DINOSAURS

Kings for 200 Million Years

- ➡ 101 Dinosaurs, Plesiosaurs & Pterosaurs
- ➡ more than 280 pages
- ➡ featuring over 63,000 words
- ➡ more than 150 images.

Enjoy the journey back to the world of the dinosaurs.

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Statement

This book would have been completely impossible two years ago! The latest technologies are giving dinosaur fans around the world an incredibly deep insight into the time when gigantic creatures ruled our planet.

With the help of DNA sequences, fossils, and skeletons, it has been possible to train state-of-the-art artificial intelligence programs to the point where they are capable of rendering animals in lifelike detail. Through numerous comparative experiments with animals whose appearance is familiar to us, an extremely high degree of accuracy was achieved. This allowed us to bring dinosaurs to life visually—dinosaurs whose appearance during their lifetimes we previously did not know.

Even though this book was written with the help of several programs from the world of artificial intelligence, it contains a great deal of work and attention to detail.

We present the first 101 dinosaurs, plesiosaurs, pterosaurs, and other prehistoric species here across more than 300 pages, featuring over 55,000 words and more than 150 images.

Enjoy the journey back to the world of the dinosaurs.

Personal Note:

My son asked me to write a book about dinosaurs. I hope the knowledge gathered in this book will be of some help to my children and all readers. I therefore dedicate this book to my children, Princess, Apollo Odin, and Cathaleyah Alechandra.

The Triassic Period

When the World Started Over approx. 252 to 201 million years ago

Imagine an Earth you would not recognize. No green forests. No grass. No birdsong. Instead: a single enormous supercontinent stretching from pole to pole, surrounded by one vast global ocean. That supercontinent is called Pangaea - and it is the stage on which the greatest drama in the history of life begins. Because somewhere in this bare, scorching, barely inhabited world, they appear. For the very first time. The dinosaurs.

The Triassic is an era of new beginnings. What came before it was the most devastating mass extinction this planet has ever witnessed: the Permian-Triassic event, roughly 252 million years ago. Based on fossil records gathered from every continent, estimates suggest that up to 96 percent of all marine species and around three quarters of all land-dwelling life vanished. The Earth after that extinction is nearly empty. What follows is not a gentle transition - it is a brutal reset.

The early Triassic is first and foremost a world of survivors. Extreme heat, relentless aridity, atmospheric CO_2 levels far above anything we experience today - these are not easy conditions for life. Yet those very extremes create something remarkable: open ecological space. There are almost no competitors, almost no established food chains, almost no occupied niches. Whoever adapts and pushes through now gets the world to themselves.

Born from Chaos: Who Were the Very First Dinosaurs?

The first dinosaurs to emerge in this vacuum are nothing like the towering giants you know from films. They are small, nimble, often no bigger than a dog or a large house cat. Eoraptor lunensis - roughly translated as the dawn raider - is considered one of the earliest known dinosaurs. Excavations in the La Rioja province of Argentina brought it to light. It lived around 231 million years ago, measured about one meter in length, and weighed an estimated ten kilograms. What makes it especially interesting is that it was probably an omnivore, meaning it lacked the specialized anatomy of either a pure predator or a strict plant-eater.

Not far away in evolutionary terms sits Herrerasaurus ischigualastensis, also from Argentina. At roughly three to six meters in length and a weight of up to 350 kilograms, this is a different proposition entirely - an early predatory dinosaur that actively hunted and sat near the top of its local food chain. Finds from the Ischigualasto Basin, one of the fossil-richest sites on Earth, suggest that dinosaurs, while appearing early, did not yet dominate. They shared their world with rhynchosaurs, early relatives of crocodiles, and other reptile groups all trying to capitalize on the same ecological restart.

What set dinosaurs apart from their competitors was probably a key anatomical feature: an upright posture. While many reptiles splay their legs out to the sides - an energy-inefficient way to move - the ancestors of dinosaurs placed their legs directly beneath their bodies. That allowed faster movement, more efficient breathing, and likely greater stamina. Not a revolutionary feature in isolation, but in a world where speed and adaptability were everything, possibly the decisive edge.

Pangaea Splits - and the World Shifts

A central story of the entire Triassic is the slow breaking apart of Pangaea. The supercontinent begins to stretch and crack, early rift valleys fill with water, and the first outlines of future ocean basins take shape. Geologically speaking, this is a gradual process. For life on the continent, however, it means growing climate diversity. Coastal areas become wetter, the deep interior stays hot and dry. Ferns, horsetails, conifers, and ginkgo trees spread across the landscape. Flowering plants, as we know them today, do not yet exist.

Within this shifting world, dinosaurs evolve with remarkable speed - at least on a geological timescale. By the late Triassic, roughly 210 to 200 million years ago, three major groups are already distinguishable: the Theropoda (two-legged, mostly meat-eating forms), the Sauropodomorpha (long-necked plant-eaters), and the Ornithischia (a diverse group of plant-eaters that will later include Triceratops and Stegosaurus). This three-way split will define the entire dinosaur story.

Particularly striking in the late Triassic is the rise of the Sauropodomorpha. Plateosaurus engelhardti, known from finds in

Germany and France, was an early member of this lineage: roughly nine meters long, still capable of moving on two legs, but already sporting the distinctive long neck that would make this group famous. It lived around 214 million years ago and ate plants - largely because at that body size, there was simply no other option. An animal that large cannot sustain itself on insects and small prey.

Alongside the dinosaurs, the Triassic also sees the emergence of the pterosaurs - the first flying vertebrates in Earth's history. Not dinosaurs in the strict sense, but close relatives. And in the seas, ichthyosaurs and early plesiosaurs develop into impressive marine reptiles that will come to dominate the oceans of both the Triassic and Jurassic. The Triassic is therefore not just the birthplace of the dinosaurs - it is the birthplace of an entirely new ecosystem.

The end of the Triassic arrives, as so often in Earth's history, abruptly. Around 201 million years ago, the Triassic-Jurassic mass extinction strikes, triggered most likely by massive volcanic activity linked to the opening of the early Atlantic - the so-called Central Atlantic Magmatic Province event. Enormous quantities of CO_2 and sulfur dioxide are blasted into the atmosphere, the climate destabilizes, and many animal groups disappear. Among the casualties are most early crocodile relatives and numerous other reptile groups that had been competing with the dinosaurs up to that point.

What survives is an ecosystem that now belongs almost entirely to the dinosaurs. The Triassic created them. The extinction at its boundary handed them the world. What follows is their true golden age. The Triassic was less the era of the dinosaurs than their training ground - the critical phase in which they learned to survive before they learned to dominate.

The Jurassic Period - The Golden Age of Dinosaurs

approx. 201 to 145 million years ago

If any single era shaped the image we carry of dinosaurs today, it is the Jurassic. Gigantic sauropods whose necks reach above the treetops. Stegosaurs with their strange bony plates running along their backs. Early feathered creatures hovering somewhere between dinosaur and bird. And everywhere: lush vegetation, a warm and humid climate, and a diversity of species that puts the Triassic entirely in the shade. The Jurassic is, in every meaningful sense, the golden age of the dinosaurs - and at the same time one of the most fascinating periods in all of Earth's history.

After the mass extinction at the Triassic-Jurassic boundary, the dinosaurs are the undisputed rulers of the land. The ecological niches left vacant by vanished groups are filled quickly. And this time, the dinosaurs do not hold back: within a few million years - a blink of an eye in geological terms - forms emerge on a scale that would have been unimaginable before.

The Jurassic climate plays directly into their hands. Pangaea continues to break apart: the North Atlantic begins to open, the Tethys Ocean expands, and the continents drift toward arrangements that look a little more familiar to us - though still quite different. The climate is warm, there are no polar ice caps, sea levels are high. Large parts of what is now Europe lie beneath shallow inland seas. Coastal regions are humid and covered in conifer and fern forests that supply the great sauropods with what amounts to an endless buffet.

Giants of the Jurassic: When the Earth Trembled

The most celebrated Jurassic dinosaur is almost certainly Brachiosaurus brancai - today often reclassified as Giraffatitan brancai, though the popular name has stuck. The original specimens come from the Tendaguru Formation in Tanzania, where German paleontologists between 1909 and 1913 conducted one of the most extensive excavation campaigns in the history of the science, shipping roughly 235 tons of fossils back to Europe. The assembled skeleton at the Museum of Natural History in Berlin, mounted in 1937, remains the largest mounted dinosaur skeleton in the world, standing 13.27 meters tall.

What distinguishes Brachiosaurus from most other sauropods is the angle of its neck. While the majority of long-necked giants hold their necks roughly horizontal and browse vegetation at ground level or mid-height, Brachiosaurus carried its neck steeply upward - much like a giraffe, but on a scale that makes giraffes look modest. This allowed it to reach treetops at heights of around nine to ten meters that no other land animal could touch. With an estimated body weight between 30 and 60 tons - figures that vary considerably depending on the study - it was among the heaviest land animals that ever lived.

But the Jurassic offers more giants still. Diplodocus longus was lighter than Brachiosaurus but longer - up to 26 meters from snout to tail tip. Its long, whip-like tail was identified early on by researchers at the Carnegie Institution in Washington as a possible acoustic weapon, capable of producing a crack like a bullwhip when swung at speed. Apatosaurus ajax - long known as Brontosaurus until a naming dispute made that term temporarily invalid, though it has since been partially reinstated - rounds out the roster of North American sauropods, all drawn from the Morrison Formation, one of the fossil-richest geological deposits in the world, stretching from Montana down to New Mexico.

At the same time, the Jurassic sees the continued evolution of the theropods - the two-legged meat-eaters whose lineage will eventually produce birds. Allosaurus fragilis is the dominant large predator of the late Jurassic in North America. At up to twelve meters in length and a weight of two to three tons, it posed a genuine threat to sauropods, at least to juveniles or weakened individuals. Its fossils appear in large numbers throughout the Morrison Formation, suggesting it was both common and successful. Interestingly, many Allosaurus bones show bite marks from members of the same species - a possible sign of cannibalism, or at least fierce competition within the group.

Feathers, Bones, and the In-Between: The Birth of Birds

No Jurassic fossil has occupied science more persistently than Archaeopteryx lithographica. In 1861 - just two years after Darwin published On the Origin of Species - an impression is discovered in the fine-grained limestone quarries of Solnhofen in Bavaria that changes paleontology forever: an animal with the skeleton of a small theropod dinosaur but with unmistakable feathers. Archaeopteryx is neither dinosaur nor bird in the modern sense - it is both at once, a transitional form that confirmed Darwin's theory of gradual evolution more powerfully than almost anything else could have.

More than a dozen specimens are now known from the Solnhofen limestones, which were ideal for fossilization because they formed as fine sediment in a shallow lagoon environment. Archaeopteryx had teeth - modern birds have none - along with clawed fingers on its wings and a bony tail. Its body mass was long estimated at under one kilogram, roughly the size of a raven. Whether it could truly fly, or whether it was more of a glider and climber, remains an open question in current research.

What Archaeopteryx represents is not an exception but a trend. Throughout the Jurassic, feathered forms appear with increasing frequency within the theropod branch of the dinosaur family tree. True birds, in the modern sense, do not emerge until the Cretaceous, but the roots lie clearly in the Jurassic. According to a landmark study by Xu Xing and colleagues published in the journal Nature, the key bird features - feathers, a shortened tail, and modified forelimbs - can be traced back through the maniraptorans, a group of theropods that includes not only Archaeopteryx but later forms such as Velociraptor, even if that particular predator lived millions of years later in the Cretaceous.

Another fascinating chapter of the Jurassic involves the stegosaurs. Stegosaurus stenops - the animal with the iconic bony plates along its back and four tail spikes - lived in the late Jurassic of North America and is one of the most instantly recognizable dinosaurs of all time. The function of those plates has been debated for over a century: heat regulation? Species recognition? A display structure for attracting mates? Most likely a combination of all three. What is clear is that the brain of Stegosaurus was, relative to its body size, among the smallest of any dinosaur - roughly the size of a walnut in an animal up to nine meters long. What you can conclude from that: Stegosaurus was not a strategist. It was an armored survivor.

Jurassic Europe is an island world. Rising sea levels turn the continent into a sprawling archipelago of landmasses separated by shallow seas. What happens on islands, we know well today: animals evolve in isolation, often becoming smaller through what biologists call insular dwarfism, sometimes developing in entirely unexpected directions. European Jurassic dinosaurs like Europasaurus holgeri - a sauropod that lived on an island in what is now northern Germany and reached only about six meters in length while its relatives elsewhere grew three times as large - are living proof of this. The Lower Saxony State Museum in Hanover introduced it to the public in 2006, and the excavation site near Goslar remains one of the most significant in Europe.

By the close of the Jurassic, around 145 million years ago, the climate shifts. It becomes drier in some regions, cooler in others, and the vegetation begins to change. There is no dramatic mass extinction this time - rather a gradual transition into the next chapter. Many Jurassic groups carry straight on: sauropods, theropods, ornithischians. But the stage is rearranged, and with it the cast. What follows is the Cretaceous - the long, rich, turbulent final act of the age of dinosaurs.

The Cretaceous Period - Diversity, Dominance, and the Great Silence

approx. 145 to 66 million years ago

Almost 80 million years. That is the span of the Cretaceous, making it the longest of the three great dinosaur periods. For context: between today and the end of the Cretaceous lies a gap of 66 million years - the same stretch of time in which mammals went from small, nocturnal creatures scurrying through the undergrowth to everything that walks, flies, swims, and thinks on this planet today. The Cretaceous is a vast span of time, and the diversity that unfolds within it is almost impossible to grasp. It is the period in which the dinosaurs reach their greatest variety of species. It is also the period in which they go extinct.

The word Cretaceous comes from the Latin creta, meaning chalk. The period takes its name from the thick limestone formations laid down in shallow inland seas during this time - the same deposits that now form the white cliffs of the Isle of Rugen, the English coast at Dover, and similar chalk landscapes across Europe. The Earth of the Cretaceous looks different from the Jurassic: the continents have separated further, the Atlantic continues to widen, and the landmasses are beginning to take on shapes that would look, at least vaguely, familiar. The climate is intensely warm. There are no polar ice caps. According to isotope-based reconstructions regularly published by institutions including the Alfred Wegener Institute in Bremerhaven, global average temperatures during the late Cretaceous were roughly four to eight degrees Celsius higher than today. Sea levels are high, and large parts of what is now North America and Europe lie under shallow water. In this warm, humid world, life explodes - and with it, the dinosaur world.

The World Goes Colorful: Flowers, Bees, and New Food

The most important botanical revolution in Earth's history takes place during the Cretaceous: the rise of the flowering plants, or angiosperms. Until the early Cretaceous, the land is dominated by conifers, ferns, horsetails, and ginkgos. Then, around 125 to 100 million years ago, flowering plants begin to spread - slowly at first, then with astonishing speed. By the end of the Cretaceous, they are the dominant plant group in most landscapes across the world. Co-evolving with them are the insects: bees, butterflies, and other pollinators emerge during this same window of time. The Earth quite literally becomes more colorful.

What this meant for plant-eating dinosaurs is not yet fully understood. What is clear is that several groups - especially the ceratopsids, the horned dinosaurs, and the hadrosaurs, the duck-billed dinosaurs - undergo dramatic diversification during the late Cretaceous. Whether that connects directly to the rise of flowering plants remains an active area of research. The logic is plausible: new plants mean new food sources, and whoever adapts first gains an advantage.

The hadrosaurs are a fine example of the specialization the Cretaceous made possible. Edmontosaurus regalis, known from the Horseshoe Canyon Formation in Canada, was a herd animal that may have traveled in groups of hundreds or even thousands of individuals. Its broad, tooth-lined snout was a highly efficient plant-processing machine, equipped with several hundred small teeth arranged in banks that constantly replaced themselves as they wore down. Chewing steadily as it moved, Edmontosaurus wandered through the floodplain forests of late North America. Some fossils preserve actual skin impressions - a rarity in paleontology that gives us a direct window onto what the animal's surface actually looked like.

T. rex, Triceratops, and the Last Generation

No dinosaur is more famous than Tyrannosaurus rex. The king of the tyrant lizards is not only a cultural phenomenon but also one of the most scientifically studied animals in the history of paleontology. Around 50 individual specimens have been found so far - enough for a detailed and fairly reliable picture. T. rex lived in the very last phase of the Cretaceous, between 68 and 66 million years ago, across what is now western North America. At up to 12.3 meters in length, a hip height of around four meters, and an estimated body weight of eight to fourteen tons, it was the uncontested apex predator of its ecosystem.

What makes T. rex especially striking is its proportions: an enormous skull lined with massive teeth - the longest measured up to 30 centimeters including the root - combined with front limbs so small they could barely reach the animal's own mouth. For a long time, debate raged over whether T. rex was an active hunter or a scavenger. Current research, including work published by Jack Horner of the Museum of the Rockies and other teams, points toward both: T. rex was an opportunist that hunted when it could and ate carrion when it had to, much like most large predators today.

More recent studies also suggest that T. rex may have been partly feathered, at least during some life stages. Direct skin impressions recovered at several skeleton sites show scaly skin across large body surfaces. According to a study published in the journal Biology Letters in 2017, this suggests that large theropods like T. rex secondarily lost their feathers as they grew enormous, even though their smaller ancestors were feathered. The picture that emerges is a fascinating one: T. rex as a scaly giant descended from a feathered lineage.

Alongside T. rex, Triceratops horridus is the most iconic representative of the late Cretaceous. With its massive neck shield and three prominent horns - two above the eyes and one on the nose - it is instantly recognizable to children and adults worldwide. It lived simultaneously with T. rex in the same region, and with a weight of up to twelve tons and a length of nine meters, it was far from easy prey. Bones of both species carry traces of direct encounters with each other - a remarkable fossil record of a predator-prey interaction that played out more than 66 million years ago.

Triceratops belongs to the ceratopsids - the horned dinosaurs - which appear exclusively in the Cretaceous and develop into a stunning variety of forms. Pentaceratops sternbergii had one of the largest skulls of any land animal ever recorded, measuring over three meters in length. Kosmoceratops richardsoni carried no fewer than 15 horns and bony protrusions on its head. All of these forms lived in the late Cretaceous of North America, and their rapid diversification within a relatively short window of time is a vivid demonstration of how fast evolution can move when ecological conditions allow it.

While North America is defined by T. rex and Triceratops, the other continents develop entirely independent dinosaur communities. In South America, giant sauropods like Argentinosaurus huinculensis evolve - an animal that may have weighed up to 80 tons, which would make it the heaviest land animal in Earth's history, though estimates based on fragmentary fossils always carry a wide margin of uncertainty. In Asia, theropods like Velociraptor mongoliensis flourish - in real life far smaller than in any film, standing only about 60 to 80 centimeters at the hip and almost certainly fully feathered. In Africa and Antarctica - much warmer then than today - equally distinct fauna develop on their own terms.

The late Cretaceous also brings a remarkable diversification of marine and flying reptiles. Mosasaurs, enormous aquatic lizards reaching up to

17 meters in length, come to rule the world's oceans and eventually displace the ichthyosaurs, which disappear in the early Cretaceous. Pterosaurs reach their evolutionary peak with Quetzalcoatlus northropi, whose wingspan of up to eleven meters - larger than a small aircraft - makes it the largest flying animal ever known. True birds, by this point well established, fill the skies and are quietly preparing to become the only dinosaur group to survive what comes next.

What comes next is the impact. Sixty-six million years ago, an asteroid roughly ten kilometers across strikes the Earth off the coast of what is now Mexico's Yucatan Peninsula. The energy released, according to calculations from the Lunar and Planetary Institute in Houston, equaled several billion atomic bombs. The resulting crater - the Chicxulub Crater - measures around 180 kilometers across and lies mostly beneath the Gulf of Mexico today. What follows is a global catastrophe: firestorms, tsunamis, a years-long darkening of the sky from ejected dust and soot, a planetary winter, acid rain, and the collapse of food chains at every level.

Within a geologically brief span - possibly only a few thousand to tens of thousands of years - all non-avian dinosaurs are gone. With them vanish the mosasaurs, most pterosaurs, many marine reptiles, ammonites, and a vast portion of ocean life. What survives are small mammals, birds, turtles, crocodilians, snakes, frogs, and a handful of other groups that either lived underground, in water, or were flexible enough in their diets to bridge the catastrophic conditions.

The Cretaceous does not end with a whisper. It ends with an impact heard around the world. And yet its legacy is far larger than its ending. For almost 80 million years, dinosaurs lived in a diversity of forms we are only beginning to understand. Every year, new excavations bring new species to light: in just the last two decades, the number of known dinosaur species has more than doubled from around 500 to over 1,000, according to estimates published in the Journal of Vertebrate Paleontology. Many species remain undiscovered. Many questions stay open. But one thing is certain: the Cretaceous was not the end of the dinosaurs - it is proof that an animal can rule the Earth for 165 million years. What came after was merely the next chapter.

Acrocanthosaurus

Acrocanthosaurus atokensis — Stovall & Langston, 1950

- 🦣 **Time period:** Early Cretaceous — approximately 125 to 100 million years ago (Aptian to Albian)
- 🦣 **Size:** Approx. 11 to 12 m long, about 3.5 to 4 m at the hip
- 🦣 **Weight:** Estimated 4 to 6 tons
- 🦣 **Lifespan:** Presumably 25 to 35 years
- 🦣 **Diet:** Carnivore — large sauropods, ornithopods, possibly also carrion
- 🦣 **Lifestyle:** Presumably solitary
- 🦣 **Speed:** Estimated 25 to 40 km/h
- 🦣 **Habitat:** Eastern and central North America — river plains and coastal forests of present-day Oklahoma, Texas, and Arkansas

Between the end of Allosaurus and the rise of T. rex, there is a gap of nearly 30 million years in North American dinosaur history. A gap that needed a predator. Acrocanthosaurus atokensis was that predator—a large predator of the Early Cretaceous that assumed the same ecological role in North America that Allosaurus had played in the Jurassic and that T. rex would fill in the Late Cretaceous. Not an intermediate form, not a stopgap—but a fully developed, highly specialized hunter that dominated its ecosystem for millions of years.

The name means “high-spined lizard”—and it refers directly to this animal’s most striking anatomical feature: elongated spinous processes on the dorsal vertebrae that ran along the entire spine and formed a clearly visible dorsal crest. Acrocanthosaurus was first described in 1950 by J. Willis Stovall and Wann Langston Jr. based on finds from Oklahoma—the state whose Atoka County gave the species its name. Since then, excavations in Oklahoma, Texas, and Arkansas have yielded a total of seven specimens, including several nearly complete skeletons that provide a detailed picture of this animal.

The most famous specimen—known by the nickname Fran—is now on display at the North Carolina Museum of Natural Sciences in Raleigh and is considered one of the most complete theropod skeletons in

North America. Anyone who sees it understands immediately: Acrocanthosaurus was not an animal one could overlook.

The Back That Raises Questions

The elongated spinous processes of Acrocanthosaurus are what gave this animal its name—and at the same time, what is most debated in research. The processes were significantly longer than those of a typical theropod, but nowhere near as extreme as those of Spinosaurus, whose spinous processes formed a true sail. In Acrocanthosaurus, the spines fell somewhere in between: high enough to create a visible dorsal crest, but probably not high enough for a true sail.

What lay beneath it? Two main hypotheses are in contention. The first: The crest was filled with muscle mass—a massive neck and back muscle, similar to a bison's hump, which gave the animal enormous strength for subduing large prey. This hypothesis is supported by the animal's size and hunting behavior: an animal that attacked sauropods needed exceptional strength in its upper body. The second hypothesis: thermoregulation or visual display—a crest that absorbed or released heat, or signaled to conspecifics who the dominant animal was.

It is likely that both are true to some extent. Evolutionary features of this magnitude rarely serve just a single function. What is sometimes depicted in art as a row of spikes or even a dorsal fin was in reality probably a muscular, fleshy ridge along the spine—distinctive, but organic, more like a hump than a sail.

A hunter leaves traces

Acrocanthosaurus belongs to the family Allosauroidea—the same large group to which Allosaurus also belongs. This kinship is well-documented anatomically and explains why both animals often appear similar in reconstructions: similar body proportions, similar skull structure, similar forelimb structure with three powerful claws. But Acrocanthosaurus was larger—reaching up to twelve meters in length, it surpassed most Allosaurus specimens—and lived in a different world, with different prey and different ecological conditions.

What it hunted can be inferred from the fossil record. Fossilized footprints were discovered in Texas that show direct interaction between a large theropod—most likely Acrocanthosaurus—and a sauropod. The trackway from the Paluxy River in Glen Rose, Texas, now part of Dinosaur Valley State Park, shows a theropod following a sauropod across a soft mudflat. Whether this was active hunting or the pursuit of an already weakened animal cannot be said with certainty—but the close proximity of the tracks is no coincidence. This is predator behavior, frozen in stone. The forelimbs of Acrocanthosaurus, similar to those of Allosaurus, were functional and equipped with powerful claws. Studies of the shoulder and arm bones, including those by paleontologist Matthew Bonnan, show limited mobility in the shoulder joint—the arms could not be extended far forward but were exceptionally strong. This fits a hunting style in which the arms were used to hold prey that had already been brought to the ground, not for actively grabbing from a distance.

With seven known specimens, Acrocanthosaurus is not a commonly found dinosaur—but the quality of the finds is high enough to paint a reliable picture. It laid eggs, like all dinosaurs, and was likely a solitary creature that defended its territory and tolerated conspecifics only during mating season. In a world without T. rex and without the large ceratopsids of the Late Cretaceous, it was the measure of all things—the predator against which everything else was measured.

Acrocanthosaurus filled 30 million years of North American predator history with a body that surpassed Allosaurus in size and a back that, to this day, sparks debate over what it truly was.

Agilisaurus

Agilisaurus louderbacki — Peng, 1990

- 🦣 **Time period:** Middle Jurassic — approximately 163 to 157 million years ago
- 🦣 **Size:** Approx. 1.2 to 1.7 m long, about 0.5 m at the hip
- 🦣 **Weight:** Estimated 10 to 40 kilograms
- 🦣 **Lifespan:** Presumably 10 to 15 years
- 🦣 **Diet:** Herbivore — low vegetation, ferns, horsetails, soft plant shoots
- 🦣 **Lifestyle:** Presumably solitary or in small groups; fast, agile flight animal
- 🦣 **Speed:** Estimated 40 to 50 km/h — exceptionally fast for its size
- 🦣 **Habitat:** Asia — terrestrial landscapes of present-day Sichuan Province, China

Most dinosaurs known to the public have one thing in common: they are large. Large enough to make an impression, large enough to fill entire halls in museums. Agilisaurus is the opposite of that. An animal the size of a medium-sized dog, lightly built, quick on its feet, and so unremarkable in its era that it remained completely unknown for nearly 160 million years. Yet this small herbivore from the Middle Jurassic of China holds a story that is quite relevant to our understanding of the early Ornithischia—the bird-hipped dinosaurs.

Agilisaurus was discovered in 1984 in the Shaximiao Formation in the Chinese province of Sichuan, an area that has proven to be an extraordinarily productive site for Jurassic dinosaurs in recent decades. It was described in 1990 by the Chinese paleontologist Peng Guangzhao—and to this day, only a single specimen is known. A single skeleton, which fortunately is nearly completely preserved and thus offers insights that would simply not be possible with more fragmentary finds. The name says it all: Agilisaurus means “nimble lizard”—and it points directly to what this animal’s anatomy communicates most clearly. Long, slender hind legs. A lightweight build optimized for fast movement. Short forelimbs. A long tail as a counterweight. Everything about Agilisaurus screams speed—and that in an ecosystem where speed was simply a matter of survival for a small, unarmed herbivore.

