMasna2012

Velociraptor

Light, fast, and very agile, *Velociraptor* was a bird-like hunter. This creature belongs to a group of dinosaurs called dromaeosaurids, which had feathers on their body. The entire body of *Velociraptor*, along with its powerful arms, was covered with thick feathers. *Velociraptor* could not fly, but in other ways it looked and behaved like an eagle.



FINDING COLOR IN FEATHERS AND SKIN OF DINOSAURS

Microraptor, the four-winged dinosaur from China, has melanosomes that suggest not only a blue-black coloration, but also a beautiful sheen, similar to a Eurasian magpie or a crow.

So far, 7 dinosaurs have had their colors revealed through their fossils.



Microraptor gui

Lived in Northeastern China,
In the early-Cretaceous
Period, 120 million years
ago)



CAIHONG JUJI

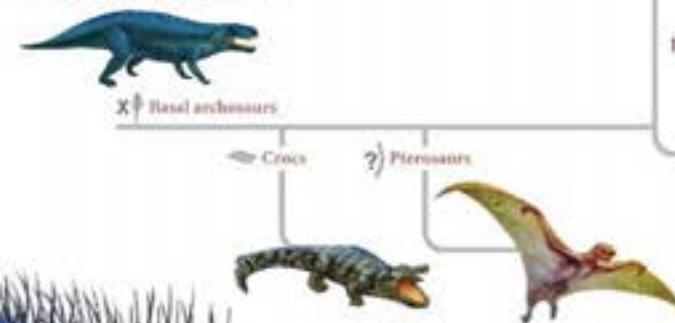




BEASTS OF A FEATHER

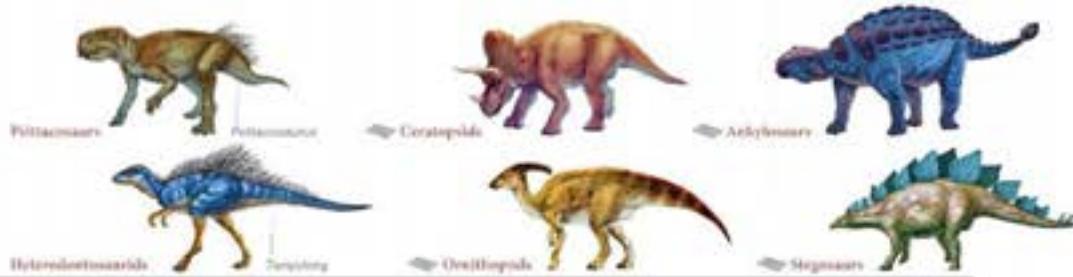
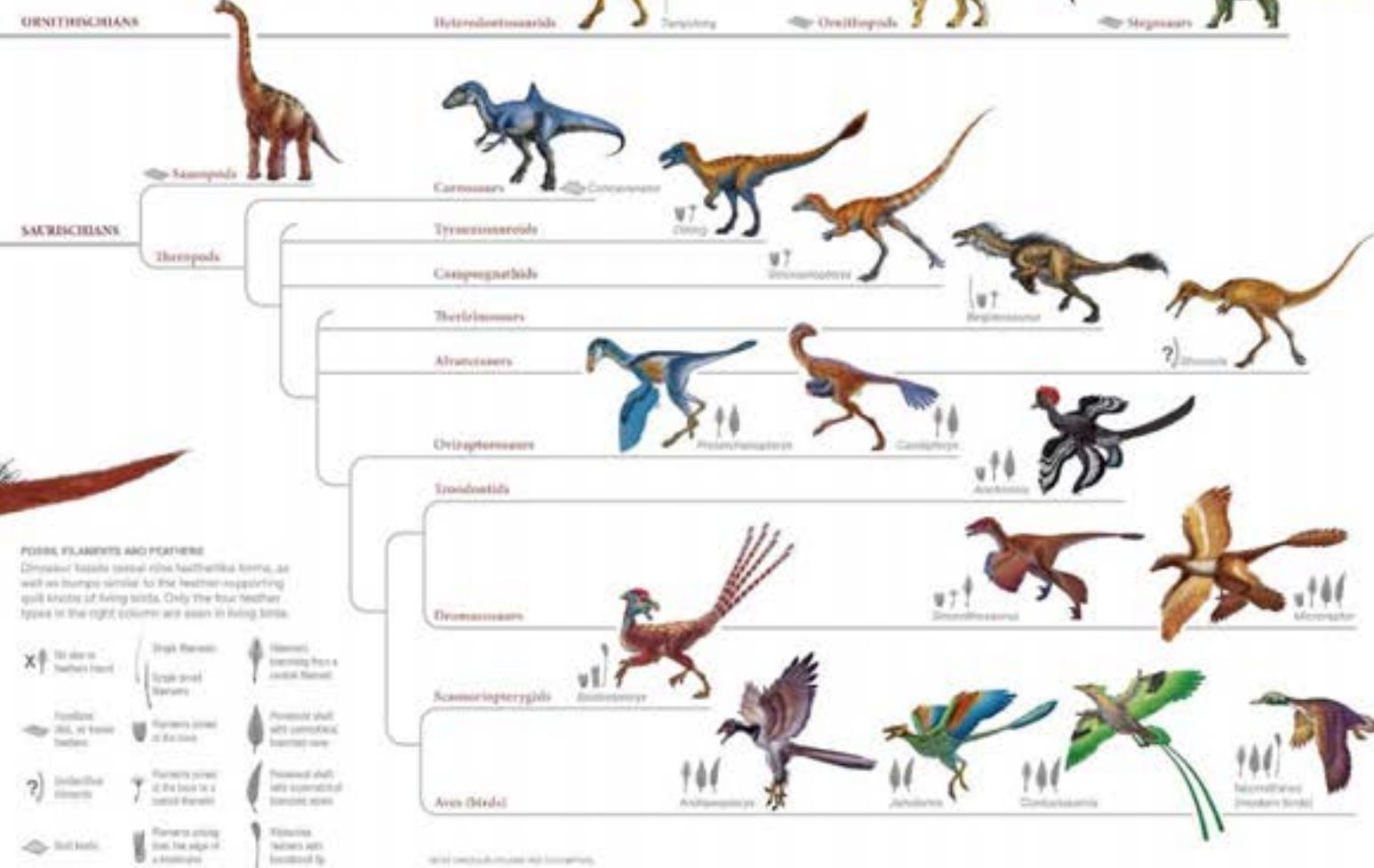
Until recently, feathers had been found only on birds and closely related theropod dinosaurs, ranging from pigeon-size *Epidexipteryx* to seven-foot-long *Biplaosaurus*. The discovery of featherlike structures on ornithischians—beaked dinosaurs far removed from birds—hints that the ancestor of all dinosaurs may have had feathers. “Fuzz” on pterosaurs suggests that protofeathers may have evolved even earlier, in the common ancestor of pterosaurs and dinosaurs.

FAMILY TREE OF ARCHOSAURS



FEATHERS, FILAMENTTS AND FEATHERS
Dinosaurs fossils reveal nine featherlike forms, as well as shapes similar to the feather-supporting spilt knobs of living birds. Only the true feather types in the right column are seen in living birds.

- X 10 size in feather head
- ↓ Feathers 100x in fossil feathers
- ? Indefinite remains
- ↔ Soft knobs
- High density, typical of feathers
- ↓ Feathers joined at the base
- ↓ Feathers joined at the base to a central filament
- ↓ Feathers joined along the edge of a membrane
- ↓ Feathers, feathers with flattened tips
- ↓ Feathers, occurring from a central filament
- ↓ Feathers with conical tips, flattened base
- ↓ Feathers with symmetrical flattened ends, narrow
- ↓ Feathers along the edge of a membrane
- ↓ Feathers, flattened tips, flattened base



Birds and crocodilians (in this case a yellow-billed stork and a Nile crocodile) are the only living archosaur groups.



Over time, very different living things have appeared, one after the other.

For example, the development of a spinal column allowed certain animals, such as fish, to swim more efficiently, more than 400 million years ago.