Small, fast, misunderstood

Agilisaurus belongs to the Ornithopoda—a large group of herbivorous dinosaurs from which animals like Iguanodon and the hadrosaurs would later emerge. In the Middle Jurassic, this lineage was still young, and Agilisaurus represents an early, still relatively unspecialized branch of it. What this means: It did not yet have the highly developed rows of teeth of the later hadrosaurs, nor the body size of Iguanodon, nor the ecological dominance that its descendants would achieve in the Cretaceous. It was, in a sense, an ornithopod in its raw state—the basic form from which everything else would later develop.

Agilisaurus's teeth were simple and leaf-shaped, suited for soft plant material such as ferns, horsetails, and young plant shoots. It was a far cry from the highly complex chewing apparatus of its later relatives. What it had was functional enough for a small animal that fed on what was close to the ground and easily accessible—and that spent most of its time trying not to get eaten. For predators were plentiful in the Shaximiao Formation. The Chinese Jurassic fauna was species-rich and included several medium-sized to large theropods, including early megalosaurids and other predatory dinosaurs that would have readily regarded an Agilisaurus-sized herbivore as a meal. The only realistic response to this threat was flight—and Agilisaurus's anatomy is consistently designed for exactly that.

One Fossil, One Question, No Definitive Answer

The problem with Agilisaurus is the same as with many little-known dinosaurs: a single specimen is a limited data set. Much of what can be said about this animal is reconstruction based on what the skeleton shows—and extrapolation from what is known about related species.

Whether Agilisaurus lived in groups or alone, whether it undertook seasonal migrations, how it reproduced, and whether it cared for its young in any way—all of this remains a mystery. What the single known skeleton does show, however, is a complete picture of its body shape. And this picture is consistent: a lightweight, bipedal animal built for speed, living in a world where small size was no disadvantage as long as one ran fast enough. In addition to Agilisaurus, the Shaximiao Formation has yielded significantly larger animals—sauropods like Shunosaurus and Omeisaurus, which weighed several tons and cared little for predators. Agilisaurus lived in a different niche, on a different level of the same ecosystem. Small, inconspicuous, efficient. Whether additional specimens will ever be found is uncertain. Sichuan is one of China's most active excavation regions, and the Shaximiao Formation has repeatedly yielded new species over the past few decades. It would come as no surprise if Agilisaurus eventually gets a second chance—a second skeleton that answers the remaining questions. Until then, it remains what it is: a rare, complete glimpse of a small Middle Jurassic herbivore that was fast enough to be remembered 163 million years later.

Agilisaurus was the smallest building block of a vast ecological system—too small for headlines, too well-preserved to be ignored, and fast enough to simply run away in a world full of predators.

Alamosaurus

Alamosaurus sanjuanensis — Gilmore, 1922

- 🦣 **Period:** Late Cretaceous — approximately 72 to 66 million years ago (Maastrichtian)
- 🦣 **Size:** Approx. 28 to 30 m long, about 7 to 8 m at the hip
- 🦣 **Weight:** Estimated 60 to 80 tons
- 🦣 **Lifespan:** Presumably 70 to 100 years Diet: Herbivore — conifers, cycads, flowering plants, high tree canopies
- 🦣 **Lifestyle:** Presumably in small herds or family groups
- 🦣 **Speed:** Estimated 10 to 15 km/h

🦣 **Habitat:** Western North America and northern Mexico — open landscapes and river plains of present-day Utah, New Mexico, and Coahuila

For many people, the Cretaceous period in North America is dominated by images of T. rex and Triceratops. What is easily forgotten is that during the very last phase of this era—the final six to seven million years before the impact—sauropods of a size that dwarfed even Brachiosaurus and Diplodocus roamed the same landscapes. Alamosaurus sanjuanensis was North America's last great sauropod—a giant that, at the end of the dinosaur era, demonstrated once again what evolution was capable of given enough time and space.

Charles Whitney Gilmore of the Smithsonian Institution described Alamosaurus in 1922 based on finds from the Ojo Alamo Formation in New Mexico—after which the animal was named, though the name has nothing to do with the famous Alamo in Texas. Since then, 30 specimens have been discovered in Utah, New Mexico, and the Mexican state of Coahuila. This makes Alamosaurus one of the most commonly found sauropods of the Cretaceous period in North America—which seems almost paradoxical given its size. An animal of this magnitude leaves behind correspondingly large bones that are hard to miss.

Alamosaurus belongs to the group of Titanosauria—the line of sauropods that dominated the late Cretaceous and was present on nearly every continent. In South America, titanosaurs had already produced giant forms since the mid-Cretaceous. In North America, however, sauropods were rare or absent for a long period—a conspicuous gap in the fossil record that remains incompletely explained to this day. Then, toward the end of the Cretaceous, they reappeared. Alamosaurus was the returnee—a South American immigrant that reached the north via land bridges or by hopping from island to island and established itself in the open landscapes of southwestern North America.

Larger than expected—and still growing

When Alamosaurus was first described, it was considered a stately but not extraordinary sauropod—similar in size to the well-known Jurassic giants, perhaps slightly more compact. Then new discoveries emerged, and the picture changed significantly. Vertebrae and bones discovered in Texas and New Mexico and analyzed in the 2010s yielded estimates that surprised even experienced paleontologists: Alamosaurus may have been among the largest land animals that ever lived—possibly heavier than Argentinosaurus, the previous title contender.

A 2011 study by Denver Fowler and Robert Sullivan, published in the journal Acta Palaeontologica Polonica, suggested that adult Alamosaurus specimens could reach a body mass of 60 to 80 tons—with a length of nearly 30 meters. By comparison, an adult African elephant weighs about five to six tons. Alamosaurus weighed ten times that much. These estimates are based on extrapolated bone measurements and are subject to uncertainty, as with all fragmentary giant dinosaur finds. But the trend is clear: Alamosaurus wasn't just big. It was exceptionally large. What an animal of this size had to eat daily can only be estimated. Hundreds of kilograms of plant matter were the bare minimum. Conifers, cycads, flowering plants—everything the open landscapes of the Late Cretaceous Southwest had to offer. Alamosaurus did not have a particularly long neck relative to its body, compared to Brachiosaurus, but even a proportionally shorter neck meant, at this body size, a reach that scarcely any other land animal surpassed.

The Last Giant in a Dying World

What makes Alamosaurus particularly interesting from a historical perspective is its timing. It lived until the end of the Cretaceous period—until the impact 66 million years ago. That means: Alamosaurus and T. rex were contemporaries. In the same landscapes, at the same time. A meeting between a fully grown Alamosaurus and a T. rex would have been an encounter in which the "King of Tyrants" would have been wise to keep his distance. A healthy adult weighing 60 to 80 tons was not a realistic target for any known predatory dinosaur. Juveniles, on the other hand, were vulnerable—and Alamosaurus juveniles remained vulnerable for many years before reaching the safety of their adult size.

The coexistence of Alamosaurus and T. rex in the same ecosystem is also fascinating from a paleogeographic perspective. It shows that the fauna of Late Cretaceous North America was more heterogeneous than long assumed. Not only the tyrannosaurids and ceratopsids of the Hell Creek Formation, but also sauropods that had migrated from the south shaped the landscape. Alamosaurus was not a relic of a bygone era—it was an active part of a living ecosystem that functioned until the very end. Thirty known specimens spread across Utah, New Mexico, and Mexico indicate a geographic distribution that suggests long-distance migrations. Whether Alamosaurus migrated seasonally, as is suspected for many large herbivores, is not directly proven. But the distribution of fossil sites across a large area suggests that these animals were not sedentary individuals, but actively moved through the landscape—in search of food, water, and the rare conditions under which a 70-ton animal can get its fill.

Alamosaurus was the last giant of an ancient lineage—a South American immigrant that, at the end of dinosaur history, proved once again that evolution knows no limits when given enough time.

Albertosaurus

Albertosaurus sarcophagus — Osborn, 1905

- 🦣 **Period:** Late Cretaceous — about 71 to 68 million years ago
- 🦣 **Size:** Approximately 8 to 9 meters long, about 2.5 to 3 meters at the hip height
- 🦣 **Weight:** Approx. 2,500 kilograms; femur measures around 905 mm
- 🦣 **Life expectancy:** Presumably 25 to 30 years
- 🦣 **Diet:** Carnivore — hadrosaurs, small ceratopsians, possibly carrion
- 🦣 **Lifestyle:** Evidence of group behavior — unusual for a large theropod
- 🦣 **Speed:** Estimated 30 to 40 km/h
- 🦣 **Habitat:** Western North America — coastal forests and river valleys of present-day Alberta, Saskatchewan, and Colorado

Albertosaurus is T. rex — just smaller, faster, and possibly smarter in dealing with its peers. As an early representative of the Tyrannosauridae, it lived around five million years before the Tyrant King and occupied the same ecological niche in late Cretaceous North America: a dominant large predator, bipedal, with small forearms and a massive skull typical of tyrannosaurids. With a body weight of 2,500 kilograms and femur bones nearly one meter long, it was still a significantly slimmer, more agile animal than T. rex — which was reflected in an estimated top speed that was noticeably higher than that of its more famous relative.

It is named after the Canadian province of Alberta, where the most significant finds were made. In total, 24 specimens are known — a remarkable number for a large theropod, allowing detailed insights into growth, anatomy, and, most interestingly, social behavior.

A pack of tyrannosaurids — no contradiction

The most fascinating finding about Albertosaurus comes from the Dry Island Buffalo Jump Provincial Park locality in Alberta, where Barnum Brown from the American Museum of Natural History discovered something in 1910 that he initially had difficulty categorizing: the remains of at least 26 Albertosaurus individuals of various age classes—juveniles, subadults, and adults—at the same site. This bonebed, which was little noticed for decades and was only systematically reexamined in the 1990s by Philip Currie from the Royal Tyrrell Museum, is still one of the strongest pieces of evidence for group behavior in a large theropod.

Whether it was true, coordinated pack hunting or simply opportunistic gathering at a common food source is not definitively clarified. But the age structure of the group is striking: younger, lighter animals were faster and more agile - possibly responsible for tracking and chasing prey, while heavier adults took over the actual attack. A functional

division of labor that remains purely speculative, but is anatomically plausible.

Growth at a Fast Pace

Bone histological studies — the analysis of growth rings in bone tissue — show that Albertosaurus grew quickly, with a particularly intense growth phase between the second and eleventh year of life. Afterward, growth slowed down. By about 14 years of age, most animals reached their full size. For a predator of this class, this is a relatively rapid developmental path — and it explains why the bonebed contains so many different size classes: Albertosaurus juveniles looked remarkably similar to their parents after just a few years.

Prey animals in its habitat were primarily hadrosaurids like Hypacrosaurus and early Ceratopsids. With its slender legs and lighter body structure, Albertosaurus was likely a long-distance pursuer — not an overpowering hunter like T. rex, but an animal that tired out its prey over distance.

Albertosaurus was T. rex in fast fast forward - lighter, faster, and possibly more social than its more famous relative, which took the same stage five million years later.

Allosaurus

Allosaurus fragilis — Marsh, 1877

- **Period:** Late Jurassic — about 155 to 145 million years ago
- **Size:** Approximately 8.5 to 12 meters long, about 3 to 4 meters at the hip height
- **Weight:** Estimated 1.5 to 3 tons
- **Life expectancy:** Presumably 22 to 28 years
- **Diet:** Carnivorous — large sauropods, ornithopods, stegosaurs
- **Lifestyle:** Probably solitary; possibly loosely congregating around large carcasses
- **Speed:** Estimated 30 to 55 km/h
- **Habitat:** Western North America — river landscapes and floodplains of the Morrison Formation; isolated finds also in Europe and possibly Africa

Anyone talking about the Jurassic carnivorous dinosaurs cannot overlook Allosaurus, which is looking similar to T. Rex, who was seen first about 90 million years later. He was the dominant large predator of his time — fast, strong, anatomically sophisticated, and so frequently found in the Morrison Formation that some paleontologists refer to him as the lion equivalent of the late Jurassic. No other theropod of its time is so well documented, so often found, and so thoroughly studied. And yet — or precisely because of that — there is still a lot in Allosaurus that keeps science busy.

Othniel Charles Marsh described Allosaurus fragilis in 1877 based on fragmentary bones from Colorado. The name means "different lizard" — a somewhat sober name for an animal of this class, which can be explained by the fact that Marsh found the unusual vertebral structure of Allosaurus so different that he justified a new genus. What followed was one of the richest fossil stories in paleontology. The most famous site is the Cleveland-Lloyd Dinosaur Quarry in Utah, from which over 10,000 individual Allosaurus bones have been recovered — more than from any other large predatory dinosaur worldwide. The Natural History Museum of Utah in Salt Lake City houses a large portion of this material and has reconstructed some of the most complete Allosaurus skeletons in the world from it.

Allosaurus lived about 155 to 145 million years ago in a North America that was climatically and ecologically completely different from today. The Morrison Formation was an extensive river landscape with seasonally fluctuating water levels, crisscrossed by rivers and floodplain forests, embedded in drier semi-desert zones. Here lived Brachiosaurus, Diplodocus, Apatosaurus, Stegosaurus — and right in the middle, Allosaurus, the top predator of one of the most species-rich ecosystems in dinosaur history.

A skull like an ax

What makes Allosaurus anatomically special is its skull. It was large, but not as massive in proportion to its body size as that of T. rex — instead, it was lighter and equipped with prominent bony crests above the eyes, giving the animal a distinctive, almost grim-looking face. The teeth were flattened and serrated on the sides, like saw blades — ideal for cutting meat, not for crushing bones. This set Allosaurus apart from T. rex, which relied on raw biting power.

These differences in skull architecture have led to a fascinating hypothesis developed by paleontologist Eric Snively and colleagues: Allosaurus may have hunted with a hook-like motion of the upper jaw. Instead of biting and holding on like a modern crocodile, it swung its skull down onto its prey — an attack that relied more on neck and head muscles than pure jaw strength. Biomechanical simulations support this idea. It was a different strategy than that of T. rex — but in a world full of giant sauropods, possibly a very effective one.

The forearms of Allosaurus were powerful and armed with three long, curved claws. Unlike T. rex's tiny arms, they were actually functional— long enough to grasp and hold prey while the skull did the real work. A coordinated system of arms and jaws that made Allosaurus a flexible, versatile hunter.

Mass graves and open questions

The Cleveland-Lloyd Quarry is remarkable not only because of its sheer number of finds. It is also one of the most enigmatic dinosaur sites in the world. Over 70 percent of the bones found there come from Allosaurus — an unusually high proportion that is difficult to explain. Why so many predators in one place? And so few prey animals?

One hypothesis: The site was a kind of death trap. A seasonal watering hole that became a muddy pit in dry times. Prey animals that ventured in got stuck. Allosaurus followed the easy prey—and got stuck too. More and more animals were attracted by the corpses, and more and more got stuck. A scenario that is reminiscent of the La Brea tar pits in California, where a similar mechanism in the Ice Age led to comparable bone piles.

This hypothesis is not proven. Other researchers suspect that a flood brought many carcasses together at one point. Or that Allosaurus actually came together in loose groups at certain locations — which raises questions about possible social behavior, which has hardly been studied so far. What the Cleveland-Lloyd Quarry certainly shows: Allosaurus was extraordinarily common in its environment — and extraordinarily successful.

Bite marks from Allosaurus teeth were found on the bones of Diplodocus, Apatosaurus, and Stegosaurus. Some of these traces suggest repeated visits to the same carcasses. Others show patterns that suggest active hunting — bites in places that would be less accessible on a dead animal. Allosaurus was both: an active hunter and an occasional scavenger. Just like T. rex, only 80 million years earlier.

With the end of the Jurassic, Allosaurus disappears from the fossil record. What followed were other theropods, other ecosystems, other predators. But for almost ten million years, Allosaurus was the measure of all things — the predator by which everything else was judged.

Allosaurus was not the largest and not the most famous predatory dinosaur — but it was the most complete: a hunter that hacked instead of biting, struck instead of crushing, and made an entire ecosystem play by its rules.

Amargasaurus

Amargasaurus cazaui — Salgado & Bonaparte, 1991

🦣 **Period:** Early Cretaceous — about 130 to 125 million years ago (Barremian)

🦣 **Size:** Approximately 9 to 10 meters long, about 2.5 to 3 meters at the hip height

🦣 **Weight:** Estimated 2.5 to 4 tons

🦣 **Life expectancy:** Presumably 50 to 70 years

🦣 **Diet:** Herbivore — low to medium-height vegetation, ferns, conifers

🦣 **Lifestyle:** Presumably in small groups or family units

🦣 **Speed:** Estimated 15 to 20 km/h

🦣 **Habitat:** South America — terrestrial landscapes of present-day Neuquén Province, Argentina

Among the sauropods—a group not exactly known for restraint—Amargasaurus stands out in a way that makes even experienced paleontologists pause at first glance of the skeleton. Not because of its size: At nine to ten meters, it was downright compact for a sauropod. But because of its neck. Along the cervical vertebrae and the front part of the back, two parallel rows of long, upright spines ran— the longest of which were above the neck, where they rose up to 60 centimeters high. No other sauropod looked like this. And what exactly these appendages were remains one of the most entertaining open questions in South American paleontology to this day.

Amargasaurus was discovered in 1984 by an Argentine expedition led by José Bonaparte in the La Amarga Formation in the province of Neuquén — an area that has proven to be one of the most productive dinosaur sites in South America. It was described in 1991 by Leonardo Salgado and José Bonaparte. To this day, it has remained a single specimen — but this one skeleton is nearly complete, which, given the rarity of complete sauropod finds, is an extraordinary stroke of luck.

The name refers to the La Amarga formation and the river of the same name in the region - nothing dramatic, but geographically precise. The species name cazaui honors Luis Cazau, a geologist from the Argentine oil company YPF, whose knowledge of the terrain made the excavation possible.

Sail, spikes or something in between?

The spines of Amargasaurus are what researchers argue about the most. Two fundamental hypotheses are opposed to each other — and both have arguments on their side.

The first: The extensions carried a skin sail, similar to that of Spinosaurus or the Permian synapsid Dimetrodon. Such a sail would have been well vascularized and served for thermoregulation — absorbing heat in the morning sun, releasing it in the midday heat. For an animal in the warm seasonal climatic conditions of early Cretaceous South America, this would have been a real physiological advantage.

The second hypothesis: The spines were covered in muscle and skin, forming two parallel humps or crests along the neck - not a sail, but rather something like the neck area of a bison, only doubled. This variant would have made the appendages more stable and protected them from damage. At the same time, such a double crest would have served as a visual signal — for species recognition, for display, possibly for mate selection.

A third possibility, which is occasionally discussed: The neck extensions acted as a passive protective structure against predators. A theropod trying to bite Amargasaurus in the neck — the classic attack point for large predators — would have encountered a series of long bony spikes. Whether this would actually have had a deterrent effect or whether a determined predator would have been put off is hard to judge. But as a supplementary function, it is not implausible.

What the fossil record says about it: direct evidence of skin or soft tissue on the appendages is lacking. The only known specimen has provided the bones — what was behind or in between remains open to interpretation. The fact that the discussion has remained so lively is precisely due to this: the skeleton is clear, the function is not.

A Sauropod in a Niche

Amargasaurus was unusually small for a sauropod—and that's no coincidence. Early Cretaceous South America was ecologically complex, with a range of competing herbivores of various size classes. A medium-sized sauropod with a specialized neck apparatus likely occupied a niche that was closed off to its larger relatives — lower to mid-height vegetation that true giants would have found simply too laborious to reach.

Its dentition was typical of early sauropods: simple, peg-like teeth for stripping vegetation, no complex chewing apparatus. What it ate, it swallowed largely unchewed, leaving the digestive work to a long, fermenting stomach. Ferns, conifers, low flowering plants — the menu of early Cretaceous Argentina.

The predators of its time in the La Amarga Formation were medium-sized theropods, about which relatively little is known. That Amargasaurus had developed some form of protective mechanism — be it the hypothetical sail, the spikes, or both — suggests that the selection pressure from predators was real.

Amargasaurus was the sauropod with the strangest neck in evolutionary history — a single fossil that still does not provide a definitive answer to what exactly grew up there.

Anchiornis

Anchiornis huxleyi — Xu et al., 2009

🦣 **Period:** Middle to Late Jurassic — about 168 to 151 million years ago

🦣 **Size:** Approximately 30 to 40 cm long, about 15 to 20 cm at the hip height

🦣 **Weight:** Estimated 100 to 250 grams

🦣 **Life expectancy:** Presumably 5 to 10 years

🦣 **Diet:** Carnivore — insects, small lizards, possibly small vertebrates

🦣 **Lifestyle:** Probably solitary; arboreal or ground-dwelling

🦣 **Speed:** Exact values unknown; presumably quick and agile

🦣 **Habitat:** Asia — terrestrial and wooded landscapes of present-day Hebei Province, China

Anchiornis is smaller than a crow. Lighter than a smartphone. And yet it is one of the most scientifically significant animals ever found - not despite its tiny size, but because it forces us to redraw the line between dinosaur and bird. Or, more accurately, to accept that this boundary was never as sharp as we thought.

Xu Xing and colleagues described Anchiornis huxleyi in 2009 based on finds from the Tiaojishan Formation in the Chinese province of Hebei. The species name honors Thomas Henry Huxley — the British biologist who, in the 19th century, was the first to seriously advocate the relationship between dinosaurs and birds and was initially ridiculed by the scientific community for it. century as the first to seriously advocate the relationship between dinosaurs and birds, and was initially ridiculed by the scientific community for it. With Anchiornis, Huxley was posthumously proven right—more emphatically than he probably imagined.

Three specimens are known. Few — but the preservation quality of the Chinese finds from this era is exceptional. Feathers, bones, and occasionally even soft tissues are preserved in the fine sediments of the Tiaojishan Formation, allowing insights that would simply not be possible in coarser deposits.

Four wings and an open question

Anchiornis had feathers. Not just on the arms — but also on the hind legs, down to the toes. Four feathered limbs that together formed a kind of biplane wing configuration. This feature it shares with the slightly younger Microraptor from the Cretaceous period and suggests a phase in bird development where four-winged feathering was not an exception, but possibly a widespread transitional stage.

Whether Anchiornis could fly, glide, or do both with it is not definitively clarified. The arms were shorter than those of true fliers, and the flight muscles were weaker than those of modern birds. Gliding from branch to branch — or from elevated positions downwards — is the most plausible scenario. Active flying with flapping movements was anatomically hardly possible. What it could do instead: climb, jump, possibly use short gliding phases to catch insects or evade predators.

The color that no one expected

What really made Anchiornis famous in science is not its anatomy — but its color. In 2010, a team led by Ryan Carney and Jakob Vinther published a study in the journal Nature that identified melanosomes — microscopic color pigment structures — in the fossilized feathers of Anchiornis and compared them with those of modern birds. The result was astonishingly specific: Anchiornis had a black-and-white body with red and orange accents on its head—a color pattern reminiscent of a modern woodpecker.

This was the first time in the history of paleontology that the color of a non-bird dinosaur could be reconstructed using scientific methodology. Not speculated — reconstructed. Based on fossilized cell structures that had survived for 160 million years. Anchiornis was colorful. And that fundamentally changed how science thinks about signaling, camouflage, and social communication in early bird ancestors.

Anchiornis lived around 10 million years before Archaeopteryx — the previous candidate for the earliest known bird precursor. This makes it older than the most famous transitional fossil in evolutionary history and raises the question of whether the evolution of birds began earlier than long assumed.

Anchiornis was crow-sized, weighed as much as an apple - and has given science more information about the origins of birds than animals a thousand times its size.

Anhanguera

Anhanguera blittersdorffi — Cararajou & Price, 1987

- 🦣 **Period:** Early Cretaceous — about 112 to 100 million years ago
- 🦣 **Size:** Wingspan approximately 4 to 4.5 m
- 🦣 **Weight:** Estimated 10 to 20 kilograms
- 🦣 **Life expectancy:** Unknown
- 🦣 **Diet:** Fish-eater — Hunts over open waters
- 🦣 **Lifestyle:** Probably solitary or in loose groups; marine environment
- 🦣 **Speed:** Flight speed estimated at 30 to 50 km/h
- 🦣 **Habitat:** South America — coastal waters and open seas of present-day Brazil

One thing is clear: Anhanguera was not a dinosaur. He was a pterosaur - a flying reptile that lived at the same time as the dinosaurs and shares the same ancestral group, but represents a separate evolutionary line. The kinship is real, the equation would be wrong. Pterosaurs were the first vertebrates ever to develop active flight — and Anhanguera was one of the most successful representatives of this group in the early Cretaceous period.

The name comes from Tupi, an indigenous language of Brazil, and means "old devil"—a reference to the distinctive, slightly eerie appearance of this animal. The first fossil was discovered in 1985 in the Santana Formation in northeastern Brazil, one of the world's most significant sites for pterosaur fossils. The Santana Formation formed in a shallow, warm inland sea during the early Cretaceous period — ideal conditions for the fossilization of flying reptiles, whose fragile hollow bones are rarely preserved elsewhere. 17 specimens are known today, making Anhanguera one of the best-documented pterosaurs of its era.

Anhanguera belongs to the family Anhangueridae within Ornithocheiroidea — large, marine-dwelling pterosaurs with specialized fish-hunting adaptations. With a wingspan of four to four and a half meters, it was a medium-sized representative of this group, significantly smaller than the late Cretaceous Quetzalcoatlus, but large enough to hunt effectively over open waters.

Built for hunting over water

What anatomically distinguishes Anhanguera is its skull. Long, narrow, with numerous sharp, slightly forward-leaning teeth — clearly designed for grasping fish, not for crushing hard food. At the tip of the snout, both above and below, Anhanguera bore a bony knob — a thickening whose exact function is debated. Possible explanations range from aerodynamic stabilization when dipping the snout into the water to a signaling organ for species recognition.

The hunting style was probably similar to that of modern frigatebirds or gannets: Anhanguera flew low over the water's surface, spotted fish in the shallow coastal area or at the surface, and struck quickly with its beak. The so-called skim-feeding — skimming the water surface in flight, as modern skimmers do — has also been discussed for Anhanguera, but is considered less likely. The arrangement of the teeth and the geometry of the skull are more suited to a targeted plunge diver than to a surface skimmer.

The hollow bones of Anhanguera — like all pterosaurs, extremely thin-walled and air-filled — kept the body weight to a minimum despite the considerable wingspan. Estimates range from ten to twenty kilograms. That is less than a house cat - for an animal with the wingspan of a

small glider, a remarkable lightweight construction that made active endurance flight over open waters possible.

What separates pterosaurs from dinosaurs

Anhanguera is a good opportunity to clarify a common misconception. Pterosaurs are often referred to as flying dinosaurs — they weren't. Dinosaurs are defined by their upright posture and a specific hip joint structure, which pterosaurs do not share. Both groups belong to the Archosauria, a larger group of reptiles, but they split evolutionarily as far back as the Triassic. Pterosaurs developed their flight independently of the ancestors of birds — a parallel experiment in evolution that was successful for over 150 million years and ended with the mass extinction 66 million years ago.

What came after Anhanguera were larger, increasingly specialized pterosaurs of the Late Cretaceous. Its own line ended sometime in the Cenomanian, around 100 million years ago — long before the big extinction. What pushed him out, or whether his line simply transitioned into other forms, is not known.

Anhanguera was neither a dinosaur nor a bird — but rather the result of a completely independent evolutionary experiment with flying, which functioned over the open seas of the Cretaceous period like hardly anything before.

Apatosaurus

Apatosaurus ajax — Marsh, 1877

🦣 **Period:** Late Jurassic — approximately 152 to 151 million years ago

🦣 **Size:** Approximately 21 to 23 m long, approximately 4 to 5 m hip height

🦣 **Weight:** Estimated 20 to 35 tons

🦣 **Life expectancy:** Probably 70 to 100 years Diet: Herbivore — ferns, horsetails, conifers, cycads

🦣 **Lifestyle:** Probably in small herds or family groups

🦣 **Speed:** Estimated 9.3 to 12.4 miles per hour

🦣 **Habitat:** Western North America — floodplains and river landscapes of the Morrison Formation

Hardly any other dinosaur has a more confusing name history. Anyone who read books about dinosaurs as a child probably knows it as Brontosaurus — the thunder lizard, one of the most evocative names in all of paleontology. Then science came along and declared: Brontosaurus does not exist, it is Apatosaurus, the name was a mistake. Decades later, the next twist followed: Brontosaurus may have been a separate genus after all. Today, Brontosaurus is once again considered valid in a limited sense — but that doesn't change the fact that Apatosaurus ajax, named by Othniel Charles Marsh in 1877, remains the older and scientifically established name. One animal, two names, a century of controversy. Welcome to the world of dinosaur taxonomy.

Behind the confusion over names lies a simple oversight that grew into one of the most famous errors in the history of science. In 1879, just two years after Apatosaurus, Marsh himself described another skeleton and named it Brontosaurus excelsus. It later turned out that both animals belonged to the same genus — and according to the rules of zoological nomenclature, the older name applies. Brontosaurus was thus officially a so-called junior synonym and disappeared from textbooks. What remained was a certain sadness for a name that had become more deeply engraved in cultural memory than almost any other dinosaur name. A 2015 study by Emanuel Tschopp and

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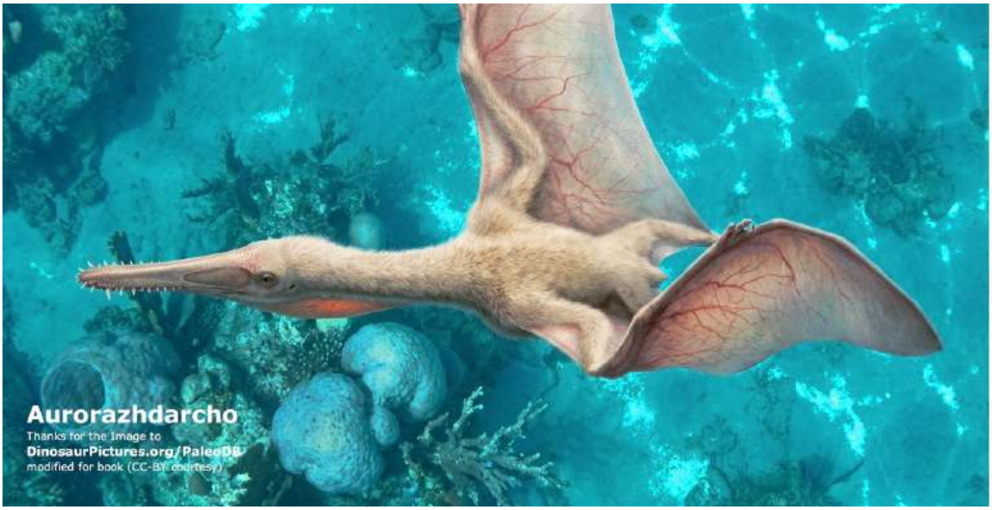
colleagues, published in the journal PeerJ, concluded that the differences between the known specimens could be large enough to justify Brontosaurus as a separate genus after all. The debate continues.

Apatosaurus itself was an animal of impressive proportions. With a length of 21 to 23 meters and an estimated weight of 20 to 35 tons, it was one of the heaviest land animals of the Jurassic period. Not the longest sauropod, not the tallest — but one of the most massive. Compared to the more slender Diplodocus, its close relative from the same formation, Apatosaurus appears downright stocky: broader bones, a stronger neck, a more robust overall build. An animal that relied not on elegance, but on sheer substance.

The tail as a sonic weapon

The tail of Apatosaurus is long, thin, and tapers to a thread-like tip — a design that Apatosaurus shares with other diplodocids and that has fueled a fascinating hypothesis for decades. Philip Currie of the Royal Tyrrell Museum and other researchers have calculated that such a tail, whipped with enough momentum, could break the sound barrier. The bang would have been loud — comparable to a gunshot. Whether Apatosaurus actually used this tail as an acoustic signal, to defend itself against predators or to communicate with conspecifics, has not been proven. But physics suggests that it could have done so.

Apatosaurus had another option for defending itself against predators: its sheer weight. Allosaurus, the largest predatory dinosaur in its ecosystem, weighed a maximum of two to three tons — one-tenth of what a fully grown Apatosaurus weighed. A frontal attack on a healthy



adult animal would have been a life-threatening undertaking for Allosaurus. Young and weakened animals were certainly vulnerable, but the adult Apatosaurus had little to fear as long as it remained on its feet.

The Morrison Formation, where almost all known Apatosaurus fossils come from, is one of the most fossil-rich areas in the world. It covers large parts of what is now Colorado, Utah, Wyoming, and Montana and has yielded Brachiosaurus, Diplodocus, Allosaurus, Stegosaurus, and dozens of other species in addition to Apatosaurus. The ecosystem of the late Jurassic period in North America was extraordinarily rich in species — and Apatosaurus was one of the most common large herbivores of all. Fossil finds suggest that it lived in groups, possibly in small family units, which roamed the river landscapes together and ate what the Jurassic had to offer: ferns, horsetails, conifers, and cycads.

What Apatosaurus really ate — and how

Apatosaurus' teeth were pencil-shaped and thin — completely unsuitable for chewing hard plant material. This meant that Apatosaurus did not chew. It plucked vegetation and swallowed it whole.

The actual digestive work was done by a massive, fermenting stomach, possibly aided by swallowed stomach stones, known as gastroliths, which mechanically crushed the plant material. Given the sheer amount of food that an animal of this size needed every day, this system must have been astonishingly efficient.

How much Apatosaurus ate each day can only be estimated. Models based on the energy requirements of modern large mammals and applied to sauropods arrive at quantities of several hundred kilograms of plant matter per day — although the exact figure depends heavily on whether one assumes a warm-blooded or cold-blooded metabolism. Research in recent decades clearly points toward an active, warm-blooded metabolism, which significantly increases daily requirements. For Apatosaurus, eating was not an occasional pastime, but a full-time occupation.

The skeleton of Apatosaurus louisae — a second, slightly smaller species of the same genus — at the Carnegie Museum of Natural History in Pittsburgh is considered one of the most beautiful and complete sauropod skeletons in the world. It was assembled in 1915 and remains one of the museum's highlights to this day. Anyone who sees it immediately understands why this dinosaur, regardless of its name, has captured the imagination of humans for almost 150 years.

Apatosaurus was the dinosaur with two names, a whip-like tail, and a body so massive that even the largest predator of its time thought twice — a silent giant that made the Jurassic earth tremble with every step.

Archaeopteryx

Archaeopteryx lithographica — Meyer, 1861

🦣 **Period:** Late Jurassic — about 152 to 149 million years ago

🦣 **Size:** Approximately 50 cm long, about 20 cm at the hip height

🦣 **Weight:** Approx. 260 grams — about as heavy as a pigeon

🦣 **Life expectancy:** Presumably 5 to 10 years

🦣 **Diet:** Insectivorous; possibly also small lizards and invertebrates

🦣 **Lifestyle:** Probably solitary; near the ground or climbing

🦣 **Flight ability:** Limited — short upward flights, followed by gliding phases

🦣 **Habitat:** Europe — coastal landscapes and lagoons of present-day Bavaria and Baden-Württemberg

No fossil has occupied science as much as Archaeopteryx. No other find came at a more opportune moment - in 1860, just a year after the publication of Darwin's work on the origin of species, an imprint appeared in the Solnhofen limestone of Bavaria, which was immediately interpreted as evidence of gradual evolution. An animal with bird feathers and dinosaur bones. Science responded with the term missing link — and has since repeatedly redefined it.

Hermann von Meyer described Archaeopteryx lithographica in 1861 based on a feather imprint; the first complete skeleton followed shortly thereafter and ended up in the Natural History Museum in London, where it is still kept today. The name refers to the place of origin: Lithographica for the lithographic limestone of Solnhofen, whose fine-grained sediments formed in a shallow lagoon world of the late Jurassic and preserved soft tissues with a level of detail that is hardly possible elsewhere. More than a dozen specimens are now known - all from the same geological horizon in Bavaria, with one exception from Spain.

With a body weight of 260 grams and a length of about 50 centimeters, Archaeopteryx was the size of a pigeon. What it had: real feathers, a furcula — the collarbone of birds — and a brain whose endocast shows an exceptionally well-developed visual region for its time. What it didn't have: the hollow, pneumatic bones of modern birds, a true bird beak, and feet that would have allowed for a secure grip on branches. Its toes were not designed to grasp branches — a feature that fundamentally distinguishes it from modern songbirds.

Half dinosaur, half something new

The reptilian features of Archaeopteryx are clear and numerous. Teeth in the jaw — no modern bird has teeth. A long, bony tail made up of individual vertebrae — modern birds have a short, stubby tail. Claws on the wings. A skull structure closely related to small theropods like Deinonychus and Velociraptor. Anyone seeing the skeleton without feathers would recognize a small theropod, not a bird.

The wings could not be raised above the horizontal — an anatomical limit that severely restricted active flapping flight. Short upward flights, followed by gliding phases, are the most likely movement pattern. Whether Archaeopteryx launched from elevated positions - rocks, trees, coastal cliffs - or from the ground is debated. The lagoon world of Solnhofen offered few trees, but rocks and elevated coastal formations that could have served as launch pads.

Vision was remarkable. Analyzes of the brain imprint, published by, among others, Naturalis Biodiversity Center in Leiden, show optical lobes of a size that is significantly above what would be expected in contemporary reptiles. Archaeopteryx had good vision - possibly as good as modern raptors. In a hunt for insects and small prey in a complex coastal landscape, this was a decisive advantage.

First bird or last dinosaur?

The question of whether Archaeopteryx is the first bird or a feathered non-bird dinosaur has been reexamined in the scientific community for decades. With the discovery of Anchiornis, Xiaotingia, and other feathered theropods from the Middle Jurassic of China—older than Archaeopteryx—he lost his status as the earliest bird ancestor. An analysis published in Nature in 2011 by Xu Xing and colleagues temporarily placed Archaeopteryx outside of birds, which sparked significant debate. Subsequent studies have come to different conclusions. The debate is ongoing.

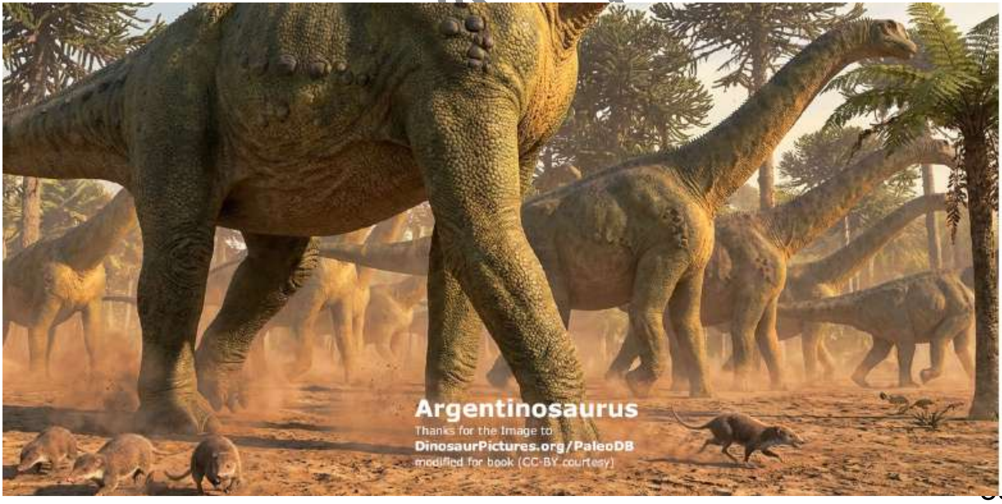
What is certain: Archaeopteryx is not a starting point, but a data point — an extraordinarily well-preserved fossil in a phase of bird evolution that was significantly more complex and branched than the image of a single missing link suggests.

Archaeopteryx was neither the first bird nor the last dinosaur — but rather the most precise moment that the fossil record has provided us of one of the greatest transitions in evolutionary history.

Argentinosaurus

Argentinosaurus huinculensis — Bonaparte & Coria, 1993

- 🦣 **Period:** Late Cretaceous — about 96 to 92 million years ago (Cenomanian to Turonian)
- 🦣 **Size:** Estimated 30 to 40 m long, about 7 to 8 m at the hip height
- 🦣 **Weight:** Estimated 70 to 80 tons — possibly more
- 🦣 **Life expectancy:** Presumably 70 to 100 years; growth presumably lifelong
- 🦣 **Diet:** Herbivore — coniferous trees, tree ferns, high tree canopies
- 🦣 **Lifestyle:** Probably solitary or in small groups
- 🦣 **Speed:** Estimated 5 to 10 km/h
- 🦣 **Habitat:** South America — open landscapes and river plains of the province of Neuquén, Argentina



There are animals where the numbers alone tell the story. Argentinosaurus huinculensis is one of them. A single vertebra — 1.59 meters tall. A shinbone measuring 1.55 meters in length. A body length, depending on the reconstruction, between 30 and 40 meters. A weight that was probably between 70 and 80 tons and possibly more. Argentinosaurus is the number one candidate for the heaviest land animal to have ever lived — and that is based on a single, fragmentary specimen.

José Bonaparte and Rodolfo Coria described Argentinosaurus in 1993 based on finds from the Huincul Formation in the Argentine province of Neuquén—a geological unit that has proven to be one of the most significant sites for titanosaurs worldwide over the past three decades. The material is fragmentary: some dorsal and sacral vertebrae, a tibia, parts of the ribs. No skull, no complete neck, no tail. What is missing is therefore significant — and that is precisely what makes all size estimates extrapolations that must be treated with appropriate caution.

Argentinosaurus belongs to the group of Titanosauria, that Late Cretaceous line of sauropods that was present on almost all continents and produced the largest land animals in Earth's history. In South America, this group reached its most extreme forms — Patagotitan mayorum, described in 2017, and Argentinosaurus have since competed for the title of the heaviest known dinosaur, without the data allowing for a definitive decision.

The problem with superlatives

Referring to Argentinosaurus as the largest animal in Earth's history is tempting — and scientifically problematic. The only known specimen is too fragmentary to provide precise body measurements. All estimates are based on comparisons with better-preserved relatives, allometric formulas, and the assumption that the preserved bones are representative of the entire animal.

What the known vertebrae show is clear: Argentinosaurus was exceptionally large. The vertebrae belong to the largest known vertebrae of a land animal ever. A 2014 biomechanical study published in PLOS ONE by William Sellers and colleagues from the University of Manchester reconstructed the gait and movement of Argentinosaurus using computer modeling and concluded that the animal could reach a walking speed of about eight kilometers per hour at full load—meaning its full body weight—before the stress on its bones and muscles became critical. Faster was simply not possible for an animal of this mass without risking structural damage.

Argentinosaurus — Image by Gürkan Özsoy from Pixabay

The question of whether Argentinosaurus grew throughout its life is biologically plausible. Bone histological studies on related titanosaurs show no clear growth stops - the growth rings become closer together with age, but a complete stop to growth is not evidenced. An animal that never stops growing and lives to be 70 to 100 years old ultimately reaches dimensions that exceed any intuitive conception.

Predators and Prey in Neuquén

What hunted Argentinosaurus — or rather: what hunted Argentinosaurus? In the Huincul Formation, Mapusaurus roseae, a large Carcharodontosaurid, lived at the same time, which was described in a 2006 study by Rodolfo Coria and Philip Currie in the journal Geodiversitas, based on a bonebed that contained several individuals of different age classes. The hypothesis: Mapusaurus hunted in packs — and Argentinosaurus was possibly the target.

An adult Argentinosaurus weighing 80 tons was untouchable for any single predator. But hatchlings, vulnerable for years after hatching from eggs before reaching the safety of their size, were exposed. And even an adult animal that was weakened or injured could become the target of a coordinated group of large theropods. It is an encounter for which there is no direct fossil evidence — but the ecological logic is compelling.

Argentinosaurus hat hat Eier gelegt - wie alle Dinosaurier. That means: An animal that weighed 80 tons as an adult began its life weighing a few kilograms. The growth from egg to adult was one of the most extreme changes in body mass that evolution has ever produced.

Argentinosaurus is the superlative that paleontology cannot fully substantiate and yet cannot ignore — too big for safe statements, too impressive for restraint.

Aurorazhdarcho

Aurorazhdarcho micronyx — Frey et al., 2011

🦣 **Period:** Late Jurassic — about 152 to 145 million years ago (Tithonian)

🦣 **Size:** Wingspan approximately 60 to 80 cm — very small pterosaur

🦣 **Weight:** Estimated 50 to 150 grams

🦣 **Diet:** Fish-eater — Hunts over coastal waters and lagoons

🦣 **Lifestyle:** Probably solitary; marine environment

🦣 **Habitat:** Europe — coasts and lagoons of present-day Bavaria, Germany

First, the usual clarification: Aurorazhdarcho was not a dinosaur, but a pterosaur — a flying reptile that lived at the same time but belongs to a separate evolutionary line. The relationship to dinosaurs is real, the equation would be wrong.

Aurorazhdarcho micronyx was described in 2011 by Eberhard Frey and colleagues from the State Museum of Natural History in Karlsruhe — based on a single specimen from the Solnhofen limestone in Bavaria. The same site that provided Archaeopteryx and is known for its exceptional preservation quality. The name combines Aurora, the Latin word for dawn, with Azhdarcho - a Central Asian dragon figure that serves as a reference genus for this group in pterosaur taxonomy. Micronyx means small claw — a reference to the animal's noticeably small foot claws.

With an estimated wingspan of 60 to 80 centimeters, Aurorazhdarcho was a decidedly small representative of the Azhdarchoidea—a group that would later include giants like Quetzalcoatlus. Between this palm-sized Jurassic pterosaur and the airplane-sized Quetzalcoatlus of the late Cretaceous, there are not only 80 million years of evolution but also a body size difference that could hardly be more incredible.

An early azhdarchoid — and what that means

The taxonomic classification of Aurorazhdarcho is scientifically the most interesting aspect of this animal. Azhdarchoidea were long considered typical of the Cretaceous period — a late development among the pterosaurs, which only truly flourished after the Jurassic. Aurorazhdarcho pushes this origin story back significantly. An azhdarchoid in the late Jurassic, in the Solnhofen lagoons, means that this line emerged earlier than previously thot — and that the diversification of pterosaurs in the Jurassic was more complex than the fossil record long suggested.

Little can be said with certainty about the lifestyle and behavior of a single specimen. The body size and marine environment suggest fishing in shallow coastal waters — small, agile prey that a light, small pterosaur could efficiently hunt. The reduced foot claws suggest that Aurorazhdarcho spent little time on the ground or in trees — a flying creature that was primarily in the air or over water.

More than that, the material does not allow. One specimen, one location, one formation. Aurorazhdarcho is a data point in a story that still has many gaps — but a data point that has pushed back the origin of one of the most successful groups of Cretaceous pterosaurs by several million years.

Aurorazhdarcho was tiny, rare and long unknown - but its mere existence in the late Jurassic forced science to rewrite the origin story of one of the most successful groups of flying reptiles.

Aurornis

Aurornis xui — Godefroit et al., 2013

🦣 **Period:** Middle Jurassic — about 168 to 161 million years ago

🦣 **Size:** Approximately 50 cm long

🦣 **Weight:** Estimated 100 to 200 grams

🦣 **Life expectancy:** Presumably 5 to 10 years

🦣 **Diet:** Carnivore — insects, small vertebrates, invertebrates

🦣 **Lifestyle:** Probably ground-dwelling; solitary

🦣 **Speed:** Unknown; likely swift due to its size

🦣 **Habitat:** Asia — terrestrial landscapes of present-day Hebei Province, China

Aurornis is one of those dinosaurs that are significant not because of their size or teeth, but because of their age. At an estimated 168 million years old, Aurornis xui may be older than Archaeopteryx - and a serious contender for the title of the earliest known bird ancestor. A title that never stays with the same animal for long in paleontology.

Pascal Godefroit from the Royal Belgian Institute of Natural Sciences and colleagues described Aurornis in 2013 in the journal Nature. The name is a tribute: Aurora is the Latin goddess of dawn - a poetic reference to the early phase of bird evolution that this animal represents. The species epithet xui honors Xu Xing, the Chinese paleontologist who has described more feathered dinosaurs than any other researcher worldwide and whose work has fundamentally shaped the modern view of bird ancestry.

Only a single specimen is known, found in the Tiaojishan Formation in Hebei Province — the same site from which Anchiornis was also discovered. The preservation quality of this formation is exceptional: fine-grained volcanic ash sediments that preserve feathers, bones, and occasionally soft tissues. Whether the specimen actually comes from this formation or from the private fossil trade in China, which would make its stratigraphic classification less certain, has been discussed in the literature — a problem that affects several Chinese dinosaur finds and complicates dating.

Older than Archaeopteryx — but what does that mean?

The phylogenetic analysis by Godefroit and colleagues placed Aurornis at the base of the Avialae — the group that includes all true birds and their closest non-bird relatives. Thus, Aurornis would not only be older than Archaeopteryx, but also more primitive in terms of evolutionary history — a more direct ancestor of today's birds than the famous Bavarian fossil.

This classification is not undisputed. Phylogenetic analyzes of feathered micro-theropods from the Middle Jurassic are methodologically challenging: The animals are anatomically very similar to each other, the features that distinguish them are often subtle, and the fossil record is fragmented enough that small changes in the data matrix can lead to significantly different phylogenetic trees. Aurornis could be an early bird. It could also be a close relative of the bird line, without being directly part of it. One single specimen is not enough to answer this question definitively.

What the specimen shows: a small, lightly built animal with long hind legs, short forearms, and a body proportion reminiscent of Anchiornis. Feathers are hinted at in the preservation, but less clearly documented than in other animals from the same formation. Teeth were present — not a modern bird feature, but perfectly normal for this stage of bird evolution.

Aurornis lived at a time when the separation between feathered dinosaurs and true birds was not yet a clear line, but a continuum of small evolutionary steps. It joins Anchiornis, Xiaotingia and Epidexipteryx - all small, feathered Jurassic theropods from China, which together paint a picture of early bird evolution that was much older, much more diverse and much less linear than the classic picture of Archaeopteryx as a lone waymarker suggested.

Aurornis may be the oldest known bird ancestor - a 168 million-year-old creature that shows how far back the roots of birds go in the Jurassic, and how little a single fossil can tell the whole story.

Austroraptor

Austroraptor cabazai — Novas et al., 2008

🦣 **Period:** Late Cretaceous — about 70 to 66 million years ago (Maastrichtian)

🦣 **Size:** Approximately 5 to 6 meters long, about 1.5 meters at the hip height

🦣 **Weight:** Estimated 200 to 300 kilograms

🦣 **Life expectancy:** Probably 20 to 25 years

🦣 **Diet:** Carnivore — likely fish and medium-sized prey animals

🦣 **Lifestyle:** Probably solitary

🦣 **Speed:** Estimated 35 to 50 km/h

🦣 **Habitat:** South America — river plains and coastal landscapes of present-day Río Negro Province, Argentina

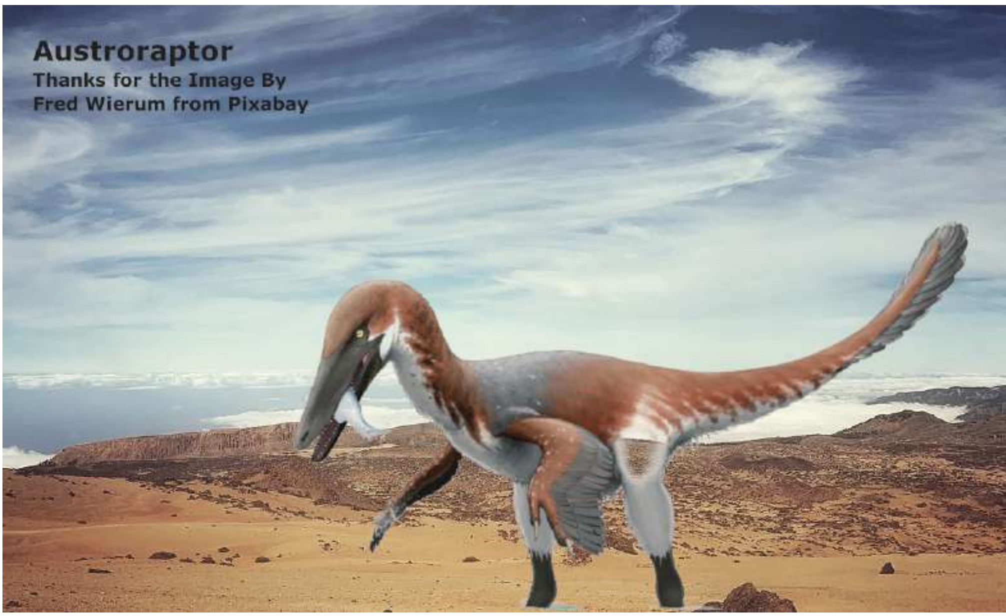
The dromaeosaurids—the family of sickle-clawed theropods that includes Velociraptor and Deinonychus—were present on almost all continents during the Late Cretaceous. In South America, they evolved in a direction no one expected: bigger, more robust, and with a snout shape reminiscent of Spinosaurus — not Velociraptor. Austroraptor cabazai is the most striking evidence that evolution on isolated continents can take its own path.

Fernando Novas from the Museo Argentino de Ciencias Naturales in Buenos Aires and colleagues described Austroraptor in 2008 based on two specimens from the Allen Formation in the province of Río Negro — a site that has yielded several significant South American dinosaurs in recent decades. The name means southern thief - geographically precise, factually correct.

At five to six meters in length, Austroraptor was one of the largest known dromaeosaurids in South America and one of the largest in this family worldwide. For comparison: Velociraptor reached just under two meters. Austroraptor was three times as long — a dromaeosaurid in a size class that did not exist in North America and Asia.

A snout that stands out

The most anatomically striking feature of Austroraptor is its skull. While most dromaeosaurids have short, high snouts with large, backward-curving fangs, the snout of Austroraptor was long, narrow, and low — with small, conical teeth designed not for tearing flesh but for grasping smooth, slippery prey. Fish, most likely. The same dental morphology that indicates fish-catching in Spinosaurus and Baryonyx is found here in a dromaeosaurid — a remarkable example of convergent evolution, where unrelated animals develop similar solutions under similar ecological pressures.



The Allen Formation, from which Austroraptor originates, was formed in a coastal and river landscape with access to open waters. Fish was plentiful. That Austroraptor utilized this resource is anatomically plausible — and would explain why it ended up in a niche so fundamentally different from its North American relatives.

The forearms were strikingly short — shorter than would be expected for dromaeosaurids, and significantly shorter than in Velociraptor relative to body size. What this meant for the hunting style is not definitively clarified. The characteristic sickle claw on the second toe was present — the definitive feature of dromaeosaurids, regardless of body size and geographical origin.

Two specimens are a narrow base. Much about Austroraptor remains open — social behavior, precise hunting strategy, growth rates. What the available bones show, however, is enough for a clear picture: a large, specialized predator at the end of the Cretaceous period, occupying an ecological niche in South America that no dromaeosaurid had ever reached elsewhere.

Austroraptor was a dromaeosaurid that ignored the rules of its family — bigger than most relatives, with a snout like a fish-eater and claws like a predator.