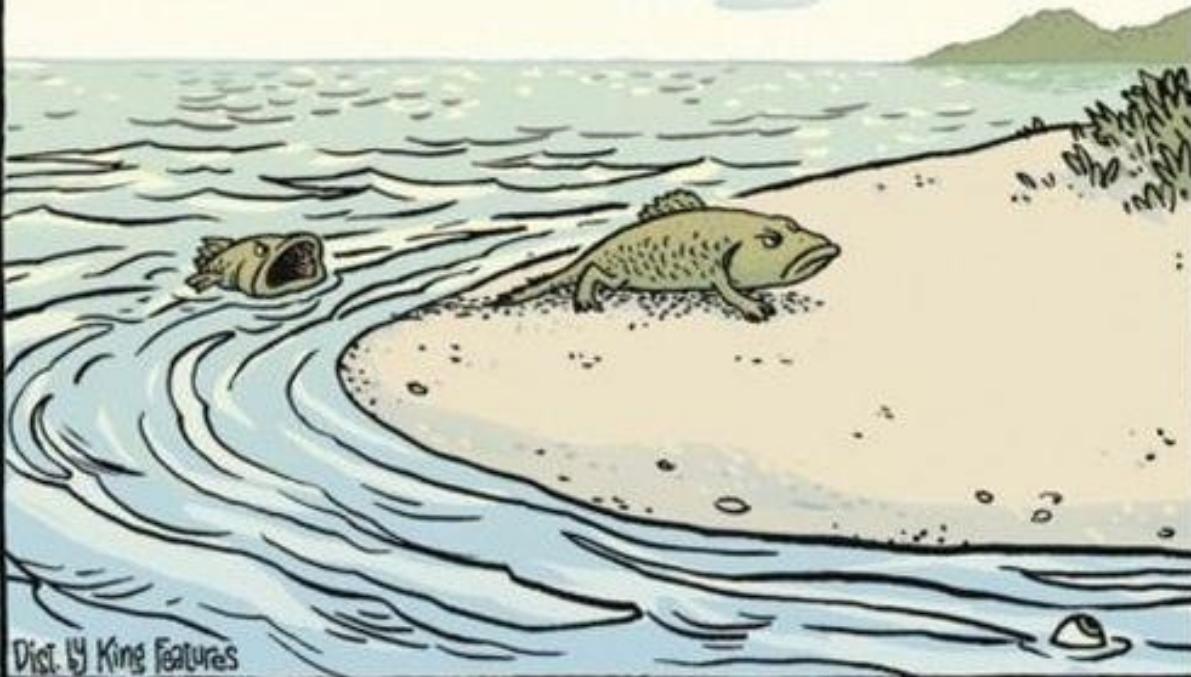
Little by little, an animal that was a mixture of a crocodile and a fish, developed lungs and feet and conquered dry land.



Univ. of Michigan Exhibit Museum of Natural History -- Life Through the Ages Diorama

IT'S DINOSAUR HUMOR TIME !!

Don't walk away when
I'm talking to you!