Bahariasaurus

Bahariasaurus ingens — Stromer, 1934

- 🦣 **Period:** Middle Cretaceous — about 112 to 94 million years ago (Cenomanian)
- 🦣 **Size:** Estimated 11 to 13 m long — Estimates vary widely
- 🦣 **Weight:** Estimated 4 to 6 tons
- 🦣 **Life expectancy:** Unknown
- 🦣 **Diet:** Carnivore — presumably large sauropods and other dinosaurs
- 🦣 **Lifestyle:** Probably solitary
- 🦣 **Speed:** Unknown; probably rather slow due to its size
- 🦣 **Habitat:** North Africa — terrestrial landscapes of present-day Egypt and Niger

Bahariasaurus is a dinosaur about which science knows almost nothing —and that's for a reason that has nothing to do with the quality of paleontology, but with World War II. Ernst Stromer von Reichenbach, the same German paleontologist who described Spinosaurus, unearthed the original fossils of Bahariasaurus ingens from the Bahariya Formation in Egypt in the 1910s — a river delta ecosystem of the mid-Cretaceous that would prove exceptionally rich in large predatory dinosaurs. The fossils were stored in the Paleontological Museum in Munich. On the nite of April 24 to 25. In April 1944, a British bombing raid destroyed the museum. The originals of Bahariasaurus — like those of Spinosaurus — were lost afterward. What remained were Stromer's descriptions, his drawings, and a name.

Five specimens are known in total, from Egypt and Niger — but none of them are complete, and none reach the quality that would allow for a reliable reconstruction. What Stromer described were mainly hip and leg bones, which indicated a very large animal. How big exactly, is still disputed today. Estimates range from eleven to thirteen meters in length — which would place Bahariasaurus in the category of the largest known theropods. But without complete skeletal material, these figures remain subject to significant uncertainty.

A predator without a face

The taxonomic classification of Bahariasaurus is unsatisfactorily open. Stromer classified it as a theropod, which is undisputed. To which family he belongs — whether he was an early tyrannosauroid, a carcharodontosaurid, or a representative of a completely different group — cannot be definitively determined from the available material. Some researchers have suggested that Bahariasaurus could be identical to Carcharodontosaurus, the large North African predatory dinosaur known from the same formation that may have surpassed T. rex in length. This synonymization has not held up — the differences in the bone material are real, even if they are subtle.

The Bahariya Formation, from which the Egyptian finds originate, was one of the most predator-rich ecosystems in dinosaur history during the mid-Cretaceous period. Spinosaurus, Carcharodontosaurus, and Bahariasaurus lived simultaneously in the same region — three large predators, each over ten meters long, in a single river delta ecosystem. How this worked without the species coming into direct competition is an open ecological question. They probably used different food sources and habitats: Spinosaurus the water, the others the land.

New excavations in the Bahariya Formation are difficult—the region is politically and logistically challenging, and the fossil trade has removed more material from North Africa in recent decades than science has been able to document. Bahariasaurus thus remains what it has been since 1944: a big name with a small data base, a puzzle from an ecosystem that is far from fully understood.

Bahariasaurus could have been one of the largest predatory dinosaurs to ever live — but the war destroyed the evidence, and what remains are drawings, fragments, and open questions.

Bakonydraco

Bakonydraco galaczi — Ösi et al., 2005

- 🦣 **Time period:** Late Cretaceous — approximately 86 to 84 million years ago (Santonian)
- 🦣 **Size:** Estimated wingspan of 3 to 4 m
- 🦣 **Weight:** Estimated 5 to 15 kilograms
- 🦣 **Diet:** Fish-eater; possibly also small vertebrates
- 🦣 **Lifestyle:** Presumably solitary Habitat: Europe — island landscapes of present-day Hungary

🦣 **Note:** Bakonydraco was not a dinosaur, but a pterosaur — a flying reptile of the Late Cretaceous that lived at the same time as the dinosaurs but belongs to a separate evolutionary lineage.

Attila Ösi of the Hungarian Natural History Museum and colleagues described Bakonydraco galaczi in 2005 based on a single specimen from the Csehbánya Formation in the Bakony region of western Hungary—after which the animal was named. The species name honors András Galácz, a Hungarian paleontologist. This is the first time a pterosaur from the Upper Santonian of Europe has been described—and to date, the only one of its kind from this region and this time period. The Csehbánya Formation formed in an island landscape. Late Cretaceous Europe was not a continuous continent, but an archipelago—a collection of islands of varying sizes, surrounded by shallow epicontinental seas. Bakonydraco lived on one of these islands, in a fauna shaped by island evolution: smaller forms, reduced species diversity, and distinct evolutionary lineages. The same site has also yielded Magyarosaurus—a dwarf sauropod that impressively demonstrates the principle of island dwarfism.

Bakonydraco belongs to the Azhdarchidae—the same family as the giant Quetzalcoatlus of the Late Cretaceous in North America. With an estimated wingspan of three to four meters, it was a medium-sized member of this family. What remains of the specimen is limited mainly to jaw material—a long, toothless lower jaw that suggests fishing or the capture of small vertebrates. Toothless jaws are typical of azhdarchids and indicate a hunting style in which prey was seized and swallowed whole, without being torn apart.

The material does not allow for further conclusions. A specimen consisting mainly of jaw fragments, from an island formation with limited fossil potential. Bakonydraco is scientifically significant as a biogeographic data point—evidence that azhdarchids also colonized the European archipelago during the Late Cretaceous—but as an individual, it remains largely shrouded in mystery.

Bakonydraco is a name, a jaw fragment, and biogeographic evidence—that is all the island world of Late Cretaceous Europe has left behind of this pterosaur.

Baryonyx

Baryonyx walkeri — Charig & Milner, 1986

🦣 **Time period:** Early Cretaceous — approximately 130 to 125 million years ago

🦣 **Size:** Approx. 7.5 to 10 m long, about 2.5 m at the hip

🦣 **Weight:** Estimated 1.2 to 1.7 tons

🦣 **Lifespan:** Presumably 20 to 30 years

- 🦣 **Diet:** Carnivore — primarily fish, possibly also small dinosaurs and carrion
- 🦣 **Lifestyle:** Presumably solitary; semi-aquatic
- 🦣 **Speed:** Estimated 20 to 30 km/h
- 🦣 **Habitat:** Europe and possibly Africa — riverine landscapes and coastal swamps of present-day England and Spain

In 1983, amateur paleontologist William Walker stumbled upon an unusually large bone in a clay pit in Surrey. What he had unearthed was a claw—31 centimeters long, curved, and heavy. The Natural History Museum in London subsequently sent a team to excavate the rest of the skeleton. What they found was a theropod that no one had expected: a large predatory dinosaur with the skull of a crocodile, teeth like a fish-eater, and a forelimb claw that gave the entire animal its name. Baryonyx — heavy claw. Alan Charig and Angela Milner of the Natural History Museum described it in 1986. The species name walkeri honors the man who found it. Nine specimens have since been discovered, from England and Spain, and possibly also from North Africa. The original English specimen is the most complete and provided the most information about its anatomy and way of life. What was preserved in its abdominal cavity immediately made clear what Baryonyx spent its time doing: scales and bones of fish of the genus Lepidotes—large, scaly freshwater fish of the Early Cretaceous—as well as the bones of a young Iguanodon. Baryonyx ate both.

A snout that explains it all

The skull of Baryonyx is the most distinctive feature of this animal. Long, narrow, with a slight bulge at the tip of the snout—almost identical to that of a modern gharial, the Indian crocodile species that has completely specialized in fishing. The teeth are conical and slightly curved backward, suited for grasping smooth, slippery prey—not for tearing flesh. The upper jaw had 32 teeth, the lower jaw 64, with a characteristic rosette at the tip of the snout that does not occur in this form in any other known theropod.

This anatomy is no coincidence. It is the result of evolutionary pressure that drove Baryonyx into an ecological niche that no other theropod of its time occupied so consistently: hunting along and in bodies of water. How it went about this—whether it stood in the water and snapped like a bear catching salmon, or whether it operated from the shore—cannot be directly proven. Both are plausible. Both fit the anatomy. The large front claw was a specialized tool. At 31 centimeters, it was significantly longer than the other claws and was located on the first finger of the hand—a hook with which fish could be pulled out of the water, similar to how bears do it today. It is possible that Baryonyx also used it to attack larger prey—the Iguanodon find in its stomach suggests that it fed opportunistically on whatever was available.

Relationship and Distribution

Baryonyx belongs to the family Spinosauridae—the same group that includes Spinosaurus and the South American Irritator. This family was present on several continents during the Early Cretaceous and developed similar adaptations everywhere to address the same ecological challenge: large bodies, fish-eating skulls, and specialized claws. Baryonyx is the best-documented European representative of this family and provided important clues as to what Spinosaurus itself might have looked like and how it might have lived—long before the groundbreaking finds from Morocco fundamentally changed our understanding of Spinosaurus.

The clay pit in Surrey, from which the original specimen comes, formed in a riverine and coastal marsh landscape of the Early Cretaceous—a habitat rich in fish, crocodiles, and other aquatic life. Baryonyx was not an occasional fisherman there, but a specialist who actively utilized this habitat and depended on it. How far it went into the water, whether it swam or waded, remains unclear. That it spent considerably more time at and in the water than most other theropods of its time is anatomically beyond doubt.

Baryonyx was discovered by an amateur fossil hunter, identified by a crocodile skull, and definitively classified by a fish found in its stomach —a dinosaur that revealed its secrets in the right order.

Bathyspondylus

Bathyspondylus saurophagus — Seeley, 1881

🦣 **Period:** Middle Jurassic — exact dating uncertain

🦣 **Size:** Unknown — only individual vertebrae known

🦣 **Diet:** Presumably carnivorous — fish, squid, possibly smaller marine reptiles

🦣 **Habitat:** Europe — marine environment, exact locality unknown

First, the usual clarification: Bathyspondylus was not a dinosaur, but a plesiosaur — a marine reptile that, although it lived during the time of the dinosaurs, belongs to a completely separate lineage. Plesiosaurs breathed air, likely gave birth to live young in the water, and dominated the seas of the Mesozoic in a way that had nothing to do with dinosaurs. Little can be said about Bathyspondylus itself—and that is no understatement. Harry Seeley, the British paleontologist, described the animal in 1881 based on isolated vertebrae. No additional material has surfaced to this day. No skull, no complete skeleton, no limb bones. What Seeley had was sufficient for naming—but it is not enough for a complete picture.

The name means "deep vertebra"—a reference to the morphology of the vertebrae, not to a specific depth at which it lived. The species name saurophagus means "lizard-eater," suggesting a carnivorous lifestyle, but this too is extrapolated from the fragmentary material.

The exact location where the fossils were found is not precisely documented in the literature—Europe is the only known geographical reference. The time period in which Bathyspondylus lived is also uncertain. Its classification in the Middle Jurassic is based on the rock formation from which Seeley's material originated, but without complete stratigraphic documentation, it is not confirmed.

Bathyspondylus is one of those animals listed in paleontology as nomina dubia—doubtful names based on material that does not allow for a reliable diagnosis. Whether the animal actually represents a distinct species or whether the vertebrae belong to an already known plesiosaur cannot be clarified without new material.

Bathyspondylus is a name, a few vertebrae, and an open question—that is all the sea has left behind of this animal.

Bradycneme

Bradycneme draculae — Harrison & Walker, 1975

Period: Late Cretaceous — about 70 to 66 million years ago (Maastrichtian)

Size: Unknown — only a single leg bone known

Diet: Unclear — originally classified as a raptor, now more likely classified as a small theropod

Habitat: Europe — Island landscapes of present-day Romania

Bradycneme draculae is one of those finds where the naming is more interesting than the scientific insight gained. The species name draculae refers to Dracula—not to the literary vampire, but to Vlad III, the Wallachian prince of the 15th century. century, whose homeland is the region where it was found. Caraș-Severin in Romania lies in the heart of historic Transylvania. Harrison and Walker, who described Bradycneme in 1975, were obviously guided by geographical romance.

What they described was a single lower leg bone — more precisely, a tibiotarsus, which is a fused lower leg and ankle bone. That's it. No skull, no vertebrae, no claws. On this basis, Harrison and Walker initially classified the animal as a giant owl — which had little persuasive power in the scientific community and was later revised. Today, Bradycneme is considered a likely theropod, possibly a maniraptor, but the data base is too thin for a secure classification.

The find region—the Hațeg Formation in Romania—is paleontologically significant. It formed in an island landscape of Late Cretaceous Europe, and has yielded several examples of island dwarfism: Magyarosaurus, a dwarf sauropod, and Telmatosaurus, a diminutive hadrosaurid, both come from the same formation. Whether Bradycneme was also an island form — smaller than its mainland relatives — cannot be deduced from a single bone.

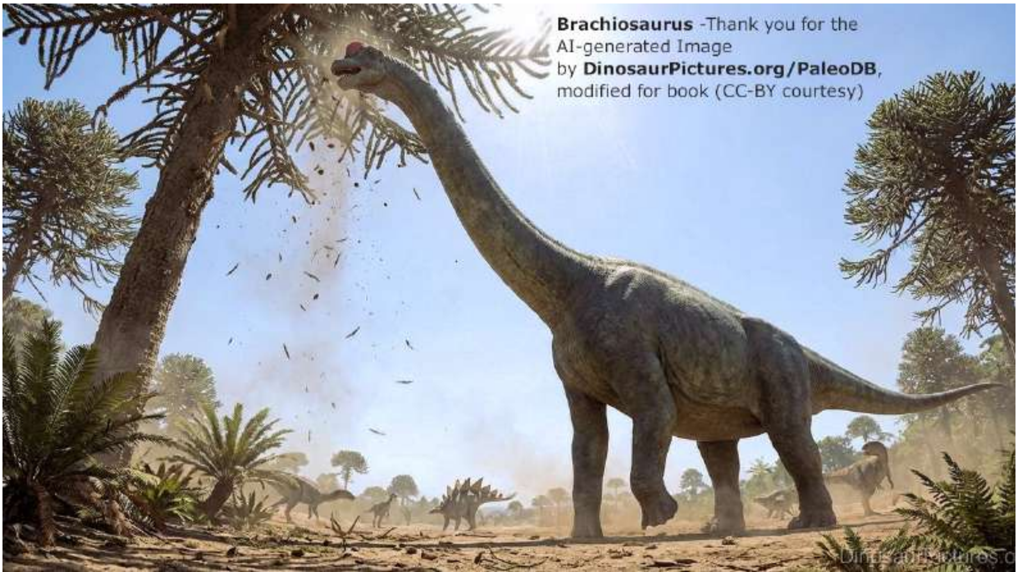
Bradycneme is listed in the literature as a nomen dubium. An animal based on a single bone cannot be reliably diagnosed — too many other theropods could have had the same bone. Without new material, that's how it will stay.

Bradycneme draculae is a bone, a vampire name, and an open question from late Cretaceous Transylvania — that's all science has so far.

Brachiosaurus

Brachiosaurus altithorax — Riggs, 1903

- 🦣 **Period:** Late Jurassic — approximately 154 to 150 million years ago
- 🦣 **Size:** Approximately 26 m long, approximately 9 to 13 m tall (head fully extended)
- 🦣 **Weight:** Estimated 30 to 60 tons
- 🦣 **Life expectancy:** Probably 80 to 100 years
- 🦣 **Diet:** Herbivore — conifers, ferns, ginkgos; preferred tree tops at high altitudes
- 🦣 **Lifestyle:** Probably in small herds or family groups
- 🦣 **Speed:** Estimated 15 to 20 km/h


Brachiosaurus -Thank you for the AI-generated Image by **DinosaurPictures.org/PaleoDB**, modified for book (CC-BY courtesy)

🦣 **Habitat:** Western North America — floodplains and woodlands of the Morrison Formation

Anyone who has ever stood in front of a mounted Brachiosaurus skeleton immediately understands why this dinosaur fascinates people. It is not its length that is so overwhelming — other sauropods were longer. It is its height. The head sits at the end of a neck that rises steeply like a living crane, reaching heights that even a modern truck driver would not see from the cab. Brachiosaurus was an animal that inhabited its own vertical world — a world that was simply unattainable for any other land animal of its time.

The name means "arm lizard," and it refers to its most striking anatomical feature: Brachiosaurus' front legs were longer than its hind legs — unusual among sauropods, where it is usually the other way around. This caused the torso to tilt slightly backward, allowing the neck to be raised even more steeply. The result was an animal that could reach treetops at a height of nine to thirteen meters, depending on how far it stretched its neck. No competitor fed up there. Brachiosaurus had this level of vegetation all to itself.

Brachiosaurus was discovered in 1900 by American paleontologist Elmer Riggs in the Morrison Formation in western Colorado. The first description followed in 1903. For decades, the skeleton in the Natural History Museum in Berlin — assembled from finds in the Tendaguru Formation in Tanzania and now mostly classified as a separate species, Giraffatitan brancai — was considered the Brachiosaurus par excellence. At 13.27 meters high, it is still the largest dinosaur skeleton on display in the world today. Anyone visiting Berlin should not miss this sight.

A neck as a model of success

The neck of Brachiosaurus was its central tool — and at the same time one of the most intensively discussed features in all of sauropod research. At an estimated eight to nine meters in length, it was longer than most other dinosaurs. The individual cervical vertebrae were lighter than they appear at first glance thanks to a sophisticated system of cavities and air sacs — a design principle also found in modern birds that keeps bones stable without making them unnecessarily heavy.

Whether Brachiosaurus permanently held its neck upright or kept it horizontal and only occasionally stretched it upwards has long been debated in paleontology. Recent biomechanical studies, including work by researchers led by Andreas Christian from the University of Flensburg, suggest that an upright posture was at least temporarily possible and probable — the skeleton was built for it, even if the energy expenditure was considerable. Similar to a giraffe today, Brachiosaurus probably used its neck depending on the situation: eating at the top when it was worthwhile; carrying it horizontally when at rest.

What it ate up there was mainly what the Jurassic period had to offer at high altitudes: conifers such as araucarias, ginkgo leaves, ferns, and possibly cycads. Flowering plants did not yet exist. The energy requirements of an animal of this size were enormous — estimates suggest that a fully grown Brachiosaurus had to consume several hundred kilograms of plant material every day to maintain its metabolism. Eating was therefore not a pastime, but the main job of this animal, from morning to night.

Warm-blooded, fast, and perhaps even caring

For a long time, the image of the sluggish, cold-blooded giant dinosaur that hardly moved and simply ate whatever was in front of it prevailed. This image is now outdated. Recent studies on growth rates in sauropods — as determined by growth rings in fossilized bones, similar to the annual rings of a tree — show that Brachiosaurus grew rapidly. According to research conducted at the Museum für Naturkunde Berlin, among other places, a young Brachiosaurus may have gained several tons of body mass in good years. That is not a cold-blooded growth rate — it requires an active, high-energy metabolism.

Whether Brachiosaurus cared for its young or at least raised them in herds cannot be determined directly from fossils. Evidence from trace fossils—i.e., fossilized footprints—shows that sauropods occasionally traveled in groups, with young animals not always walking on the outer edges, as is known from modern herd animals, but sometimes in the middle. This could indicate a certain protective behavior. It is not proof, but it is evidence that makes the image of the social sauropod more plausible.

An adult Brachiosaurus had little to fear from natural enemies in the Jurassic period in North America. Allosaurus, the dominant predatory dinosaur of its time, was simply too small, weighing up to three tons, to pose a serious threat to a healthy adult. Young animals, on the other hand, were vulnerable — and this is probably where the evolutionary pressure that led to herd behavior came from. Those who are too large to be hunted must nevertheless ensure that their offspring reach this stage first.

Brachiosaurus disappeared from the fossil record at the end of the Jurassic period, about 145 million years ago. What displaced it, or whether it simply evolved into other forms, has not been conclusively clarified. Its relatives, the Titanosauria, continued the line of giant sauropods until the end of the Cretaceous period — but none of them had this specific trick: a neck like a crane that reached into a world that was closed to all others.

Brachiosaurus ate where no other land animal of its time could reach — and built a neck that still impressively explores the limits of what is biologically possible.

Carcharodontosaurus

Carcharodontosaurus saharicus — Stromer, 1931

🦣 **Period:** Middle Cretaceous — approximately 99 to 94 million years ago (Cenomanian)

🦣 **Size:** Approx. 12 to 13 m long, about 3.5 to 4 m at the hip

🦣 **Weight:** Estimated 6 to 15 tons

🦣 **Lifespan:** Presumably 30 to 40 years

🦣 **Diet:** Carnivore — large sauropods, possibly also carrion

🦣 **Lifestyle:** Presumably solitary

🦣 **Speed:** Estimated 20 to 35 km/h

🦣 **Habitat:** North Africa — terrestrial landscapes of present-day Morocco, Algeria, Tunisia, Niger, and Egypt

Anyone who thinks T. rex is the largest predatory dinosaur has not yet encountered Carcharodontosaurus. With a length of up to 13 meters and a skull that surpassed that of T. rex in length, the “shark-toothed saur” — the literal translation of its name — was one of the heaviest and most dangerous land animals that ever lived. And yet it is far less well-known than its North American rival. The reason for this has less to do with the animal itself than with the war. Ernst Stromer von Reichenbach described Carcharodontosaurus in 1931 based on bones from Egypt that he had recovered from the Bahariya Formation in the 1910s. The original fossils were stored at the Paleontological Museum in Munich—until the night of April 24–25, 1944, when British bombers struck the museum and destroyed the collection. Stromer thus lost not only Carcharodontosaurus, but also Spinosaurus and Bahariasaurus in one fell swoop. What remained were his descriptions and drawings—and a name without evidence.

The fresh start came in 1996. Paul Sereno of the University of Chicago and his team recovered new skull fragments in Morocco that enabled a new description and definitively placed the animal among the ranks of the largest known theropods. Further discoveries in Niger, Algeria, and Tunisia—a total of 35 specimens—have since provided an increasingly complete picture.

Teeth like shark blades

The name is meant literally. The teeth of Carcharodontosaurus were flattened laterally, with fine serrations on both edges—identical in basic form to the teeth of a great white shark. Not built to crush bones, but to slice through flesh. A bite that didn't hold, but sliced—fast, deep, with maximum tissue damage. A different strategy than that of T. rex, which relied on raw biting force and bone crushing, but possibly just as effective in a world full of giant sauropods.

The skull was longer than that of T. rex—over 1.6 meters—but more lightly built, with large openings in the bone structure that saved weight without sacrificing stability. The brain was small relative to skull size, whereas the olfactory bulbs were well developed. Carcharodontosaurus likely located its prey using its sense of smell—over long distances, in the open semi-desert landscape of North Africa. Its primary prey consisted of the giant sauropods of its time—Paralititan stromeri, a titanosaur weighing possibly 70 tons, lived in the same ecosystem. Whether Carcharodontosaurus hunted alone or whether several animals occasionally gathered on the same prey is not documented. The tooth morphology suggests a hunter that delivered quick, deep bites and then waited—not a strangler, but a bleeder.

An Ecosystem Full of hunting Giants

The Bahariya Formation of the Middle Cretaceous in Egypt was an ecosystem that continues to fascinate and baffle paleontologists to this day. Carcharodontosaurus, Spinosaurus, and Bahariasaurus—three large predators, each over ten meters long—lived simultaneously in the same region. Three apex predators in a single river delta ecosystem: How this worked without them competing directly for food remains an open ecological question. The most likely answer lies in specialization. Spinosaurus was a fish-eater that utilized the waters. Carcharodontosaurus was a land hunter that preyed on sauropods. Bahariasaurus, about which we know the least, may have occupied a third niche. Three predators, three strategies—enough space in an ecosystem that, by today's standards, was virtually unmatched in biological productivity. Carcharodontosaurus belongs to the family Carcharodontosauridae, which also includes Giganotosaurus from Argentina and Mapusaurus from the same region. Giganotosaurus may have been slightly longer—estimates vary depending on the study. It is not conclusively clear which of the two was heavier. What is certain: This family produced the largest land predators in Earth's history—and Carcharodontosaurus was its North African representative, surpassing T. rex in length and matching it in brutality.

With 35 known specimens from five North African countries, Carcharodontosaurus is a comparatively well-documented animal—a remarkably solid data set for a giant of this magnitude.

Carcharodontosaurus was larger than T. rex, had teeth like a shark, and lived in an ecosystem so rich in predators that even experts still puzzle over how it all fit together.

Carnotaurus

Carnotaurus sastrei — Bonaparte, 1985

- 🦣 **Period:** Late Cretaceous — approximately 72 to 66 million years ago (Campanian to Maastrichtian)
- 🦣 **Size:** Approx. 7.5 to 9 m long, about 2.5 to 3 m at the hip
- 🦣 **Weight:** Estimated 1.3 to 2.1 tons
- 🦣 **Life expectancy:** Presumably 20 to 30 years
- 🦣 **Diet:** Carnivore — medium-sized to large prey, possibly specialized in fast hunting
- 🦣 **Lifestyle:** Presumably solitary
- 🦣 **Speed:** Estimated 40 to 56 km/h — possibly one of the fastest large theropods

🦣 **Habitat:** South America — open landscapes and semi-deserts of present-day Chubut Province, Argentina

A Tyrannosaurus with horns—that's how many describe it at first glance. That's not wrong, but it doesn't do it justice. Carnotaurus sastrei was so anatomically peculiar, so consistently geared toward a single strategy, that it stands out even among the already diverse South American theropods. Horns above the eyes, an extremely short and broad skull, forelimbs that would make even T. rex envious of its own—and legs built for speed like those of hardly any other large predatory dinosaur.

José Bonaparte of the Museo Argentino de Ciencias Naturales described Carnotaurus in 1985 based on a single specimen from the La Colonia Formation in the province of Chubut, Patagonia. This single skeleton, however, is exceptionally complete—and it yielded something rare in theropod research: extensive skin impressions. Impressions of the epidermis are preserved over large parts of the body, revealing a clear picture. No feathers, no scales in the classic reptilian sense—but rather a pattern of small, mosaic-like skin bumps interspersed with larger, conical humped scales at irregular intervals. Carnotaurus looked like something between a crocodile and a crab, at least as far as skin structure is concerned.

Carnotaurus belongs to the family Abelisauridae—a group of South American and Indian theropods that took a unique evolutionary path while tyrannosaurids dominated North America. Abelisaurids typically have short, tall skulls, greatly reduced forelimbs, and powerful hind legs. Carnotaurus took all these features to the extreme.

Horns without explanation—and arms without function

The two horns of Carnotaurus are the first thing that catches the eye. They were positioned directly above the eyes, were sturdy enough to withstand real pressure, and continued to grow with age. They were ill-suited as hunting weapons—their position above the eyes makes a targeted attack on prey anatomically difficult. An intraspecific function is more likely: fights between males, display behavior, species recognition. Whether the horns also served to intimidate competitors cannot be proven—but an animal facing you with two bony horns above its eyes is undoubtedly intimidating.

The forelimbs represent the other extreme. Smaller than those of T. rex—which is saying something—and so greatly reduced that the forearm has practically disappeared. Four fingers, barely movable, with no discernible muscle attachments for functional movement. Bonaparte himself wrote that these arms were most likely completely non-functional—true evolutionary vestigial structures on the path to complete atrophy. What this says about Carnotaurus's hunting strategy: It didn't need its arms. It handled everything with its skull and legs.

The fastest large predator?

Carnotaurus's hind legs are the most scientifically interesting aspect of this animal. A study by Pates and colleagues published in 2020 in the journal PLOS ONE analyzed the leg musculature based on the preserved bones and reached a surprising conclusion: Carnotaurus had exceptionally well-developed thigh muscles—specifically the caudofemoralis, the primary propulsive muscle in theropods—in a ratio to body size that is unique among large predatory dinosaurs. The estimate: a top speed of up to 56 km/h, possibly more during short sprints.

By comparison: T. rex is estimated to have reached a maximum of 25 km/h. Weighing less than a quarter as much, Carnotaurus was likely twice as fast—a specialist in high-speed chases across open terrain, catching up to its prey rather than ambushing it. The short, broad skull fits this profile: not designed for powerful, bone-crushing bites, but for fast, targeted attacks on unprotected body parts.

A single specimen remains a narrow basis for such far-reaching conclusions. But Carnotaurus's anatomy is so consistently geared toward speed—reduced forelimbs, powerful hind legs, a lightweight skull—that the image of the swift pursuer has more substance than many other hypotheses in paleontology.

Carnotaurus was an animal that shed everything it didn't need—arms, skull weight, complexity—and in doing so became faster than almost any other large predator of its time.

Centrosaurus

Centrosaurus apertus — Lambe, 1904

- 🦣 **Period:** Late Cretaceous — approximately 77 to 75 million years ago (Campanian)
- 🦣 **Size:** Approx. 5 to 6 m long, about 1.8 m at the hip
- 🦣 **Weight:** Approx. 1,080 kilograms
- 🦣 **Life expectancy:** Presumably 20 to 30 years
- 🦣 **Diet:** Herbivore — low vegetation, ferns, flowering plants

🦣 **Lifestyle:** Strongly gregarious — exceptionally well documented due to mass discoveries

🦣 **Speed:** Estimated 20 to 30 km/h

🦣 **Habitat:** Western North America — coastal plains and riverine landscapes of present-day Alberta and Saskatchewan

Centrosaurus is not the best-known ceratopsid — that title belongs to Triceratops. But in one category, it surpasses almost every other dinosaur: the quality and extent of the evidence for herd behavior. What was found in Dinosaur Provincial Park in Alberta is no ordinary bone bed—it is one of the densest accumulations of dinosaur bones ever excavated, and it tells a story that goes far beyond the anatomy of a single animal.

Lawrence Lambe of the Geological Survey of Canada described Centrosaurus apertus in 1904 based on finds from Alberta. Forty-six specimens have since been identified—an exceptionally high number for a ceratopsian, allowing for detailed insights into growth, variability, and population structure. The name means "pointed lizard," a reference to the distinctive nasal horn that distinguishes Centrosaurus from related species.

Centrosaurus belongs to the subfamily Centrosaurinae—the short-faced ceratopsids, typically characterized by a dominant nasal horn and a comparatively simple nuchal frill. The nasal horn of Centrosaurus was long, slightly curved forward or backward—depending on the individual and age—and significantly more robust than the brow horns, which remained small in this group. The nuchal plate bore small, hook-shaped bony spines along its edge and two larger, curved protrusions in the center—distinctive enough for species identification, but no match for the sweeping structures of Triceratops or Torosaurus.

A bone bed that made history

The Centrosaurus bone bed in Dinosaur Provincial Park has been the subject of intensive research for decades. Spanning an area of several hundred square meters lie the remains of hundreds, possibly thousands, of individuals—juveniles, adolescents, and adults intermingled, all of the same species. Phillip Currie of the Royal Tyrrell Museum, who led the excavations for many years, described it as one of the most impressive paleontological discoveries in North America.

The significance of this bone bed goes beyond merely confirming herd behavior. The age range of the individuals found—from newborns to elderly animals—suggests a mixed herd in which different generations migrated together. Geological analysis of the site shows signs of rapid burial by a flood—a deluge that swept up and killed an entire herd as it crossed a river. A single catastrophic moment that pressed hundreds of animals into the sediment at once, thereby preserving a snapshot of a living population.

Recent research, including a 2021 study by Mallon and colleagues published in the journal PeerJ, has examined the growth rates of Centrosaurus based on bone histology. The result: rapid growth in the early years of life, slowing after sexual maturity—a pattern reminiscent of large mammals and suggesting warm-blooded metabolism. Full body size was reached at around ten years of age.

Northern Laramidia and the Question of Provinciality

Centrosaurus lived in the northern part of Laramidia—the western peninsula of North America, which was separated from the east by the western inland sea. Styracosaurus and Coronosaurus, both closely related, lived in the same period and region. In the south of Laramidia, in present-day Utah and New Mexico, other ceratopsids such as Nasutoceratops and Utahceratops were found—similar in build but anatomically distinct.

This division into northern and southern faunas within the same continent is one of the most fascinating biogeographic puzzles of the Cretaceous. What separated north and south—climate zones, vegetation boundaries, river barriers—remains unclear to this day. Centrosaurus is a key data point in this debate: common, well-documented, and clearly located in northern Laramidia.

As a herbivore, Centrosaurus specialized in vegetation growing close to the ground. Its physique—low-set head, broad horned snout, powerful forelimbs—is consistent with an animal that grazed on ferns, flowering plants, and low shrubs. In a herd of possibly thousands of animals, the grazing pressure on the local vegetation was considerable—seasonal migrations, similar to those of modern wildebeests or caribou, are the obvious consequence.

Centrosaurus was not an animal of extremes—no record-breaker in size or armament—but no other dinosaur has given us such a direct glimpse into the life of a migrating herd as this unassuming horned creature from Alberta.

Ceratops

Ceratops montanus — Marsh, 1888

🦣 **Period:** Late Cretaceous — about 84 to 72 million years ago (Campanian)

🦣 **Size:** Unknown — only fragmentary material known

🦣 **Weight:** Unknown

🦣 **Diet:** Herbivore — low vegetation, probably similar to other ceratopsians

🦣 **Habitat:** Western North America — Montana and New Mexico

Ceratops montanus holds a special place in paleontology—not because it is well-documented, but because its name became one of the most influential in the entire science. Ceratops is the namesake of

Ceratopsia, the entire group of horned dinosaurs that includes Triceratops, Styracosaurus, Nasutoceratops and dozens of other species. A group that was among the most successful herbivores of the late Cretaceous — named after an animal about which we know very little.

Othniel Charles Marsh described Ceratops montanus in 1888 based on two fragmentary horn cores and some skull bones from Montana. That was little — and it has remained little to this day. No complete skeleton, no skull, no usable body bones. What Marsh had was enough for naming, but not for reconstruction. Ceratops montanus is now considered a nomen dubium — a dubious name based on material that does not allow for a reliable diagnosis compared to other ceratopsids.

The namesake of an entire group

What Ceratops itself was remains unclear. What its group was, is one of the most fascinating success stories in dinosaur history. Ceratopsia probably originated in Central Asia — the common ancestor of all horned faces lived there about 100 million years ago, but has not been found to this day. Via a land bridge that connected Asia and North America — the same route early humans would use millions of years later — ceratopsians migrated into North America, where they evolved into an extraordinary diversity.

What united all ceratopsians: a bony neck shield to protect the neck and throat, forward-facing horns in various arrangements, a sharp horned beak for cutting vegetation, and battery jaws for efficient chewing. The size range was enormous—from small, lightly built forms like Protoceratops to titans like Torosaurus, which, at up to 16 tons, was among the heaviest land animals of its time.

Herd behavior is evidenced in several ceratopsids thru bonebeds — Centrosaurus, Einiosaurus, Pachyrhinosaurus. They migrated in large groups, provided protection for young ones, and presented a united front against the threat posed by tyrannosaurids. The most dramatic evidence for ceratopsid-predator interactions is the famous Fighting Dinosaurs fossil from Mongolia: a Protoceratops and a Velociraptor, fossilized in a death embrace — direct evidence that ceratopsids actively fought against attackers.

Ceratops montanus itself remains a shadow—too fragmentary for definitive statements, too significant in name to be ignored. Whether new material will ever emerge that allows for a complete diagnosis is uncertain. Until then, its name stands over a whole group of remarkable animals - a placeholder for an ancestor that is still waiting to be properly found.

Ceratops montanus is little more than a name and two horn cores — but that name stands over one of the most successful dinosaur groups in Earth history.

Ceratosaurus

Ceratosaurus nasicornis — Marsh, 1884

Period: Late Jurassic — approximately 161 to 145 million years ago (Tithonian)

Size: Approx. 5.5 to 9 m long, about 2 to 2.5 m at the hip

Weight: Approx. 670 kilograms to about 1 ton

Life expectancy: Presumably 20 to 30 years

Diet: Carnivore — other dinosaurs, possibly also fish and carrion

Lifestyle: Presumably solitary

Speed: Estimated 25 to 40 km/h

Habitat: North America, Europe, Africa — riverine landscapes of the Morrison Formation, as well as Tanzania and Portugal

In 1884, Othniel Charles Marsh unearthed a theropod in Colorado that immediately attracted attention — not because of its size, but because of its face. A distinctive horn on the nose, two smaller bony ridges above the eyes, and a skull that, despite its predatory anatomy, had a somewhat strangely decorative quality. Marsh named it Ceratosaurus nasicornis — horned-nose lizard — and mounted the complete skeleton at the Smithsonian Institution, where it was one of the most viewed dinosaur skeletons in the world for decades.

Sixteen specimens have since been discovered, from Utah, Colorado, Portugal, and Tanzania. The African and European finds date to a time when Pangaea was already breaking apart, but the landmasses were still close enough together to allow for the exchange of fauna. Ceratosaurus was thus one of the last theropods with a truly intercontinental distribution.

Ceratosaurus lived at the same time as Allosaurus in the Morrison Formation—both predators, both large, both in the same riverine landscapes. Allosaurus was heavier and more common. Ceratosaurus was rarer and smaller, but anatomically more distinct. How the two predators interacted—whether they competed or preferred different prey—is not documented. Their fossils are occasionally found at the same sites—which makes competition likely, but says nothing about what that competition looked like.

Horn, back armor, and four fingers

What distinguished Ceratosaurus from almost all other theropods of its time was not the horn alone—it was the combination of several unusual features. Small bony plates, known as osteoderms, ran along the center of the body, protecting the softer tissue beneath. Such structures are completely absent in most theropods. In Ceratosaurus, they formed a kind of rudimentary back armor—possibly an evolutionary precursor to the more pronounced body armor that was fully developed in some Cretaceous dinosaurs.

The forelimbs bore four fingers—one more than the three that are standard in most theropods. This is a primitive characteristic that identifies Ceratosaurus as an evolutionarily older type. Allosaurus already had three fingers, T. rex only two. Ceratosaurus retained an anatomy that had long since been simplified in its relatives.

The nasal horn itself was sturdy enough to withstand mechanical pressure—yet it was ill-suited as a hunting weapon against large sauropods. A social function is more likely: intraspecific fighting, display behavior, species recognition. Whether the horn was more pronounced in males than in females cannot be determined from the available material.

Ceratosauridae — a distinct lineage

Ceratosaurus is not just a single animal, but the namesake of an entire family: the Ceratosauridae. This group represents an early branch within the theropods—closer to the original forms than the later Tetanurae, which include Allosaurus, Spinosaurus, and T. rex. This lineage later gave rise to the Abelisauridae—South American and Madagascan theropods such as Carnotaurus and Majungasaurus, which carried the same basic architecture into the Cretaceous period and became dominant predators there.

Ceratosaurus was thus not an evolutionary endpoint, but an intermediate step—a form that was successful in its own right and simultaneously provided the template for later developments. The fact that this lineage became so successful in South America and Madagascar, while the Tetanurae dominated North America and Asia, is related to continental drift: as the landmasses drifted apart, the relatives of Ceratosaurus continued to evolve independently on the southern continents.

What Ceratosaurus ate is not fully documented. The tooth morphology —laterally flattened, serrated teeth—suggests a broad prey spectrum. Some researchers have speculated that Ceratosaurus occasionally hunted fish as well, similar to Baryonyx—based on its frequent association with river sediments. This is not proven, but it is plausible.

Ceratosaurus was the theropod with the most ornate face of the Jurassic—a horn on its nose, armor on its back, four fingers on its hand—an animal that forged its own evolutionary path and thus laid the foundation for South American giants like Carnotaurus.

Ceratosuchops

Ceratosuchops inferodios — Barker et al., 2022

- 🦣 **Period:** Early Cretaceous — about 125 million years ago (Barremian)
- 🦣 **Size:** Approximately 8 to 9 meters long
- 🦣 **Weight:** Estimated 1 to 2 tons
- 🦣 **Life expectancy:** Unknown
- 🦣 **Diet:** Carnivore — likely fish, crocodiles, small dinosaurs
- 🦣 **Lifestyle:** Probably solitary; semi-aquatic
- 🦣 **Speed:** Unknown
- 🦣 **Habitat:** Europe — coastal swamps and river mouths of present-day southern England

Ceratosuchops inferodios is a dinosaur that was only discovered by science in 2022 — and in its description, it accomplished two things at once: It definitively proved for the first time that spinosaurids lived in Europe during the early Cretaceous period, and it showed that this group developed its own evolutionary lines on the continent, independent of its African and South American relatives.

Chris Barker from the University of Southampton and colleagues described Ceratosuchops in 2022 in the journal PeerJ, based on skull material from the Wessex Formation on the Isle of Wight — a site that has established itself as the most significant dinosaur site in Britain in recent decades. The name means "horned crocodile face, ambusher of the underworld" — a somewhat dramatic combination that refers to the crocodile-like snout shape and the presumed hunting style near water bodies.

Ceratosuchops belongs to the family Spinosauridae — the same group as Spinosaurus, Baryonyx, and Irritator. The relationship with Baryonyx, which was also found on the Isle of Wight and in mainland England, is particularly close. Both animals lived in the same coastal swamps and river deltas of early Cretaceous southern England — a habitat that was then similar to today's Mekong Delta: warm, humid, rich in fish and crocodiles.

The preserved skull shows a series of small hornlets and bony ridges above the eyes and along the snout—a feature reminiscent of modern crocodiles and possibly serving similar sensory functions. Pressure receptors in this region would have allowed Ceratosuchops to sense movements in the water and locate prey even without visual contact. In murky river water, a significant advantage.

More is not possible with the material known so far. Ceratosuchops is a recent find - research is still in its infancy.

Ceratosuchops has a name like a movie monster, and proves that the spinosaurids of Europe went their own way — right off the coast of what is now England.

Confuciusornis

Confuciusornis sanctus — Hou et al., 1995

🦣 **Period:** Early Cretaceous — about 125 to 120 million years ago (Barremian to Aptian)

🦣 **Size:** Approximately 50 to 60 cm long, wingspan about 60 to 70 cm

🦣 **Weight:** Estimated 150 to 200 grams

🦣 **Life expectancy:** Presumably 5 to 10 years

- 🦣 **Diet:** Herbivorous and granivorous — seeds, possibly also fish and insects
- 🦣 **Lifestyle:** Presumably in groups or colonies; arboreal
- 🦣 **Speed:** Capable of flight — active flier, better than Archaeopteryx
- 🦣 **Habitat:** Asia — forested landscapes around lakes in the present-day provinces of Liaoning, Hebei, and Inner Mongolia

Confuciusornis is not a dinosaur in the strict sense — it is a true bird, the oldest known bird with a true horn beak without teeth and with a modern pygostyle, that is, the short tail stub where the tail feathers sit in today's birds. Both together make it a significant step in bird evolution - more developed than Archaeopteryx, but still far from modern birds.

Hou Lianhai of the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing and colleagues described Confuciusornis sanctus in 1995 based on finds from the Yixian Formation in Liaoning Province. The name honors Confucius — the Chinese philosopher whose home region it is. What followed was a bonanza: thousands of specimens were recovered from the same layers, many of them in the private fossil trade, before the Chinese government began to regulate excavations more strictly. Confuciusornis is thus one of the most frequently found Mesozoic birds overall — providing exceptionally good insights into population structure, variability, and lifestyle.

The Yixian Formation was formed around lakes in a volcanically active landscape. Periodic volcanic eruptions killed off entire animal communities and covered them with fine ash — ideal conditions for the fossilization of feathers, soft tissue, and even stomach contents. Confuciusornis specimens show both: animals with long ornamental feathers on the tail and those without. This suggests sexual dimorphism — males with ornamental feathers, females without, or vise versa, similar to modern birds.

A toothless beak — what it means

The toothless beak of Confuciusornis is evolutionarily remarkable. Archaeopteryx still had teeth. Many later Cretaceous birds did too. Confuciusornis lost them early — and that has consequences for the understanding of bird evolution. Toothlessness apparently developed multiple times independently in bird history, not as a linear progression. Confuciusornis is an early evidence that the beak was not a late invention, but appeared early — and still did not immediately prevail.

What it ate is evidenced by preserved stomach contents in some specimens: fish bones, plant material, seeds. Confuciusornis was not a specialist, but a generalist — which makes more sense in a seasonally fluctuating lake ecosystem than narrow dietary specialization.

The ability to fly was significantly better developed than in Archaeopteryx. The pygostyle allowed for better control of the tail feathers, which increased maneuverability in flight. The shoulder anatomy allowed for a more complete wing stroke. Confuciusornis flew actively — not a glider, not a casual flier, but a true flying creature that used trees, lake shores, and open areas equally.

Mass gatherings of several hundred individuals at single locations suggest that Confuciusornis lived in colonies or large groups — possibly gathering seasonally at certain lake shores, similar to today's migratory birds at stopover sites. A social behavior that would be remarkable for a bird of this early evolutionary phase.

Confuciusornis already had a true beak, a modern tail, and flew better than its predecessors — thousands of its fossils show us a bird that had almost grasped evolution.

Corythosaurus

Corythosaurus casuarius — Brown, 1914

🦣 **Period:** Late Cretaceous — about 77 to 75 million years ago

🦣 **Size:** Approximately 9 to 10 m long, about 2 to 2.5 m at the hip height

🦣 **Weight:** Estimated 3 to 4 tons

🦣 **Life expectancy:** Presumably 20 to 30 years

🦣 **Diet:** Herbivore — leaves, needles, seeds, fruits, flowering plants

🦣 **Lifestyle:** Herd animal; social behavior well documented thru comb and find sites

🦣 **Speed:** Estimated 25 to 40 km/h

🦣 **Habitat:** Western North America — Coastal forests and river systems of present-day Alberta, Canada

Sometimes a name holds more than one might think at first glance. Corythosaurus means helmet lizard — named after the Corinthian helmet of ancient Greece, whose semicircular crest looks so similar to the headgear of this dinosaur that the comparison is immediately obvious at first glance at the skull. Barnum Brown of the American Museum of Natural History discovered and described Corythosaurus in 1914 based on finds from the Dinosaur Park Formation in Alberta — thus laying the foundation for one of the best-documented chapters in hadrosaurid research.

Corythosaurus casuarius

Corythosaurus was not an unusual dinosaur in the sense that it was extremely large or extremely armed or extremely fast. He was a medium-sized herbivore — nine to ten meters long, three to four tons heavy — in an ecosystem full of similarly built animals. What sets it apart is the quality of the fossils that have been preserved of it. Several nearly complete skeletons, including specimens with preserved skin impressions, have made Corythosaurus one of the best-understood hadrosaurids of all time. We know what its skin looked like. We know the internal structure of its comb in detail. And we have enough specimens of various ages to trace its development from juvenile to fully grown adult.

The skin impressions show a pattern of small, irregular scales — no fur, no feathers, but a textured surface similar to modern crocodiles, but finer. Color cannot be read from fossils. But the structure of the skin was complex enough that Corythosaurus would likely have been visually recognizable in a species-rich environment — especially in combination with the crest.

The helmet and its secret

The crest of Corythosaurus is semicircular, flat — when viewed from the side — and stands upright on the skull like an oversized bicycle helmet. Inside, the nasal passages loop long thru the crest before leading into the throat. This tube system was key to a capability that Corythosaurus shared with Parasaurolophus and Lambeosaurus: acoustic communication thru the crest.

David Weishampel of Johns Hopkins University and other researchers have analyzed the resonance system of Corythosaurus using computed tomography and created acoustic reconstructions. The fundamental tone that Corythosaurus could produce thru its crest was low and far-reaching — unlike that of Parasaurolophus, lower than a human bass voice but high enough to stand out from the ambient noise of a coastal forest. In a herd of several dozen or hundred animals, this sound was an effective means of communication: warning signals, contact calls, perhaps courtship calls during the mating season.

As for the shape of the comb, there is an important observation: it varied significantly between individuals. Some specimens have a high, well-developed crest—others, especially smaller animals, have hardly any trace of one. For a long time, these differences were interpreted as species differences, leading to a confusing variety of Corythosaurus species in the early literature. Today, it is clear that these are age and probably sexual differences. Males with full crests, females with smaller ones, juveniles without. A pattern that Corythosaurus shares with

Lambeosaurus and Parasaurolophus — and that shows how heavily the crest was weighted as an intraspecific communication tool.

Neighbors in a Dense World

Corythosaurus lived in the Dinosaur Park Formation in Alberta — the same ecosystem as Lambeosaurus, Parasaurolophus, Styracosaurus, and Gorgosaurus. This is an exceptionally dense community of large animals in a relatively small space, and the question of how multiple large herbivore species could coexist without depleting each other's food sources is one of the most interesting ecological questions in dinosaur research.

Part of the answer probably lies in specialization. Different hadrosaurids likely used different parts of the vegetation—different heights, different plant species, different microhabitats. Corythosaurus, with its robust dentition and dental batteries, was well-suited for tougher plant material. Its beak was broad and designed for cutting vegetation, with the chewing surface behind it efficient enough for needles, twigs, and fibrous leaves. A generalist in an ecosystem that rewarded generalists.

Another answer lies in time. The Dinosaur Park Formation does not represent a single moment, but a period of several million years. Not all species lived at the same time — many only partially overlapped.

Corythosaurus and Lambeosaurus, for example, lived in overlapping but not identical time windows. What appears as an overwhelming simultaneity in the fossil record was, in reality, a staggered succession of faunas that changed slowly.

The formation's predators were primarily Gorgosaurus libratus—a slender, fast tyrannosaurid that posed a serious threat to a hadrosaurid of this size. Like Edmontosaurus and Lambeosaurus, Corythosaurus relied on herd behavior as a primary defense mechanism: many eyes, acoustic alerting, and the sheer mass of a group, which forced even a determined predator to be cautious.

Corythosaurus went extinct about 75 million years ago—or more precisely, it disappeared from the fossil record of the Dinosaur Park Formation as the region's faunas changed. What followed were the later hadrosaurids of the Hell Creek Formation, which did without the crest. An evolutionary experiment with the crest that was extraordinarily successful for several million years — and then, without a dramatic conclusion, ended.

Corythosaurus wore a helmet that was no protection but had a voice — proving that in the world of dinosaurs communication was sometimes more powerful than any armor.

Cryptoclidus

Cryptoclidus eurymerus — Phillips, 1871

🦣 **Period:** Middle to Late Jurassic — about 166 to 145 million years ago

🦣 **Size:** Approximately 4 to 8 meters long

🦣 **Weight:** Estimated 500 to 800 kilograms

🦣 **Diet:** Carnivorous — fish, squid, small marine creatures

🦣 **Reproduction:** Viviparous — like modern marine mammals

🦣 **Habitat:** Europe — shallow epicontinental seas of present-day England and France

Preliminary: Cryptoclidus was not a dinosaur, but a plesiosaur — a marine reptile that lived at the same time as the dinosaurs but belongs to a separate evolutionary line. Plesiosaurs breathed air, moved thru underwater flight similar to modern sea turtles, and probably gave birth to live young directly in the water — a finding published in 2011 thru an exceptionally preserved Polycotylus specimen with an embryo in the journal Science, which has since been considered evidence of live-bearing reproduction in plesiosaurs.

Cryptocleidus and Cryptoclidus are the same animal. The spelling with "ei" is an outdated variant that occasionally appears in older sources but is no longer used today. The correct and scientifically recognized name is Cryptoclidus eurymerus.

Phillips described Cryptoclidus eurymerus in 1871 based on finds from the Oxford Clay in England—a marine rock layer from the Middle Jurassic that has proven to be one of the most significant fossil sites for marine reptiles in Europe. The name means hidden collarbone — a reference to an anatomical peculiarity of the shoulder girdle that Phillips noticed in the original description. Since then, 17 specimens have been known, making Cryptoclidus one of the best-documented plesiosaurs of the European Jurassic.

Cryptoclidus belongs to the family Cryptoclididae within the Plesiosauroidea — the long-necked plesiosaurs, which fundamentally differed from the short-necked, large-headed pliosaurs. With a length of four to eight meters, it was a medium-sized representative of its group — not a giant like Liopleurodon, which inhabited the same ocean, but also not an insignificant bycatch.

Hundreds of teeth for a technique

What anatomically distinguishes Cryptoclidus is its dentition. The skull was narrow and long, the teeth numerous, thin, and slightly curved outward — not a tool for biting hard prey, but a net system. When Cryptoclidus closed its jaws, the interlocking teeth formed a kind of cage, from which small fish, squid and crustaceans could not escape as water drained between the teeth. The same basic strategy is used by baleen whales today — only Cryptoclidus actively hunted, rather than filtering.

The movement thru the water was achieved using four large, paddle-like flippers — underwater flight, not rowing. Modern studies of flipper movement, including biomechanical analyzes at the University of Bristol, show that plesiosaurs coordinated their front and back flippers, much like sea turtles or penguins. Cryptoclidus was therefore not a fast hunter, but an endurance swimmer — precise, agile, adapted to mid-depths and shallow coastal waters.

The Oxford Clay, from which most of the finds originate, formed in a shallow, warm epicontinental sea that covered large parts of present-day England and France. This sea was rich in fish, ammonites and belemnites - ideal conditions for a specialist small fish eater. Cryptoclidus was common in this ecosystem — as suggested by the 17 known specimens from relatively under-researched layers.

Live birth in Cryptoclidus itself is not directly evidenced — no embryo has been found in the abdominal area. But the body shape practically rules out laying eggs on land: An animal of this size with four flippers and a long neck would hardly have been able to move on land, let alone dig a nest. The analogy with other plesiosaurs, where live birth is documented, makes the same reproductive pattern for Cryptoclidus very likely.

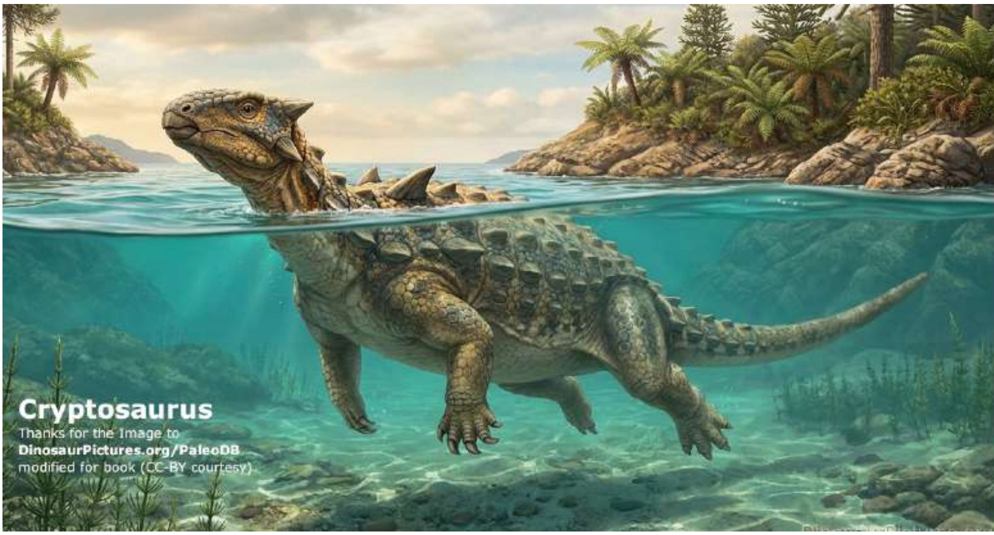
Cryptoclidus was a plesiosaur with hundreds of small teeth, four paddle-like flippers and a life in the shallow Jurassic seas over England - a creature that bridged the gap between fish-eater and underwater flier in its own way.

Cryptosaurus

Cryptosaurus eumerus — Seeley, 1875

- 🦣 **Period:** Middle Jurassic — about 166 to 163 million years ago (Oxford Clay)
- 🦣 **Size:** Unknown — only a femur known
- 🦣 **Weight:** Unknown
- 🦣 **Diet:** Herbivore — further details unknown
- 🦣 **Habitat:** Europe — marine sedimentary environment of present-day England

Harry Seeley described Cryptosaurus eumerus in 1875 based on a single femur from the Oxford Clay in England — the same marine sediment that also yielded Cryptoclidus. The name means hidden lizard, which has a certain unintentional irony given that the animal is based on a single bone.



What Cryptosaurus was is not definitively known. Seeley classified it as an ornithischian — a bird-hipped dinosaur, thus a herbivore. More recent assessments are more cautious. A single femur is not enough to make a secure family assignment, let alone a complete diagnosis. Cryptosaurus is now considered a nomen dubium — a dubious name based on material that does not allow for a reliable distinction from other known dinosaurs.