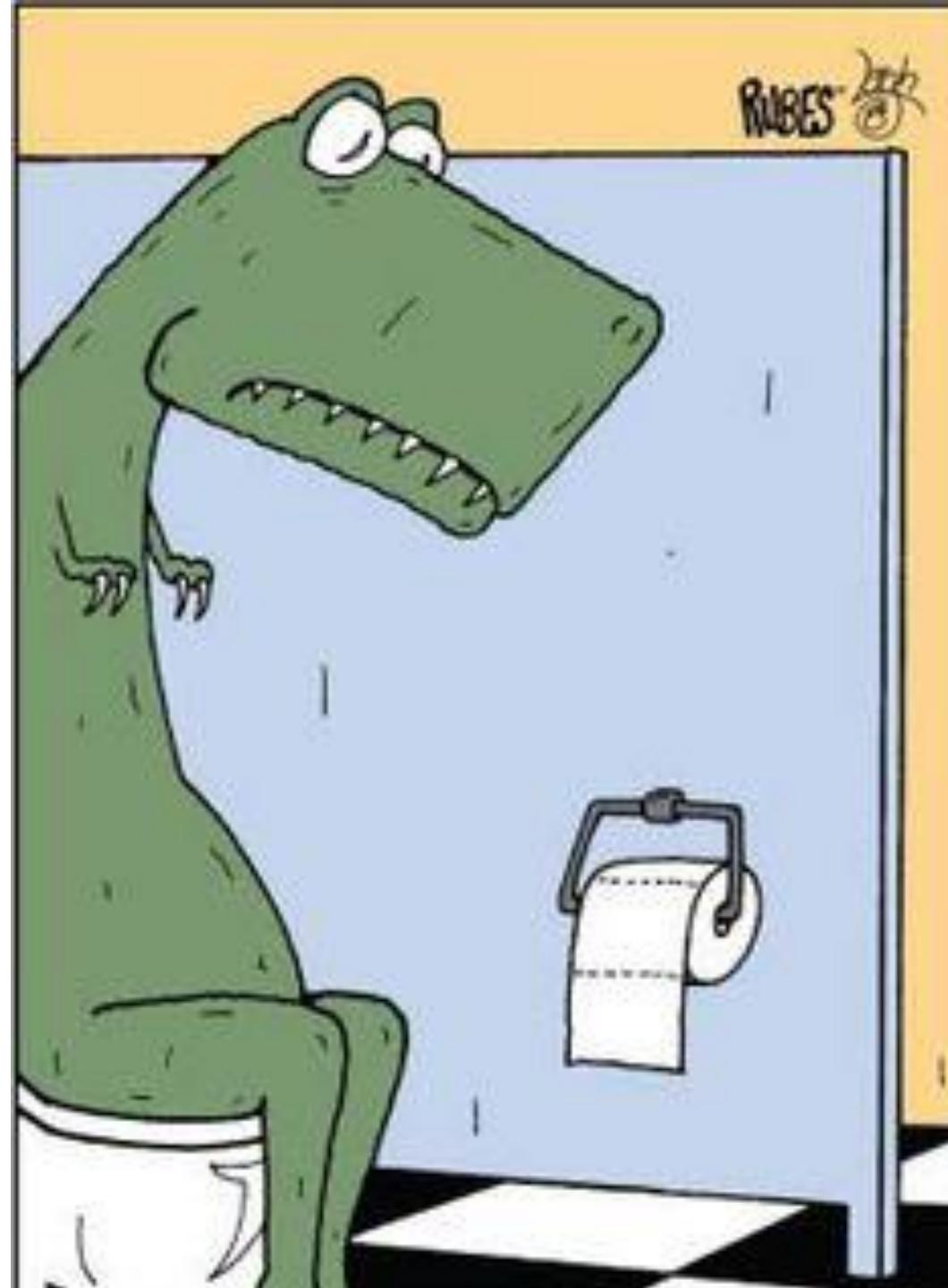






"Geez, how far did you set the clocks
back?"

T-Rex's short arms
may have been a
problem when they
went to the potty !!



What do you call it when a dinosaur
Crashes their car?



Tyrannosaurus Wrecks

WHAT DO YOU CALL A GROUP OF
SINGING DINOSAURS?