The fact that the bone was found in the Oxford Clay - a marine sediment - does not necessarily mean that Cryptosaurus lived in the sea. Land animals were often washed out to sea and buried in marine sediments. This also explains why individual dinosaur bones occasionally appear in marine rocks, even tho the animals were not marine dwellers.

There is nothing more to say. A bone, a name, an open question.

Cryptosaurus is a hidden lizard that lives up to its name — a single bone from the Jurassic Sea of England that raises more questions than it answers.

Daspletosaurus

Daspletosaurus torosus — Russell, 1970

- 🦣 **Period:** Late Cretaceous — about 77 to 74 million years ago (Campanian)
- 🦣 **Size:** Approximately 8 to 9 meters long, about 2.5 to 3 meters at the hip height
- 🦣 **Weight:** Approx. 2,700 kilograms; femur approximately 1,006 mm long
- 🦣 **Life expectancy:** Presumably 25 to 30 years
- 🦣 **Diet:** Carnivore — ceratopsians, hadrosaurs, possibly also carrion
- 🦣 **Lifestyle:** Probably solitary; indications of possible group behavior
- 🦣 **Speed:** Estimated 25 to 35 km/h
- 🦣 **Habitat:** Western North America — coastal forests and river valleys of present-day Alberta and Saskatchewan

Daspletosaurus is T. rex — just older, slightly smaller, and significantly less famous. That's unfair. For Daspletosaurus torosus was, in its time and habitat, exactly what T. rex was thirty million years later in the Hell

Creek Formation: the dominant large predator that everything else oriented itself around. Translated, the name means something like "frightful lizard" — and anyone who looks at the anatomy will understand why.

Dale Russell from the National Museum of Canada described Daspletosaurus torosus in 1970 based on finds from the Oldman Formation in Alberta. Since then, 15 specimens have been known, including several well-preserved skulls that provide detailed insights into anatomy and growth. The femurs measure around one meter — at 2,700 kilograms of body weight, a solid foundation for an animal that actively hunted.

Daspletosaurus belongs to the family Tyrannosauridae and is thus a direct relative of T. rex, Albertosaurus, and Gorgosaurus. In the Dinosaur Park Formation in Alberta, it lived alongside Gorgosaurus libratus — a slimmer, faster tyrannosaurid. Two large predators of the same family in the same ecosystem: how that worked is one of the more interesting ecological questions of Cretaceous paleontology.

Two Tyrannosaurids, One Formation

The simultaneous occurrence of Daspletosaurus and Gorgosaurus in the Dinosaur Park Formation is well-documented — and hard to explain. Modern large predators hardly tolerate competing species in the same area. Lions and leopards share territories, but with clear niche separation. What separated Daspletosaurus and Gorgosaurus may have been prey: Gorgosaurus was lighter and faster, possibly specializing in hadrosaurids. Daspletosaurus was bulkier and more robust, with a skull more similar to that of T. rex than that of Gorgosaurus — suited for larger, heavier prey like ceratopsians.

This hypothesis is supported by bite marks. Bite marks have been found on ceratopsid bones from the Dinosaur Park Formation, which originate from a large tyrannosaurid — probably Daspletosaurus. Attacking ceratopsids was risky: an adult Centrosaurus or Styracosaurus could effectively defend itself with horns and body mass. The fact that Daspletosaurus still chose this prey speaks for a hunter who relied on raw strength and a strong jaw — not on speed.

Evidence of possible group behavior in Daspletosaurus was provided by a 2021 finding by Zelenitsky and colleagues published in the journal PeerJ: Several Daspletosaurus individuals of different age classes at a single site in Alberta, along with hadrosaurid remains. Whether this was coordinated hunting or simply opportunistic gathering at a food source is not definitively resolved — but the finding is reminiscent of the Albertosaurus bonebed and raises the same questions.

Growth analyzes based on bone histology show a pattern typical for tyrannosaurids: slow growth in the first years of life, an intense growth phase during adolescence, then a slowdown upon reaching full body size. By around twenty years of age, most individuals were fully grown. The known specimens include various age stages — which is rarer than one might think and allows valuable insights into the population structure.

Whether Daspletosaurus was the direct ancestor of T. rex has been discussed in the literature. The temporal and anatomical proximity makes it plausible — but the fossil record between the two is patchy enough that this question remains open.

Daspletosaurus was T. rex before T. rex existed — heavier, more robust and more dangerous than its reputation, with a jaw for ceratopsians and a patience that taught even horned faces to fear.

Deinonychus

Deinonychus antirrhopus — Ostrom, 1969

- **Period:** Early Cretaceous — about 115 to 108 million years ago
- **Size:** Approximately 3.4 m long, about 0.9 to 1 m at hip height
- **Weight:** Estimated 70 to 100 kilograms
- **Life expectancy:** Presumably 15 to 20 years
- **Diet:** Carnivore — medium prey, possibly also larger ornithopods
- **Lifestyle:** Debated — solitary or social behavior; research inconclusive
- **Speed:** Estimated 40 to 55 km/h
- **Habitat:** Eastern North America — river landscapes and floodplain forests of present-day Montana, Wyoming, and Oklahoma

There are dinosaurs that are famous. And there are dinosaurs that changed science. Deinonychus belongs to the second category. Not because he was particularly large — he wasn't. Not because he looked particularly spectacular - although that is certainly debatable. But because its discovery and description by John Ostrom from Yale University in 1969 turned the entire field of paleontology upside down and sparked a revolution whose effects are still felt today.

Before Ostrom, the image of the dinosaur as a sluggish, cold-blooded reptile was taken for granted. Clumsy, slow, evolutionarily failed. Deinonychus refuted this image with every bone that Ostrom unearthed. Here was an animal with long, grasping forearms, a lightweight skeleton optimized for rapid movement, and — most strikingly — a large, upright sickle claw on the second toe of each hind foot. An animal that must have been obviously active, agile, and fast. Cold-blooded and sluggish? Unthinkable.

Ostrom concluded that dinosaurs could have been warm-blooded — a thesis that was considered provocative at the time and is now part of scientific consensus. Moreover, he recognized structural similarities between Deinonychus and early birds that were so convincing that he seriously brought the bird ancestry of theropods into discussion. This is also considered established today. Deinonychus was therefore not just a fascinating animal — it was the key to two of the most important discoveries in modern paleontology.

The claw that redefined everything

The name Deinonychus means terrible claw — and it refers directly to the feature that made this animal famous. The sickle claw on the second toe was raised, that is, lifted off the ground when walking, and could grow up to 12 centimeters long. It was sharp, curved and clearly built for more than just walking.

What exactly it did is one of the liveliest debates in dinosaur research. The classic idea - that Deinonychus jumped on its prey, held on with its forearms and slashed with the claw - has problems. Biomechanical analyzes, including work by Phil Manning of the University of Manchester, show that the claw was structurally more suited to holding than slicing. It was a holding tool, not a knife.

This leads to a different picture: Deinonychus pinned its prey with its claw — similar to a bird of prey — and killed with its bite. The jaws were powerful, the teeth curved backward, meaning that prey once in the jaws could hardly escape. A combination of claw and jaw that was precise and efficient — and that explains why Deinonychus apparently also targeted prey that was significantly larger than itself.

Precisely that is demonstrated by one of the most fascinating fossil finds related to Deinonychus. In the Cloverly Formation in Montana, several Deinonychus individuals were discovered along with the remains of a Tenontosaurus — an ornithopod up to seven meters long and weighing several tons. A single Deinonychus would have been able

to do little against such an animal. Several together, yes.

Pack hunter — Fact or film legend?

Here begins one of the most persistent debates surrounding Deinonychus. The joint find with Tenontosaurus was long interpreted as evidence of coordinated pack hunting - a group of Deinonychus taking down a prey animal many times their size. Jurassic Park cemented this image, even tho the film used Velociraptor and shrank Deinonychus down to the size of the real Velociraptor, which in turn was blown up to the size of Deinonychus.

Science is more skeptical now. Raphael Herrera and other researchers have pointed out that the Deinonychus bones at the Tenontosaurus site show bite marks — from other Deinonychus. This could mean that the animals ate each other after they were together on a carcass. Not a coordinated pack, but an opportunistic collection of individual hunters who used the same carcass and did not disdain the fallen fellow species. An image that is less heroic than the film's promise — but biologically quite plausible.

Other researchers still consider coordinated hunting behavior to be possible. Modern Komodo dragons, not particularly social animals, occasionally exhibit group-like behavior when hunting large prey. Whether Deinonychus behaved similarly cannot be definitively determined from the fossil record alone. The truth probably lies somewhere between Hollywood and skepticism.

What is certain: Deinonychus was feathered. Bone structures on the forearms clearly indicate feather origins. He was not a scaly reptile, but a bird-like predator, whose posture, movement, and anatomy were closer to modern birds than to classic dinosaur depictions. Anyone who observes a hawk hunting today sees something that Deinonychus must have been quite similar to — just without wings, but with a sickle claw.

Deinonychus died out about 108 million years ago. What remained of its lineage continued to evolve — into birds that now inhabit every continent. His real career is long behind him. It flies past the window every morning.

Deinonychus was not the largest predator of its time — but it was the dinosaur that forced science to rethink everything, and thus changed more than any T. rex ever could.

Dilophosaurus

Dilophosaurus wetherilli — Welles, 1954

Dilophosaurus

- 🦣 **Period:** Early Jurassic — approximately 193 to 183 million years ago
- 🦣 **Size:** Approximately 6 m long, approximately 1.5 m hip height
- 🦣 **Weight:** Estimated 300 to 500 kilograms
- 🦣 **Life expectancy:** Probably 15 to 25 years
- 🦣 **Diet:** Carnivore — medium to large prey, possibly also carrion

🦣 **Lifestyle:** Probably solitary or in loose groups

🦣 **Speed:** Estimated 30 to 40 km/h

🦣 **Habitat:** Western North America — floodplains and semi-deserts of present-day Arizona and possibly China

Anyone who has seen Jurassic Park knows Dilophosaurus as the small, cheerful-looking animal with the fold-out frill that suddenly spits venom and kills Dennis Nedry in his Jeep. It is one of the most memorable scenes in the film. It is also completely fictional. The real Dilophosaurus was neither small nor harmless — and to date, scientists have found no evidence of venom glands or a frill. What they have found instead is almost more interesting.

Dilophosaurus wetherilli is one of the earliest large predatory dinosaurs ever. It lived in the early Jurassic period, about 193 to 183 million years ago, at a time when dinosaurs were just beginning to claim the world for themselves. The mass extinction at the Triassic-Jurassic boundary was not long past. Ecological niches were freshly occupied, and competition was still manageable. Dilophosaurus was one of the largest carnivores in this early ecosystem — with a length of six meters and a weight of up to 500 kilograms, it was an animal not to be underestimated.

It was first described in 1954 by Sam Welles of the University of California, based on finds from Navajo land in northern Arizona. The name means double-crested lizard — and refers to the most distinctive feature of this animal: two parallel bone crests that run from the front of the skull to far back. No other dinosaur of its time had anything similar. No other dinosaur looked anything like Dilophosaurus.

Two crests, zero function — or did they?

The crests of Dilophosaurus are thin. Very thin. So thin that they were completely unsuitable as weapons or protection — a moderately hard impact would have broken them. Scientists agree that they had no defensive or offensive function. So what then?

The most likely explanation is the same one we already know from Parasaurolophus and Styracosaurus: appearance and communication. A striking headdress that signals to conspecifics who is the healthiest, strongest, most attractive specimen. Whether the crests were brightly colored cannot be determined from fossils — but the logic of sexual selection suggests that they were anything but inconspicuous. Birds, as direct descendants of theropods, show us today what bone structures in the head area are capable of when evolution and mate selection interact.

It is also interesting to note what the crests reveal about the age of the most famous specimen. When Welles described the original finds in 1954, the crests were still missing — the animal was initially classified as a crocodile-like predator. It was not until another specimen, excavated by Welles himself in 1964, revealed the complete crests. Later investigations suggested that the first specimen may have been a young animal whose crests were not yet fully developed. This would mean that Dilophosaurus only developed its most striking features with age — similar to how lions develop their manes.

What the film doesn't mention — and what the fossils reveal

Back to Jurassic Park. The film version shows an animal about the size of a large dog. The real Dilophosaurus was twice as long as a full-grown human and weighed as much as a heavy motorcycle. No ruff, no venom

— but powerful hind legs, long grasping forearms, and a jaw that, despite an anatomical peculiarity, was quite capable of grabbing.

This peculiarity is actually interesting from a scientific point of view: the upper jaw of Dilophosaurus has a notch behind the front teeth — a kind of constriction that seems to divide the skull into two sections. Earlier researchers interpreted this as a weakness, suggesting that Dilophosaurus was unable to tear large prey and may have been dependent on carrion. More recent analyses, including an extensive study by Adam Marsh and Timothy Rowe of the University of Texas, published in 2020 in the Journal of Paleontology, paint a different picture. The notch was not a structural weakness, but part of a complex skull structure that was perfectly suited for active hunting. Dilophosaurus could bite. Hard.

It is impossible to say with certainty what it hunted. Early sauropodomorphs, small ornithischians, and a number of other reptiles lived in its environment. A 500-kilogram predator with strong legs and grasping forelimbs had free choice in this ecosystem. It probably took carrion when it was available — but it was not built to be a pure scavenger.

Also noteworthy is a possible relative from China: Sinosaurus triassicus from Yunnan Province shows similar anatomical features and lived at the same time. This suggests that early large theropods had a much wider geographical distribution in the early Jurassic than had long been assumed — at a time when Pangaea was breaking apart, but the land masses were still close enough together to exchange fauna.

Dilophosaurus was the first true large predator of its time — with two crests on its head that had nothing to hide and a bite force that the film preferred to replace with venom spitting.

Diplodocus

Diplodocus carnegii — Hatcher, 1901

- 🦣 **Period:** Late Jurassic — approximately 154 to 152 million years ago
- 🦣 **Size:** Approximately 24 to 26 m long, approximately 4 m hip height
- 🦣 **Weight:** Estimated 10 to 16 tons
- 🦣 **Life expectancy:** Probably 70 to 80 years
- 🦣 **Diet:** Herbivore — ferns, horsetails, low vegetation; probably not a canopy feeder
- 🦣 **Lifestyle:** Probably in herds; possibly seasonal migrants
- 🦣 **Speed:** Estimated 6 to 12 miles per hour
- 🦣 **Habitat:** Western North America — river landscapes and floodplains of the Morrison Formation

When you see a Diplodocus, you inevitably think: That can't be right. This animal is simply too long. Almost 26 meters from the tip of its snout to the tip of its tail — and its torso isn't even that huge. What

Diplodocus carnegii

creates this length are two extremes: a neck that protrudes far forward and a tail that extends even further back, ending in a hair-thin tip that looks almost like a whip. And that's no coincidence.

Diplodocus carnegii is named after Andrew Carnegie, the American steel industrialist and patron who financed the excavation of the most famous specimen. When the skeleton was discovered in 1899 in the Sheep Creek Formation in Wyoming and assembled in 1907 at the Carnegie Museum of Natural History in Pittsburgh, the reaction was clear: amazement. Carnegie had casts made and gave them to the world's most important natural history museums — in London, Paris, Berlin, Vienna, Bologna, and Buenos Aires. Diplodocus thus became the first dinosaur to be truly known worldwide. A PR coup from the early 20th century that continues to have an impact today.

The species itself lived around 154 to 152 million years ago in the area we now know as the western United States. The Morrison Formation, a geological treasure trove from the late Jurassic period, has yielded more Diplodocus material than almost any other site in the world. This means we know this animal well. Very well, in fact, compared to many other dinosaurs, of which only individual bones are known.

A whip that breaks the sound barrier

The tail of Diplodocus is anatomically unusual. It consists of up to 80 vertebrae — significantly more than other sauropods — and becomes so thin toward the tip that the last vertebrae are barely recognizable as such. Philip Currie from the Royal Tyrrell Museum in Canada and other researchers have calculated that such a tail, when swung in the right way, could break the sound barrier. The resulting bang would have been comparable to a gunshot — loud, sharp, and far-reaching.

Whether Diplodocus actually did this cannot be directly deduced from fossils. But physics allows for it, and evolutionary pressure suggests it did. An animal with no effective weapon against predators such as Allosaurus needs some kind of deterrent mechanism. A cracking whip-like tail would have been a good one — loud enough to keep an attacker at bay without Diplodocus having to turn around and fight.

At the same time, the tail probably served as a counterweight to the long neck. Diplodocus carried its neck and tail in a relatively horizontal line — so the animal was not a high-necked creature like Brachiosaurus, but a horizontal record holder. Its head was at or slightly above torso level, suggesting that Diplodocus fed close to the ground: ferns, horsetails, low vegetation that was abundant in the riverine landscape of the Jurassic period.

Small in the head, big in the system

The skull of Diplodocus is tiny for an animal of this size — flat, long, with pencil-shaped teeth located exclusively in the front of the jaw. No molars, no chewing surface. Diplodocus did not chew. It stripped vegetation — branches were pulled through its teeth like a comb, the leaves remained attached and were swallowed whole. This so-called stripping can still be observed in some reptiles today and was probably highly efficient in Diplodocus, even if it seems primitive at first glance.

What came next was a matter for the digestive system. A long, massive digestive tract with fermentation chambers broke down the plant material, possibly aided by swallowed stomach stones. For an animal that processed hundreds of kilograms of plant matter every day, this was no small task. But Diplodocus had time. Lots of time. When you live for seven to eight decades, you can afford to eat all day long and hardly ever rush.

Socially, Diplodocus was probably not a loner. Trace fossils from the Morrison Formation repeatedly show groups of sauropods traveling together. Whether this was genuine herd behavior or simply the use of the same watercourses and feeding grounds is difficult to say. Probably both.

Young animals would have been better protected in a group — and Allosaurus would probably have thought twice about attacking a fully grown Diplodocus swinging its tail around.

Diplodocus was not a dramatic animal — but with a length of 26 meters, a tail like a sonic weapon, and an elegance that no other sauropod could match, it was perhaps the most perfect structure that the evolution of the Jurassic period produced.

Dimorphodon

Dimorphodon macronyx — Buckland, 1829

Period: Early Jurassic — about 201 to 190 million years ago (Hettangian to Pliensbachian)

Size: Wingspan approximately 1.4 m; body length approximately 1 m

Weight: Estimated 1 to 2 kilograms

Diet: Fish-eater; possibly also insects and small vertebrates

Lifestyle: Presumably both ground-dwelling and climbing; limited flying ability

Habitat: Europe — coastal regions of present-day southern England

First, the usual clarification: Dimorphodon was not a dinosaur, but a pterosaur — a flying reptile from the early Jurassic period that belongs to a distinct evolutionary line.

William Buckland described Dimorphodon macronyx in 1829 based on finds from the Lias strata of Lyme Regis in Dorset — the same coast where the legendary fossil collector Mary Anning had recently presented the first complete ichthyosaur to science. The name was later given by Richard Owen: Dimorphodon means two-form tooth — a reference to the unusual dentition with two different types of teeth, large grasping teeth at the front and smaller ones behind. Three specimens are known, none of which are complete.

What makes Dimorphodon immediately recognizable is the skull. For an animal the size of a pigeon, it was absurdly large — almost a third of its total length, deep as a toucan's head, with large openings in the bony framework that saved weight. The teeth were only in the front of the jaw, which, together with the shape of the skull, suggests it was a fish-catcher — snapping, not chewing.

On the ground — with wings as support

What distinguished Dimorphodon from most other pterosaurs was possibly its lifestyle on the ground. The anatomy of the hind legs and the short, strong forearms with long claws are suited to an animal that climbed and walked on the ground — using the folded wings as additional support, similar to how modern bats occasionally do. Earlier reconstructions showed Dimorphodon almost exclusively in flight. Today, it is considered one of the prime examples of a pterosaur that was not primarily a flying animal, but rather a climber and ground runner with the ability to fly — for short distances, presumably for escape or to move between elevated positions.

The ability to fly was limited by the body proportions. The large head shifted the center of gravity forward, making controlled gliding difficult. Short, intense flights — from one rock ledge to another, or to snatch fish at the water's surface — are the most plausible picture.

Dimorphodon lived on a coast in the early Jurassic, shortly after the mass extinction at the Triassic-Jurassic boundary had re-sorted the ecosystem. As one of the earliest known pterosaurs with clear specialization, it is an important data point — an animal that shows how quickly pterosaurs occupied their own ecological niches after the extinction.

Dimorphodon had the head of a toucan, the claws of a climber, and wings that it preferred to use as a support — a pterosaur that preferred to travel on foot.

Dolichorhynchops

Dolichorhynchops osborni — Williston, 1902

- **Period:** Late Cretaceous — about 94 to 66 million years ago
- **Size:** Approximately 3 to 5 meters long
- **Weight:** Estimated 200 to 400 kilograms
- **Diet:** Carnivorous — Fish, squid, small marine creatures
- **Reproduction:** Live-bearing
- **Habitat:** North America — Western Interior Seaway, the shallow inland sea of present-day Kansas, South Dakota, and Colorado
- **Preliminary:** Dolichorhynchops was not a dinosaur, but a plesiosaur — a marine reptile of the late Cretaceous period that lived at the same time as the dinosaurs but belongs to a separate evolutionary line.

Samuel Wendell Williston described Dolichorhynchops osborni in 1902 based on finds from the Niobrara Chalk in Kansas — a marine rock layer that formed in the shallow Western Interior Seaway, the inland sea that divided North America from north to south during the late Cretaceous period. The name means "long snout" — direct and apt, as the narrow, elongated snout is the most distinctive feature of this animal. 16 specimens are known, including remarkably complete skeletons that provide a clear picture of the anatomy.

Dolichorhynchops belongs to the family of Polycotylidae — the short-necked plesiosaurs, which fundamentally differed from the long-necked forms like Cryptoclidus. Short neck, large head, long snout — a body plan that resembles a modern dolphin more than the classic image of a plesiosaur with a long swan neck. Four large fins, underwater flight as a means of locomotion - that was shared by all plesiosaurs.

Live birth in the open sea

What makes Dolichorhynchops particularly interesting is its reproductive biology. Live birth in Polycotylids is evidenced by a spectacular find: A specimen of Polycotylus latippinus — a close relative of Dolichorhynchops — published in the scientific journal Science in 2011 showed a nearly fully developed embryo in the mother's abdominal area. This was the first direct evidence of live birth in plesiosaurs and practically ruled out egg-laying on land at the same time. No embryo of Dolichorhynchops itself has been documented, but the close relationship makes the same reproductive pattern very likely.

The Western Interior Seaway, in which Dolichorhynchops lived, was a shallow, warm sea — rich in fish like Xiphactinus, sharks, and squid. Dolichorhynchops was a mid-sized predator in this ecosystem — not big enough to threaten the real giants of the seaway like Tylosaurus or Mosasaurs, but efficient enough for fast fish and squid. The narrow snout with conical teeth was a precision tool — to grasp, not to crush.

The fact that 16 specimens are known from relatively little-studied strata suggests a common and widespread species - a successful inhabitant of the inland sea, present from Kansas to South Dakota, and occupying the Western Interior Seaway for almost 30 million years.

Dolichorhynchops was a Cretaceous dolphin - same idea, different line, same sea - and gave birth to live young directly in the water, 66 million years before mammals did the same in the ocean.

Dolichosuchus

Dolichosuchus cristanoi — Huene, 1932

➡ **Period:** Late Triassic — about 235 to 225 million years ago

- **Size:** Estimated 3 to 5 m long — Estimate based on fragmentary bones
- **Weight:** Unknown
- **Diet:** Carnivore — likely other reptiles and small vertebrates
- **Habitat:** Europe — terrestrial landscapes of present-day Germany or Spain

Friedrich von Huene described Dolichosuchus cristanoi in 1932 based on a single lower leg bone—a tibia—from the late Triassic of Europe. The name means long crocodile lizard, which says less about the animal itself than about the spirit of the Triassic paleontology: Many early reptile finds were reflexively associated with crocodiles before dinosaur research established clear taxonomic boundaries.

What Dolichosuchus was is not certain to say. Huene classified it as an early theropod — a bipedal carnivorous dinosaur. More recent assessments are more skeptical. A single lower leg bone is not enough to make a reliable diagnosis or to safely distinguish the animal from other early archosaurs. Dolichosuchus is now considered a nomen dubium — a name without sufficient diagnostic basis.

The late Triassic of Europe was a time when dinosaurs had just emerged and had not yet established themselves as the dominant land animals. Early theropods of this size are known from the Triassic of Europe — Liliensternus from Germany is one example — but without more complete material, it is impossible to say whether Dolichosuchus belonged to this group, was another early archosaur, or simply a fragment of a previously known animal.

The material does not yield more.

Dolichosuchus is a lower leg bone, a name from 1932, and an animal that Triassic paleontology has not been able to definitively classify to this day.

Dreadnoughtus

Dreadnoughtus schrani — Lacovara et al., 2014

- 🦣 **Period:** Late Cretaceous — approximately 77 to 66 million years ago (Campanian)
- 🦣 **Size:** Approx. 26 m long, about 6 m at the hip
- 🦣 **Weight:** Estimated 65 tons — possibly more
- 🦣 **Life expectancy:** Presumably 50 to 80 years
- 🦣 **Diet:** Herbivore — trees, conifers, and flowering plants at high elevations
- 🦣 **Lifestyle:** Presumably solitary or in small groups

🦣 **Speed:** Estimated 5 to 10 km/h

🦣 **Habitat:** South America — river plains and forested landscapes of present-day Santa Cruz Province, Patagonia

The name says it all. Dreadnoughtus—named after the British battleship HMS Dreadnought, which was considered invincible at the beginning of the 20th century. Kenneth Lacovara of Drexel University chose this name deliberately: A fully grown Dreadnoughtus schrani simply had no natural enemies. No predator of the Late Cretaceous period in South America was large enough to seriously threaten a healthy adult. With an estimated body weight of 65 tons and a length of 26 meters, Dreadnoughtus is among the heaviest land animals ever to have lived on this planet.

Lacovara and colleagues described Dreadnoughtus in 2014 in the journal Scientific Reports—based on a single specimen from the Cerro Fortaleza Formation in the Argentine province of Santa Cruz. What this single specimen provided, however, is extraordinary: over 70 percent of the skeleton is preserved—a remarkably complete record for a titanosaur of this magnitude. No skull, but vertebrae, ribs, shoulder girdle, pelvis, and limb bones in sufficient numbers to allow for reliable weight estimates.

Dreadnoughtus belongs to the group of Titanosauria—the line of sauropods that dominated the Late Cretaceous on nearly every continent and produced the largest land animals in Earth's history. In

South America, this group was particularly diverse: Argentinosaurus, Patagotitan, Alamosaurus—all from the same region, all in the same size class. Dreadnoughtus fits into this lineup without holding a clear size record—the overlap in estimates among these giants is too great for definitive rankings.

Weight, Growth, and an Open Question

The weight estimate of 65 tons is based on a method developed in 2014, which Lacovara and colleagues applied using the circumferences of the humerus and femur. This method yields reliable results for modern animals—but for extinct giant dinosaurs, there remains a margin of error that makes estimates ranging from 40 to over 80 tons for Dreadnoughtus entirely plausible. What the bones also reveal: The known specimen was not yet fully grown. The growth plates on several bones are not yet fully closed—the animal was still in an active growth phase. A fully grown Dreadnoughtus was therefore possibly even larger and heavier than what we know.

This finding raises a question that is fundamentally difficult to answer for titanosaurs: When did these animals stop growing—and did they ever stop at all? Modern reptiles grow throughout their lives, albeit at a slower rate. If Dreadnoughtus had a similar growth pattern, the known specimen is simply a young animal—and the limits of what is biologically possible in terms of body size for land animals are pushed even further.

It is difficult to calculate how much Dreadnoughtus ate daily to sustain a body mass of 65 tons. Estimates based on modern large herbivores and sauropod digestive models suggest several hundred kilograms of plant matter per day. Its long neck—reconstructed at about eleven to twelve meters—allowed access to tree canopies at heights no other land animal could reach. For Dreadnoughtus, eating was not a leisure activity, but a full-time occupation.

Predators of the Cerro Fortaleza Formation are poorly understood—Late Cretaceous South America had no tyrannosaurids, but rather abelisaurids as the dominant large predators. Even the largest abelisaurid would have been powerless against a fully grown 65-ton animal. Juveniles were a different story—it took years for Dreadnoughtus offspring to reach a size that offered real protection, during which time they were vulnerable.

Dsungaripterus

Dsungaripterus weii — Young, 1964

- 🦣 **Period:** Early Cretaceous — about 140 to 100 million years ago (Valanginian to Albian)
- 🦣 **Size:** Wingspan approximately 2.5 to 3.5 m
- 🦣 **Weight:** Estimated 5 to 10 kilograms
- 🦣 **Diet:** Probably hard-shelled animals, mussels, crabs — despite classification as a fish-eater
- 🦣 **Lifestyle:** Probably solitary; coastal and lake shores
- 🦣 **Habitat:** Asia and possibly Africa — coasts and shorelines of present-day Xinjiang, China
- 🦣 **Preliminary:** Dsungaripterus was not a dinosaur, but a pterosaur — a flying reptile of the early Cretaceous period, belonging to a distinct evolutionary line.

Chung Chien Young described Dsungaripterus weii in 1964 based on finds from the Dzungarian Basin in the Chinese province of Xinjiang — after which the genus was named. Three specimens are known, including a remarkably complete skull that clearly reveals the anatomy of this animal. The species name honors Wei Jingzhi, the Chinese geologist who discovered the site.

What makes Dsungaripterus immediately unmistakable is the jaw. The snout was long, narrow, and distinctly curved upwards at the tip — a hook that anatomically has nothing in common with a classic fish catcher. Fish are caught with a straight or slightly curved snout, not with an upward hook. What this jaw could do instead: grab under stones and in rock crevices, pry mussels and crabs out of cracks. The teeth in the back jaw area were flat and broad — perfect grinding stones for hard-shelled animals. The classification as a fish-eater in the source data is therefore likely inaccurate. Dsungaripterus was most likely a specialist in hard-shelled animals — one of the few pterosaurs that consistently occupied this niche.

The skull bore a low bony crest along the top—presumably a signaling organ for species recognition or intraspecific communication. Similar crests are found in many pterosaurs, without their exact function ever being conclusively determined.

With a wingspan of up to 3.5 meters, Dsungaripterus was a medium-sized pterosaur—large enough for stable flight over coastal waters and lake shores, yet light enough for agile maneuvers while foraging on the ground. The combination of a hooked snout, grinding teeth, and stable flying abilities makes it one of the most anatomically unique pterosaurs of its time.

Dsungaripterus had a bottle-opener snout and teeth like millstones — a pterosaur that cracked mollusks while its relatives hunted fish.

Einiosaurus

Einiosaurus procurvicornis — Sampson, 1995

- ➡ **Period:** Late Cretaceous — about 74 to 72 million years ago
- ➡ **Size:** Approximately 4.5 to 6 meters long, about 1.5 to 1.8 meters at the hip height
- ➡ **Weight:** Estimated 1.5 to 2 tons
- ➡ **Life expectancy:** Presumably 20 to 30 years
- ➡ **Diet:** Herbivores — low vegetation, ferns, flowering plants
- ➡ **Lifestyle:** Highly developed herd animals; very well documented thru mass finds
- ➡ **Speed:** Estimated 15 to 25 km/h
- ➡ **Habitat:** Western North America — coastal plains and river landscapes of present-day Montana, Laramidia

There are dinosaurs about which we know a lot because many specimens have been found. And then there's Einiosaurus - a dinosaur whose herd behavior we know more about than most other ceratopsids, because two extraordinary mass finds in Montana have cleared up almost any doubt. Hundreds of individuals, stacked on top of each other, young and old mixed together, at two different sites in the same formation. Einiosaurus was no occasional pack animal. He was a committed herd animal — and the fossils show that with a clarity that is rare.

The name comes from the language of the Blackfoot — an indigenous people of Montana and Alberta who inhabited the region long before the first paleontologist set a spade there. Eini means buffalo, and that's no coincidence. Einiosaurus may have been the Cretaceous equivalent of the North American bison in its ecology and behavior — a medium-sized herbivore in enormous herds that shaped the landscape and on which the entire ecosystem depended. The species name procurvicornis refers to the most distinctive feature of this animal: the forward-curving nasal horn.

Einiosaurus was first described in 1995 by Scott Sampson, who also co-described Nasutoceratops and has established himself as one of the leading researchers on the ceratopsid diversity of Laramidia. The finds come from the Two Medicine Formation in Montana — the same formation that has also yielded important Deinonychus and Maiasaura finds and is one of the most productive sites of the late Cretaceous in North America.

The horn that points downwards

No feature of Einiosaurus is as immediately recognizable as the nasal horn. In most ceratopsids, the nasal horn points upwards or forwards — as a weapon, as a signaling organ, as a display apparatus. In Einiosaurus, it points forward and downward, at an angle that is almost dramatic. It is not a straight horn, but one with a distinct downward curve toward the snout tip — like an oversized hook.

The function of this unusual horn is debated. As a weapon against predators like tyrannosaurids, in this form it is less ideal than a horn pointing straight forward — an upward thrust would be difficult to execute. More likely, it served a signaling function within the species. The shape of the horn made Einiosaurus distinguishable from other ceratopsids at first glance — and this was quite relevant in a world where several similarly built horned faces inhabited the same environment. Who belongs to one's own species and who does not — processing this information quickly saves time and energy.

Interestingly, the way the horn changed with age is noteworthy. Young Einiosaurus had a straight, upright nasal horn that only bent forward and downward as they grew. The specimens from the mass finds clearly show this — a continuum from almost straight juvenile horns to the fully curved adult horn. This development is a beautiful example of how much dinosaurs could change throughout their lives, and how important it is to have fossils of different age stages to understand the overall picture.

Einiosaurus procurvicornis

The neck shield of Einiosaurus was relatively simple compared to other ceratopsids — not an elaborate structure like that of Triceratops or Torosaurus, but a medium-sized shield with two long, backward-curving spikes at the top and two shorter spikes below. Here, too, it is striking enough for species recognition, but not as massive as with the large relatives. Einiosaurus invested evolutionarily more in its nasal horn than in its frill — a different strategy than Triceratops, but evidently a successful one in its niche.

What mass finds really reveal

The two Einiosaurus bonebeds in the Two Medicine Formation are more than just a confirmation of herd behavior. They are a window into a specific ecological catastrophe — or at least a dramatic moment in the life of this herd.

The bones show hardly any bite marks from predators and little evidence of being scattered by flowing water. This suggests that many animals died at the same time or in a short period of time and were then relatively quickly embedded. The most likely explanation: a seasonal catastrophe, possibly drought. Einiosaurus may have been a migratory animal - a herd animal that moved seasonally between water sources, much like wildebeest in the Serengeti today. In a dry year, when water holes dried up, an entire herd could have collapsed at a last remaining water point.

This is a hypothesis, not proof. But it fits with the geology of the sites and what we know about the climate of the Two Medicine Formation: seasonally variable, with dry spells that could have been dangerous for large herbivores. Einiosaurus lived in a beautiful but not always forgiving world.

As a herbivore, Einiosaurus was specialized in low vegetation. Its body structure — low-set head, broad beak, strong forelimbs — suggests an animal that fed close to the ground and was not picky. Ferns, flowering plants, low shrubs — everything the coastal plains of Montana had to offer in the late Cretaceous. In a herd of possibly hundreds of animals, the grazing pressure on the local vegetation was significant — which in turn would explain seasonal migrations.

Einiosaurus shared its habitat with Maiasaura, a hadrosaur whose brood care is legendary, as well as with early tyrannosaurids and a number of smaller theropods. He was right in the middle—neither a giant nor a specialist, but an extraordinarily successful animal in a well-functioning herd.

Einiosaurus had a horn that pointed downward and lived in herds that filled the landscape — a Cretaceous buffalo with a face you won't forget easily.

Edmontosaurus

Edmontosaurus regalis — Lambe, 1917

🦣 **Period:** Late Cretaceous — about 73 to 66 million years ago

🦣 **Size:** Approximately 9 to 13 m long, about 3 to 4 m at the hip height

🦣 **Weight:** Estimated 4 to 8 tons

🦣 **Life expectancy:** Presumably 20 to 30 years

🦣 **Diet:** Herbivore — conifer needles, leaves, fruits, flowering plants

🦣 **Lifestyle:** Highly social herd animals; one of the best-documented herd dinosaurs of the Cretaceous period

🦣 **Speed:** Estimated 25 to 45 km/h

🦣 **Habitat:** Western North America — coastal forests, river valleys, and open landscapes from Alaska to Wyoming

Edmontosaurus is not the dinosaur that children first mention when you ask them. No single dramatic feature leaps out at you — no meter-long horn, no bony plates, no giant skull. What Edmontosaurus has is something else: completeness. More complete skeletons than almost any other large dinosaur. Skin. Soft tissue remnants. Stomach contents. Bite marks from T. rex. And a distribution from Alaska to Wyoming, which shows how extraordinarily successful this animal was. Edmontosaurus is not a glamor dinosaur. It is a window into a past world that is more open than almost any other.

Lawrence Lambe described Edmontosaurus regalis in 1917 based on finds from the Horseshoe Canyon Formation in Alberta, Canada — the province of Edmonton, after which the name was chosen. Since then, excavations in Canada, the USA, and even Alaska have produced a picture that is unusually complete for a dinosaur. Particularly significant are the so-called mummies — several specimens in which the skin and even soft tissues were dried and preserved before fossilization. The first of these specimens, known as the Berlin Edmontosaurus mummy, arrived at the Senckenberg Natural History Museum Frankfurt in 1908, where it has been preserved to this day. Another specimen named Dakota, discovered in 1999 in North Dakota and extensively studied by Tyler Lyson and colleagues, provided such detailed information about musculature, skin, and body proportions that paleontologists can now reconstruct the body shape of this animal with a level of accuracy that is simply not possible for most dinosaurs.

What these mummies show: Edmontosaurus was more muscular than long assumed. The tail was stronger, the legs were slimmer, the body overall less sluggish than early reconstructions suggested. An animal that could move quickly — and had to, because it lived at the same time and in the same space as Tyrannosaurus rex.

A mouth like a factory

The most striking part of Edmontosaurus is its dentition — or more precisely, what lies behind it. The broad, flat horn material beak was built for slicing thru vegetation, efficient and robust. Behind them were the real marvels: battery jaws, consisting of several hundred closely packed small teeth, stacked in multiple layers. When one tooth was worn down, the next one moved up. A biological conveyor belt for teeth that worked for a lifetime.

Edmontosaurus — Image by Dariusz Sankowski from Pixabay

These tooth batteries were so effective that Edmontosaurus could practically process anything the Cretaceous had to offer in terms of plant material. Fossilized stomach contents — a find that nature rarely allows — show needles from conifers, twig parts, seeds, and leaves.

Edmontosaurus was not picky about what it ate. It ate what was there, and a lot of it. An animal weighing up to eight tons has a corresponding daily energy requirement — and this could only be met with a digestive system that operated at full capacity around the clock.

The posture of Edmontosaurus was flexible. It could run on two legs — quickly when necessary — and eat on all fours, with its head close to the vegetation. This switching between two- and four-legged locomotion is well-documented in hadrosaurids and made Edmontosaurus a versatile animal capable of utilizing various food sources at different heights.

T. rex and the Question of Survival

Edmontosaurus and T. rex lived at the same time, in the same areas, under the same ecological conditions. That meant: Edmontosaurus was prey. Several Edmontosaurus skeletons bear clear T. rex bite marks — on tail vertebrae, on pelvic bones, on ribs. Particularly well-known is a specimen from the Hell Creek Formation, whose tail vertebra shows a healed T. rex bite wound. The animal survived the attack and lived for years afterward. The bone tissue around the wound had fully regenerated.

This is more than an anatomical curiosity. It shows that T. rex attacks on Edmontosaurus were not rare exceptions, but part of everyday life — and that Edmontosaurus did not always come off worse. A healthy, fully grown animal weighing several tons was not an easy target. Speed, herd protection, and sheer body mass were the means by which Edmontosaurus survived.

Herds of Edmontosaurus were apparently large. Bonebeds in Canada and the USA, including a site in the Lance Formation in Wyoming with remains of at least a thousand individuals, suggest mass migrations reminiscent of modern large herbivores like caribou or wildebeests. Alaska finds show that Edmontosaurus even inhabited subarctic regions — suggesting seasonal migrations over great distances, possibly from northern summer ranges to southern winter quarters. A migratory dinosaur that utilized the entire breadth of Laramidia.

One last find deserves special mention. An Edmontosaurus specimen from South Dakota, known as the Schweitzer specimen, showed remnants of a soft tissue appendage at the tip of its skull—similar to a rooster's comb. Not bone, not horn, but soft tissue that was only visible due to extraordinary conditions of preservation. Whether all Edmontosaurus wore this adornment or only certain individuals — perhaps males during mating season — is not known. But it is an impressive testament to how much of a dinosaur remains invisible when only bones are preserved.

Edmontosaurus was the dinosaur that had it all — skin, stomach, bite marks and a crest — proving that the most unassuming animals are often the most revealing.

Elasmosaurus

Elasmosaurus platyurus — Cope, 1868

- 🦣 **Period:** Late Cretaceous — approximately 94 to 71 million years ago (Coniacian to Campanian)
- 🦣 **Size:** Approx. 10 to 14 m long — more than half of which was neck
- 🦣 **Weight:** Estimated 2 to 3 tons
- 🦣 **Diet:** Carnivore — fish, squid, small marine organisms
- 🦣 **Reproduction:** Viviparous
- 🦣 **Habitat:** North America — Western Interior Seaway, the shallow inland sea of present-day Kansas and South Dakota

🦣 **Note:** Elasmosaurus was not a dinosaur, but a plesiosaur — a marine reptile of the Late Cretaceous period belonging to a distinct evolutionary lineage.

Edward Drinker Cope described Elasmosaurus platyurus in 1868 based on a nearly complete skeleton from the Niobrara Chalk in Kansas—and in doing so committed one of the most famous errors in the history of paleontology. Cope assembled the skeleton with the skull at the wrong end: he mistook the long neck for an extremely long tail and placed the head at the tail end. Othniel Charles Marsh—Cope's bitterest rival in the Bone Wars, that legendary paleontological rivalry of the second half of the 19th century—recognized the error and made it public. Cope then bought up as many copies of the scientific publication in question as he could find in order to remove the description from circulation. He did not succeed completely. The error remains documented to this day—and is one of the most frequently cited anecdotes in the history of science.

What Cope had misjudged was a neck of unprecedented length. Elasmosaurus had 72 cervical vertebrae—more than any other known vertebrate in Earth's history. By comparison: Almost all mammals, from mice to giraffes, have exactly seven cervical vertebrae. Elasmosaurus had ten times that number, and its neck accounted for more than half of its total body length. In an animal perhaps 14 meters long, that meant a neck seven to eight meters long—supported by a comparatively compact torso with four large flippers.

A Neck as a Hunting Tool

The purpose of this extreme neck has long been debated in research. The most obvious idea—that the neck was stretched upward like a duck's neck to surprise prey from above—is anatomically hardly tenable. The cervical vertebrae of Elasmosaurus did not allow for a strong upward curvature. The neck was mobile, but not as flexible as that of a snake or giraffe. What it could do: lateral movements, quick repositioning, and precise positioning of the small skull.

The most plausible explanation that has gained acceptance in current research is the one also suggested in the original description: The long neck allowed Elasmosaurus to reposition its head quickly and precisely without having to move its heavy body. A school of fish that can evade the body cannot evade the neck—the head is simply faster. Elasmosaurus was not a fast hunter, but a precision hunter that compensated for its slowness with reach.

The teeth were long, thin, and angled outward—a cage for fish and squid, not a tool for crushing. Stomach contents are occasionally preserved in Elasmosaurus relatives and reveal fish bones, belemnites, and occasionally small stones—gastroliths that may have served as ballast or to aid digestion.

Ten specimens are known, all from the Western Interior Seaway—the shallow, warm inland sea that divided North America from north to south during the Late Cretaceous. This sea was rich in fish, ammonites, and other marine life, but also in dangerous predators: mosasaurs like Tylosaurus, giant sharks, and other plesiosaurs shared the same waters. Whether Elasmosaurus itself was hunted is not documented—but an animal without protective armor and with a long, vulnerable neck was not invulnerable in this ecosystem.

Elasmosaurus had 72 cervical vertebrae, was assembled upside down by its discoverer—and thus proved that even science's greatest errors sometimes tell the most interesting stories.

Euoplocephalus

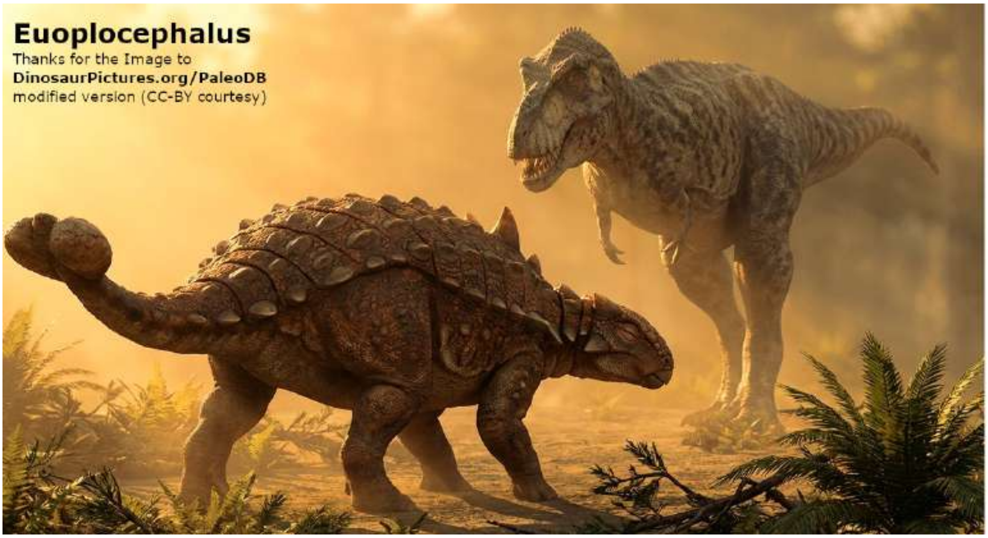
🦣 ***Euoplocephalus tutus — Lambe, 1910***

- 🦣 **Period:** Late Cretaceous — approximately 76 to 66 million years ago (Campanian to Maastrichtian)
- 🦣 **Size:** Approx. 5.5 to 7 m long, about 1.8 m at the hip
- 🦣 **Weight:** Estimated 2 to 3 tons
- 🦣 **Life expectancy:** Presumably 20 to 30 years
- 🦣 **Diet:** Herbivore — low vegetation, ferns, flowering plants
- 🦣 **Lifestyle:** Presumably solitary
- 🦣 **Speed:** Estimated 8 to 15 km/h
- 🦣 **Habitat:** Western North America — coastal forests and river plains of present-day Alberta and Montana

Euoplocephalus tutus was a walking bunker. From the tip of its snout to its tail club, nearly every inch of this animal was protected against attacks—with bony plates, spikes, bony spikes, and a tail club capable of shattering a tyrannosaurid’s shinbone. The name means “well-armored head"—and even this animal's eyelids were ossified. No other dinosaur took the concept of passive defense to such an extreme.

Lawrence Lambe of the Geological Survey of Canada described Euoplocephalus tutus in 1910 based on finds from Alberta. It is the most commonly found ankylosaurid in North America—over forty specimens are known, allowing for detailed insights into its anatomy, variability, and growth. It is noteworthy that almost all specimens were found as solitary individuals—never several together, never any evidence of herd behavior. Euoplocephalus was apparently not a social animal.

Euoplocephalus belongs to the family Ankylosauridae, the club-tailed ankylosaurs, and is its best-known representative. Its back was covered with bony plates—so-called osteoderms—arranged in rows and topped by pointed bony spikes. This armor was not an external protective covering but was directly embedded in the skin—biologically fused to the body, non-sheddable, and immobile. An attack from above would strike a surface that had more in common with a crocodile's back than with anything a predator could reasonably target.



The club at the tail's end

The most iconic feature of Euoplocephalus is the tail club—a massive bony knob at the end of the tail, formed from fused osteoderms and tail vertebrae. In adult animals, this club could reach a considerable diameter and weighed enough to cause serious injury with a well-aimed blow.

Victoria Arbour of the University of Alberta, one of North America's leading ankylosaurid researchers, has analyzed the biomechanics of the tail club in several studies. Her calculations show that a fully grown Euoplocephalus could generate forces with its club capable of breaking bones—including the legs of a tyrannosaurid. The tail vertebrae fused together at the rear into a rigid rod that served as a lever, maximizing the club's momentum. Not a tool for stabbing or cutting—but a blunt impact, brutal and precise.

Whether Euoplocephalus actively fought or used the club merely as a deterrent is not directly proven. But the anatomy is clearly designed for active use—too massive, too specialized to be merely a display organ.

Armored Eyes and a Small Brain

Something that occasionally causes astonishment even among paleontologists: Euoplocephalus's eyelids were ossified. Small, semicircular bony plates directly protected the eyes—a specialization found in no other known dinosaur in this form. In an animal attacked by predators that targeted the eyes as vulnerable spots, this was a logical final line of defense.

The brain was small relative to body size—typical for ankylosaurids. Euoplocephalus was not a strategic thinker. It fed, moving slowly through the coastal forests of Alberta, relying on the fact that no predator would expend the time and effort to attack a fully armored two-ton hulk capable of swinging its tail club. A simple strategy—but one that worked for millions of years.

Euoplocephalus was so completely armored that even its eyelids were made of bone—an animal that evolution had turned into a walking bunker, complete with a built-in club.

Falcarius

Falcarius utahensis — Kirkland et al., 2005

🦣 **Period:** Early Cretaceous — approximately 130 to 125 million years ago (Barremian)

🦣 **Size:** Approx. 3.5 to 4 m long, about 1.2 m at the hip

🦣 **Weight:** Estimated 80 to 100 kilograms

🦣 **Life expectancy:** Unknown

🦣 **Diet:** Controversial — likely herbivore or omnivore, despite classification as a carnivore

🦣 **Lifestyle:** Possibly in groups

🦣 **Speed:** Unknown

🦣 **Habitat:** Western North America — terrestrial landscapes of present-day Utah

Falcarius utahensis is one of the most scientifically interesting dinosaurs of the early Cretaceous period in North America—not because of its size or its teeth, but because of what it tells us about evolutionary change. It is a therizinosaur—a member of a group that evolved from carnivorous theropods and gradually transitioned toward herbivory. Falcarius stands precisely at this threshold, and its anatomy illustrates the transition to a degree rarely seen so clearly in paleontology.

James Kirkland of the Utah Geological Survey and colleagues described Falcarius in 2005 in the journal Nature, based on finds from the Cedar Mountain Formation in Utah. What they discovered there was unusual: a massive accumulation of bones from hundreds of individuals at a single site—a bone bed suggesting a colony or a regularly used water source. Two specimens have been formally described, but the fossil material includes bones from far more animals.

On the Path from Predator to Herbivore

Falcarius's teeth are the key feature. They are leaf-shaped and serrated—not the tools of an active carnivore, but a dentition adapted for soft plant material. At the same time, the overall body plan is still unmistakably theropod: bipedal, with long arms and the characteristic sickle-shaped claws that gave the genus its name—Falcarius means "sickle-bearer."

As far as can be reconstructed from the bone anatomy, the digestive tract was already adapted to larger quantities of plant food—a wider pelvis than in typical carnivores suggests a larger intestinal tract. Falcarius likely ate mainly plants, possibly supplemented by occasional animal food. The classification as a strict carnivore in the source data is therefore untenable.

What makes Falcarius so valuable: It shows that the transition from carnivore to herbivore was not an abrupt event, but a gradual process—evident in a single animal that anatomically straddles both worlds.

Falcarius was a theropod on the path from predator to herbivore—with the sickle-shaped claws of a hunter and the teeth of a herbivore, frozen in an evolutionary moment that the fossils have preserved for us.

Feilongus

Feilongus youngi — Wang et al., 2005

- 🦣 **Time period:** Early Cretaceous — approximately 129 to 113 million years ago (Barremian to Aptian)
- 🦣 **Size:** Wingspan approx. 2.4 m
- 🦣 **Weight:** Estimated 1 to 3 kilograms

🦣 **Diet:** Fish-eater

🦣 **Lifestyle:** Presumably solitary; coastal and lakeshore areas

🦣 **Habitat:** Asia — coastal and lake regions of present-day Liaoning, China

🦣 **Note:** Feilongus was not a dinosaur, but a pterosaur — a flying reptile of the Early Cretaceous that belongs to a distinct evolutionary lineage.

Wang Xiaolin of the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing and colleagues described Feilongus youngi in 2005 based on two specimens from the Yixian Formation in Liaoning Province—the same exceptionally productive site that has also yielded Confuciusornis, Microraptor, and numerous other feathered dinosaurs and early birds. The name Feilongus is a combination of the Chinese Fei Long, meaning "flying dragon," and the Latin suffix for lizard. The species name youngi honors the Chinese paleontologist Yang Zhongjian, known as C.C. Young—one of the founding figures of Chinese vertebrate paleontology.

Feilongus belongs to the family Germanodactylidae within the Pterodactyloidea—the short-tailed, advanced pterosaurs that dominated the Cretaceous period. What distinguishes it within this family is the skull crest: an upright bony ridge that extended from the front of the snout far back over the skull. Such crests are common among pterodactyloids but vary greatly in shape and size between species and individuals. In Feilongus, it was comparatively tall and well-developed—likely a signaling organ, possibly differing in expression between males and females.

Teeth were present only in the front of the jaw—a feature that distinguishes Feilongus from tooth-bearing pterosaurs with fully dentate jaws and suggests a specialized hunting strategy. A few specialized grasping teeth at the front, followed by a toothless jaw—a pattern that was efficient for rapid snapping at the water's surface.

Two specimens constitute a narrow basis. Thanks to its exceptional state of preservation, the Yixian Formation provides more details than would be possible elsewhere—but the material is insufficient for far-reaching conclusions about the behavior and ecology of Feilongus.

Feilongus was a flying dragon from Cretaceous China—with a crest, grasping teeth, and a name that sounds better than any scientific description ever could.