A TYRANNOCHORUS

**What DO you call a Dinosaur
with an extensive vocabulary?**

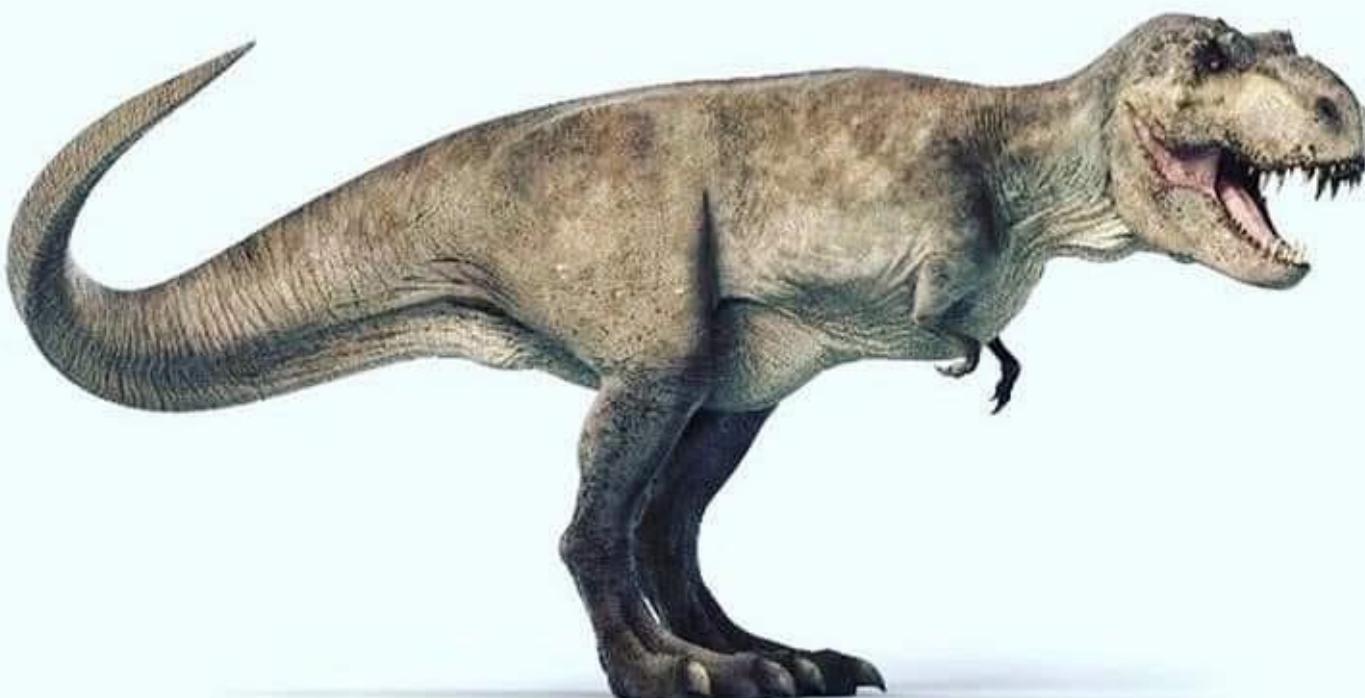


A THESAURUS

TACOSAURUS



COULDN'T WASH HANDS



IS NOW EXTINCT



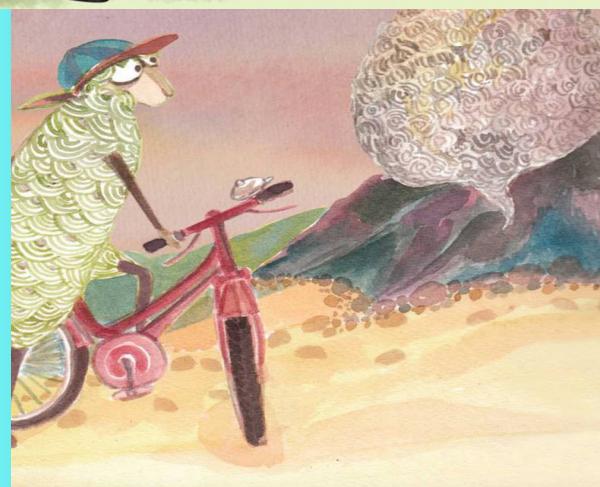
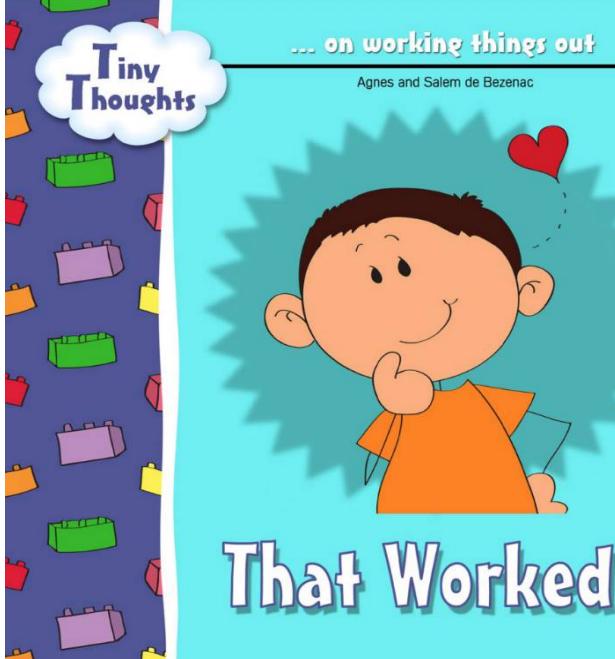
THE END

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Jurassic World Evolution all 68 dinosaurs

<https://www.youtube.com/watch?v=Q5sQ98p4IV8&t=3558s>



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