Fenghuangopterus

Fenghuangopterus lii — Cheng et al., 2012

🦣 **Period:** Middle to Late Jurassic — approximately 168 to 161 million years ago (Bathonian)

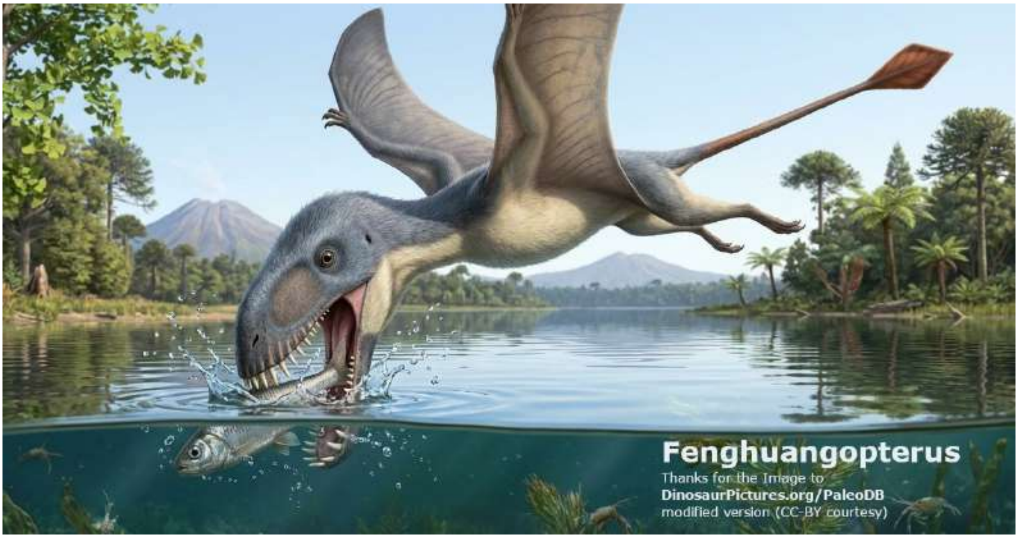
🦣 **Size:** Wingspan approx. 70 to 90 cm — small pterosaur

🦣 **Weight:** Estimated 100 to 300 grams

🦣 **Diet:** Fish-eater; possibly also insects

🦣 **Habitat:** Asia — coasts and lake regions of present-day Liaoning, China

🦣 **Note:** Fenghuangopterus was not a dinosaur, but a pterosaur — a flying reptile of the Middle Jurassic that belongs to a distinct evolutionary lineage.



Cheng Xin and colleagues described Fenghuangopterus lii in 2012 based on a single specimen from the Tiaojishan Formation in the Chinese province of Liaoning—the same formation that yielded Anchiornis and Aurornis and is known for its exceptional preservation quality. The name refers to the Fenghuang—the phoenix of Chinese mythology, one of the most significant birds of good fortune in East Asian cultural tradition. The species name lii honors Li Yinxian, who made the specimen available to science.

Fenghuangopterus belongs to the family Rhamphorhynchidae—the long-tailed, more primitive pterosaurs of the Jurassic period, which differed fundamentally from the short-tailed pterodactyloids of the Cretaceous period. The long, stiff tail with a membrane flap at the end served as a stabilizer in flight—an aerodynamic tool that later pterosaurs abandoned in favor of greater maneuverability.

What the single specimen reveals: a small, lightly built animal with long, narrow wings and a dentition suggesting a diet of fish or insects. The material does not allow for more. One specimen, one formation, few confirmed details. Fenghuangopterus is scientifically significant as further evidence of the diversity of Rhamphorhynchids in the Middle Jurassic of China—a group that apparently developed considerable species diversity in this region and time period.

Fenghuangopterus bore the name of the Chinese phoenix—and left science with exactly one fossil that reveals just enough to pique curiosity.

Giganotosaurus

Giganotosaurus carolinii — Coria & Salgado, 1995

- 🦣 **Period:** Middle Cretaceous — approximately 99 to 93 million years ago (Cenomanian to Turonian)
- 🦣 **Size:** Approx. 12 to 13 m long, about 3.5 to 4 m at the hip
- 🦣 **Weight:** Approx. 6,000 kilograms — possibly up to 8 tons
- 🦣 **Life expectancy:** Presumably 30 to 40 years
- 🦣 **Diet:** Carnivore — primarily giant titanosaurs
- 🦣 **Lifestyle:** Presumably solitary; possible group activity when hunting large prey
- 🦣 **Speed:** Estimated 40 to 50 km/h
- 🦣 **Habitat:** South America — open river landscapes of today's Neuquén Province, Patagonia

Rubén Carolini was an auto mechanic and passionate fossil collector. In 1993, he discovered a bone in the Patagonian desert that was too large to ignore. What he had found was the femur of an animal that surpassed T. rex in length—forcing paleontology to rethink its understanding of the largest predatory dinosaur in Earth's history.

Rodolfo Coria of the Museo Carmen Funes in Plaza Huincul and Leonardo Salgado described Giganotosaurus carolinii in the journal Nature in 1995. The species name honors Carolini. Three specimens have been identified since then.

Measuring up to 13 meters in length and weighing six to possibly eight tons, Giganotosaurus was the largest known predatory dinosaur in South America—and one of the largest in the world. A direct comparison with T. rex is tempting but misleading: both animals lived on different continents, in different eras, under completely different ecological conditions. Giganotosaurus lived about 30 million years before T. rex. The two meet only in the imagination.

Giganotosaurus belongs to the family Carcharodontosauridae—the same group as Carcharodontosaurus from North Africa, with which it has more in common than with T. rex. On separate continents, both developed similar solutions to the same problem: How do you hunt sauropods that are ten times as heavy as you are?

A Skull for Titanosaurs

The skull of Giganotosaurus was longer than that of T. rex—over 1.8 meters, making it the longest known theropod skull—but more lightweight, with large skull windows that saved weight. The teeth were laterally flattened and serrated, like saw blades—designed for cutting, not crushing. The same morphology as in Carcharodontosaurus, the same strategy: deep, rapid bites that caused massive tissue damage without the animal having to hold onto its prey.

This technique made sense against titanosaurs. A direct wrestling match with a forty- or fifty-ton animal would have been fatal even for Giganotosaurus. Instead: bite, retreat, wait. Bleeding and shock did the rest. Modern large predators like lions and hyenas use comparable strategies against prey that physically overwhelms them.

Fossil finds from the Candeleros Formation in Neuquén show Giganotosaurus in close proximity to the remains of Argentinosaurus—a titanosaur weighing possibly sixty to eighty tons. This is no coincidence. Argentinosaurus was the most obvious food source in this ecosystem, and Giganotosaurus was the only animal large enough to seriously take it on. Whether it hunted alone or in groups is not documented. A possible pack discovery of Mapusaurus—a close relative—described in 2006 has brought the hypothesis of group hunting among carcharodontosaurids into discussion, but there is a lack of corresponding evidence for Giganotosaurus itself.

Comparisons with T. rex regarding intelligence are popular and largely speculative. The brain of Giganotosaurus, as far as can be reconstructed from skull casts, was elongated and banana-shaped—less complex in structure than that of T. rex, with well-developed olfactory bulbs. A scent hunter, not a tactical thinker—but in a world where Argentinosaurus was the main meal, that was entirely sufficient.

Giganotosaurus was longer than T. rex, lived thirty million years earlier, and hunted sauropods that were ten times as heavy—a predator that proves South America had its own rules for gigantism.

Gorgosaurus

Gorgosaurus libratus — Lambe, 1914

- 🦣 **Period:** Late Cretaceous — approximately 77 to 75 million years ago (Campanian)
- 🦣 **Size:** Approx. 8 to 9 m long, about 2.5 to 3 m at the hip
- 🦣 **Weight:** Estimated 2 to 2.5 tons
- 🦣 **Life expectancy:** Presumably 20 to 25 years
- 🦣 **Diet:** Carnivore — hadrosaurids, ceratopsids, possibly also carrion
- 🦣 **Lifestyle:** Presumably solitary; evidence of juveniles in groups
- 🦣 **Speed:** Estimated 30 to 40 km/h
- 🦣 **Habitat:** Western North America — floodplains and coastal forests of present-day Alberta and Montana

Gorgosaurus libratus is the tyrannosaurid that most people don't know about — and that's unfair. With 17 known specimens, it is one of the best-documented large theropods ever, better documented than Daspletosaurus, better documented than many of its more famous relatives. Lawrence Lambe of the Geological Survey of Canada described it in 1914 based on finds from the Dinosaur Park Formation in Alberta—a site that remains one of the most productive in the world to this day. The name means "terrifying lizard"—a name that could hardly be more fitting for a tyrannosaurid.

Gorgosaurus lived about 77 to 75 million years ago—roughly ten million years before T. rex, and at the same time as Daspletosaurus in the same formation. Two tyrannosaurids, one ecosystem. Gorgosaurus was the slimmer, faster of the two—lighter in build, with longer legs relative to its body size, an animal designed for speed. Daspletosaurus was more massive and robust. The hypothesis that both species preferred different prey groups—Gorgosaurus the faster hadrosaurs, Daspletosaurus the armored ceratopsians—is plausible but not conclusively proven.

At eight to nine meters long and weighing two to two and a half tons, Gorgosaurus was smaller than T. rex, but by no means an insignificant predator. In the Dinosaur Park Formation, where no heavier tyrannosaurids lived, it was the undisputed apex predator—the predator against which everything else was measured.

Growth, Bones, and What They Reveal

The 17 known specimens include animals of various life stages—from juveniles to fully grown adults. This is rare and valuable. Bone histological studies, including work by Phil Currie of the Royal Tyrrell Museum and Gregory Erickson of Florida State University, have reconstructed the growth pattern of Gorgosaurus in detail.

The result: rapid growth in youth, with an intensive phase between the ages of five and fifteen, during which Gorgosaurus gained several hundred kilograms per year. Full body size was reached at around eighteen to twenty years of age. Maximum life expectancy was about twenty-five years—shortly after reaching full growth, the bone structure began to show signs of age and wear.

Juvenile Gorgosaurus looked different from adults—proportionally larger eyes, longer legs relative to the torso, a slimmer skull. They were presumably faster than adults and hunted different prey: small dinosaurs, juveniles of other species. This pattern—different age groups occupying different ecological niches—has been proposed by Phil Currie and others as an explanation for why large tyrannosaurids could dominate an ecosystem despite their enormous energy demands: parents and offspring rarely competed for the same prey.

A specimen that made history

The most complete known Gorgosaurus skeleton—discovered in 1913 in Alberta and now on display at the Royal Tyrrell Museum in Drumheller—is considered one of the finest theropod skeletons in the world. Nearly complete, well-preserved, with a skull that reveals every anatomical detail. This specimen formed the basis for much of the early Gorgosaurus research and remains a reference point for tyrannosaurid studies to this day.

In 2023, a Gorgosaurus skeleton was auctioned at Sotheby's in New York for $6.1 million—a move that sparked significant criticism within the paleontological community, as fossils sold at commercial auctions are often permanently lost to science. The specimen comes from Montana, making it one of the few Gorgosaurus skeletons found outside of Canada.

Gorgosaurus was the T. rex of ten million years ago—sleeker, faster, and just as unchallenged in its own forests as the "King of Tyrants" was in his.

Halszkaraptor

🦣 ***Halszkaraptor escuilliei — Cau et al., 2017***

- 🦣 **Period:** Late Cretaceous — about 75 to 71 million years ago (Campanian)
- 🦣 **Size:** Approximately 45 to 60 cm long — about the size of a duck
- 🦣 **Weight:** Estimated 1 to 2 kilograms
- 🦣 **Life expectancy:** Unknown
- 🦣 **Diet:** Carnivore — likely fish and small aquatic animals

- **Lifestyle:** Probably solitary; semi-aquatic
- **Speed:** Efficient in water; agile on land
- **Habitat:** Asia — waters and shore regions of today's Gobi Desert, Mongolia

Halszkaraptor escuilliei is one of the rare dinosaur finds that briefly leave even experienced paleontologists speechless. A dromaeosaurid — a relative of Velociraptor — that looks like a cross between a duck, a penguin, and a predator dinosaur. Long, flexible swan neck. Flat, broad snout with numerous small teeth. Short, powerful forearms with an anatomy reminiscent of rowing. And all of this in an animal the size of a domestic duck that lived in the Cretaceous period of Mongolia.

Andrea Cau from the Giovanni Capellini Geological Museum in Bologna and colleagues described Halszkaraptor in 2017 in the journal Nature — based on a single specimen from the Djadochta Formation in the Ömnögovi Province of Mongolia. The name honors Halszka Osmólska, the legendary Polish paleontologist who described more Mongolian dinosaurs than almost any other researcher of her generation. The species name escuilliei honors François Escuillié, the fossil collector who made the specimen available to science - after it had apparently circulated in the private fossil trade.

The specimen itself was initially incased in a private block. Cau and colleagues used synchrotron radiation at the European Synchrotron

Radiation Facility in Grenoble to fully analyze the skeleton without damaging it — a method that allows for three-dimensional insights into the stone that mechanical preparation could never provide. What they found surprised the entire team.

Penguin anatomy in a dromaeosaurid

The forearms of Halszkaraptor are the key feature. They were short and stout, with a shoulder joint structure that allowed for lateral movement in the water — similar to the wings of modern penguins, which have been repurposed for underwater flight. On land, the same arms likely served as support when running on all fours, which is highly unusual for dromaeosaurids.

The neck was remarkably long and flexible — proportionally more like that of a swan than that of a typical theropod. Together with the broad, flat snout and the numerous small teeth, this paints a clear picture: Halszkaraptor hunted in the water, probably fish, which it caught with quick neck movements — similar to how modern herons or cormorants do today.

Neurosensory pits along the snout—similar to those of crocodiles—indicated, according to the original description, pressure receptors that could sense movements in the water. A hunter who not only saw but felt what was happening around him in the water.

What places Halszkaraptor in the broader field of dinosaur research: It is further evidence that dromaeosaurids were ecologically much more diverse than the classic image of the fast land hunter with a sickle claw suggests. Austroraptor ate fish. Microraptor glided thru trees. Halszkaraptor swam. The same basic architecture — sickle claw, long tail, feathers — was directed by evolution in completely different directions.

The sickle claw was, by the way, present. Even a semi-aquatic dromaeosaurid stayed true to its family in this respect.

Halszkaraptor was a dromaeosaurid with a swan neck, duck bill, and penguin arms — an animal that proves that Velociraptor relatives literally popped up everyplace in the Cretaceous, even in the water.

Hatzegopteryx

Hatzegopteryx thambema — Buffetaut et al., 2002

- 🦣 **Period:** Late Cretaceous — approximately 71 to 66 million years ago (Maastrichtian)
- 🦣 **Size:** Wingspan approx. 10 to 12 m — one of the largest known pterosaurs
- 🦣 **Weight:** Estimated 200 to 250 kilograms
- 🦣 **Diet:** Probably not a fish-eater — rather a large terrestrial predator that fed on small dinosaurs
- 🦣 **Lifestyle:** Presumably solitary; terrestrial
- 🦣 **Habitat:** Europe — the island landscapes of present-day Romania
- 🦣 **Note:** Hatzegopteryx was not a dinosaur, but a pterosaur — a flying reptile of the Late Cretaceous period belonging to a distinct evolutionary lineage.

Eric Buffetaut of the French CNRS and colleagues described Hatzegopteryx thambema in 2002 based on skull and arm bone fragments from the Hațeg Formation in Romania—the same island formation that also yielded Bakonydraco and the dwarf sauropod Magyarosaurus. The name means “Hațeg wing”—named after the Hațeg Basin in Transylvania. Thambema comes from Greek and means “monster”—a reference to the animal’s sheer size. Two specimens are known.

With a wingspan of ten to twelve meters, Hatzegopteryx ranks among the largest flying reptiles that ever lived—comparable to Quetzalcoatlus from North America, the other giant among the azhdarchids. What distinguished Hatzegopteryx from Quetzalcoatlus, however, was its skull: exceptionally robust, with thick bone walls and a jaw that was massive for an animal of this size. Quetzalcoatlus had a long, slender skull—Hatzegopteryx had a short, broad, structurally stable one.

Not a fish-eater — an island predator

The classification as a fish-eater in the source data is most likely incorrect — and that is one of the most interesting findings of recent pterosaur research. Mark Witton of the University of Portsmouth and Darren Naish have argued in several studies that large azhdarchids like Hatzegopteryx were not fish-eaters, but terrestrial predators—animals that walked on land, fed on small to medium-sized vertebrates, and used their long necks to pick up prey from the ground, much like a modern marabou or saddle-billed stork.

For Hatzegopteryx on Haţeg Island, this meant a unique ecological role. The island landscape of Late Cretaceous Europe had lost its large theropods due to insular dwarfism—there were no tyrannosaurids or large abelisaurids on Hațeg. The island's largest terrestrial predators were small. Hatzegopteryx filled this vacuum—a pterosaur that walked on the ground and fed on small dinosaurs such as Telmatosaurus or Zalmoxes. A flying apex predator that occupied the niche belonging to the large theropods on mainland continents.

The robust skull fits this lifestyle. Fish-eaters need light, fast jaws. An animal that grabs and kills vertebrates on the ground needs structural stability. Hatzegopteryx had both—and apparently used it for the latter.

Hatzegopteryx was not a fish-eater, but rather the apex predator of an island—a pterosaur with an airplane's wingspan that walked on the ground and ate the dinosaurs that no one else on Hațeg would have eaten.

Iberodactylus

Iberodactylus andreui — Holgado et al., 2019

- 🦣 **Period:** Early Cretaceous — approximately 130 to 125 million years ago (Barremian)
- 🦣 **Size:** Estimated wingspan of 4 to 5 m
- 🦣 **Weight:** Estimated 5 to 15 kilograms
- 🦣 **Diet:** Probably fish-eater

🦣 **Habitat:** Europe — coasts and river systems of present-day Aragon, Spain

🦣 **Note:** Iberodactylus was not a dinosaur, but a pterosaur — a flying reptile of the Early Cretaceous that belongs to a distinct evolutionary lineage.

Borja Holgado and colleagues described Iberodactylus andreui in 2019 in the journal PeerJ—based on skull fragments from the Blesa Formation in the Spanish region of Aragon. The name is straightforward: "Ibero" for the Iberian Peninsula, "dactylus" for finger—the classic reference to the elongated finger bones that span the wing membrane in pterosaurs. The species name "andreui" honors Félix Andrés Peña, who made the material available to science.

Iberodactylus belongs to the family Anhangueridae—the same group as Anhanguera from South America, which we have already discussed. What makes the Anhangueridae recognizable is the characteristic bony crest at the tip of the snout—on both the upper and lower jaws—which is well-preserved in Iberodactylus and clearly confirms its family affiliation. The teeth were conical and adapted for catching fish.

What makes the discovery scientifically interesting: Iberodactylus is the oldest known anhanguerid in Europe and one of the oldest worldwide. Its presence in Spain during the Early Cretaceous suggests that this group was more widespread and existed earlier than long assumed—it may have originated in Europe or spread from there before reaching its greatest diversity in South America.

The available material does not allow for further conclusions. Skull fragments without a complete skeleton, a single specimen, a single site.

Iberodactylus was the oldest known anhanguerid in Europe—a snapshot from a time when this group was just beginning to colonize the coasts of the Early Cretaceous.

Iberospinus

Iberospinus natarioi — Malafaia et al., 2020

- 🦣 **Time period:** Early Cretaceous — approximately 130 to 125 million years ago (Barremian)
- 🦣 **Size:** Estimated 7 to 9 m long
- 🦣 **Weight:** Estimated 1 to 2 tons
- 🦣 **Life expectancy:** Unknown
- 🦣 **Diet:** Carnivore — likely fish and other vertebrates
- 🦣 **Lifestyle:** Presumably solitary; semi-aquatic
- 🦣 **Habitat:** Europe — coasts and river systems of present-day Portugal

Iberospinus natarioi is a recent discovery — described in 2020 based on material that had already been discovered near Lisbon in 1999. Ironically, it was in Portugal—a country known paleontologically primarily for its Jurassic dinosaurs—that a spinosaurid turned up, and one that significantly expands the known range of this family in Europe.

Octávio Mateus of the Universidade Nova de Lisboa and colleagues described Iberospinus in the journal PLOS ONE. The name is straightforward: Ibero for the Iberian Peninsula, spinus for thorn—a reference to the elongated spinous processes of the spine, which are typical of spinosaurids. The species name natarioi honors Carlos Natário, who discovered the site.

Iberospinus belongs to the family Spinosauridae—the same group as Spinosaurus, Baryonyx, and the recently described Ceratosuchops from England. European spinosaurids are piling up: Baryonyx from England, Ceratosuchops from the Isle of Wight, and now Iberospinus from Portugal. The picture emerging is that of a group that was considerably more diverse in early Cretaceous Europe than long assumed—with regional species across different parts of the archipelago at that time.

What the known material shows: teeth and partial skeleton, including ribs and vertebrae, which clearly confirm a spinosaurid classification. A complete picture of the animal cannot yet be drawn from this. The body size estimate of seven to nine meters is based on comparisons with related species—Iberospinus was thus smaller than Spinosaurus, but in the same size class as Baryonyx.

Portugal's coastal and riverine landscape during the Early Cretaceous was rich in fish and aquatic reptiles—a habitat ideal for a semi-aquatic spinosaurid and explaining why this group occupied similar ecological niches multiple times and independently across Europe.

Iberospinus shows that European spinosaurids were not a marginal phenomenon—Portugal, England, the Isle of Wight: this family had a firm grip on early Cretaceous Europe.

Ichthyovenator

Ichthyovenator laosensis — Allain et al., 2012

- 🦣 **Period:** Early Cretaceous — approximately 125 to 113 million years ago (Aptian to Albian)
- 🦣 **Size:** Estimated 8 to 9 m long
- 🦣 **Weight:** Estimated 1 to 2 tons
- 🦣 **Life expectancy:** Unknown
- 🦣 **Diet:** Carnivore — likely fish and other vertebrates
- 🦣 **Lifestyle:** Presumably solitary; semi-aquatic
- 🦣 **Habitat:** Asia — riverine landscapes of present-day Laos and possibly Thailand

Ichthyovenator laosensis is the only known spinosaurid from Southeast Asia—and it possesses an anatomical feature that is unique even within this already anatomically unusual family.

Ronan Allain of the Muséum National d'Histoire Naturelle in Paris and colleagues described Ichthyovenator in 2012 in the journal Nature, based on a single partial skeleton from the Grès supérieurs Formation in Savannakhet Province, Laos. The name means “fish hunter from Laos”—direct, functional, and geographically precise. The source data lists Thailand as the discovery site, which is incorrect—the fossils come from Laos, even though the animal may have had a wider range.

A sail with a gap

What distinguishes Ichthyovenator from all other known spinosaurids is its back. The spinous processes of the vertebrae are elongated—as in Spinosaurus—but not continuous. There is a distinct interruption between the lumbar vertebrae and the anterior dorsal vertebrae: two separate sail sections, divided by a gap. No other known dinosaur has such a structure. Whether it was a true double sail connected by skin or two separate muscular bulges cannot be determined from the bones alone—but the anatomy is clear and unmistakable.

The function of this structure, as with all spinosaurid dorsal structures, has not been conclusively clarified. Thermoregulation, display organ, muscle attachment—all known hypotheses apply equally here, with the additional question of why the gap exists and whether it was functionally relevant.

Ichthyovenator demonstrates that spinosaurids had a wide geographic distribution in the Early Cretaceous—from Europe through North Africa to Southeast Asia. How they covered this distance, via which land bridges or island chains, is an open biogeographic question that cannot be answered with a single specimen from Laos.

Ichthyovenator was the only dinosaur to have a split dorsal crest with a gap—an anatomical detail for which science still has no complete explanation.

Iguanodon

***Iguanodon bernissartensis* — Boulenger, 1881**

🦣 **Period:** Early Cretaceous — about 126 to 122 million years ago

🦣 **Size:** Approximately 9 to 11 m long, about 2.7 m at the hip

🦣 **Weight:** Estimated 3 to 4.5 tons

🦣 **Life expectancy:** Presumably 20 to 30 years

🦣 **Diet:** Herbivore — ferns, horsetails, low flowering plants, conifer shoots

🦣 **Lifestyle:** Presumably in herds; well-documented thru mass finds

- 🦣 **Speed:** Estimated 20 to 35 km/h on two legs
- 🦣 **Habitat:** Western Europe — river deltas and coastal forests of present-day Belgium, England, and Spain; related forms in North America and Asia

Iguanodon is not a dinosaur that is known because it was the largest or the fastest or the most dangerous. You know him because he was one of the first. One of the first ever found. One of the first to be described. And one of the first to even create the image of the dinosaur. Without Iguanodon, the term dinosaur might not exist — at least not so early and not so precisely. It is an animal that made history before anyone knew what dinosaurs actually were.

The story begins in the 1820s in England. Gideon Mantell, a country doctor and passionate fossil collector from Sussex, comes across unusual teeth that remind him of the teeth of a modern iguana lizard — only many times larger. He concludes that they must come from a giant herbivorous reptile and names it Iguanodon — iguana tooth — in 1825. The scientific community reacts skeptically. A giant plant-eating reptile? Mantell insists. He is right.

What follows is one of the most fascinating discovery stories in paleontology. In 1878, miners in a coal mine in Bernissart, Belgium, at a depth of 322 meters, stumbled upon a layer of bones that proved to be extraordinary: 38 complete or nearly complete Iguanodon skeletons, stacked on top of each other like a natural time capsule. To this day, it is one of the most significant dinosaur discoveries in Europe. The skeletons are painstakingly excavated over the years and displayed at the Royal Belgian Institute of Natural Sciences in Brussels — where they still stand today, welcoming visitors from all over the world.

The thumb spike and a long-standing error

Anyone who knows the early reconstructions of Iguanodon knows that something was wrong. The first official model, erected in 1854 in London's Crystal Palace Park, where it still stands today, depicts Iguanodon as a massive, four-legged, rhinoceros-like reptile—with a horn spike on its nose. This horn was actually a bone that belonged to the animal. It just wasn't on the nose. He sat on the thumb.

The thumb spike of Iguanodon is one of the most distinctive anatomical features in the entire history of dinosaurs. A sharp, conical bone spike that sat on the first digit of the hand, and could reach a considerable length in adult animals. As a weapon, it was obviously suitable — a thrust with it into an attacker would have caused real damage. Whether Iguanodon actually used it actively for defense or whether it was more of a tool for opening fruits and breaking branches has not been conclusively determined. Both are plausible. Both fit the anatomy.

The remaining fingers of Iguanodon tell their own story. The middle three fingers were broad and equipped with hooves — suitable for bearing the weight of the animal when walking on all fours. The fifth finger was mobile and grasping, almost like a rudimentary thumb. Iguanodon could therefore walk on both two and four legs, depending on speed and situation, and grasp with its hands. An anatomical flexibility that was not common in the world of dinosaurs.

An animal for two eras

What makes Iguanodon scientifically valuable is the sheer amount of available material. Thanks to the Bernissart finds and numerous other skeletons from England, Spain, and Germany, Iguanodon is one of the best-documented dinosaurs in Europe. This allows insights that are simply not possible with fragmentarily preserved animals — into growth stages, body proportions, variations between individuals.

And these insights have significantly changed the image of Iguanodon over the decades. For a long time, it was considered a cumbersome, upright biped — a posture that the early skeleton mounts in Brussels reflect. Today we know that Iguanodon adopted a horizontal body posture, stretched its tail as a counterweight, and switched between bipedal and quadrupedal locomotion depending on speed. A significantly more dynamic image than that of the sluggish giant reptile from the 19th century. Century.

Iguanodon

Iguanodon lived in early Cretaceous Western Europe, at a time when the continents were still closer together than today and faunal exchange between Europe, Asia, and North America was still possible. His relatives are found on several continents — which shows that the Iguanodontia, the group to which he belongs, was extraordinarily successful and adaptable. In the late Cretaceous, this line gave rise to the hadrosaurids, the duck-billed dinosaurs, which became the most common herbivores of their time.

Iguanodon itself fed on low-lying to mid-height vegetation. Its beak was broad and horned, suitable for cutting plant material, with the molars behind it designed for grinding. The teeth resembled — as Mantell correctly recognized — those of modern iguanas, only more massive and arranged in an efficient chewing structure. He ate ferns, conifer shoots, horsetails, and increasingly the flowering plants that rapidly spread during the early Cretaceous period.

Herd behavior is well-documented in Iguanodon. The 38 individuals from Bernissart of different age classes at the same site, along with trace fossils from England and Spain showing groups of animals — the picture is consistent. Iguanodon traveled in groups, ate in groups, and offered young animals the protection that a single animal could not provide. In a world with large predators like Baryonyx and early tyrannosaurs, that was no bad strategy.

Iguanodon was the dinosaur that taught science what dinosaurs are — an animal that started with a misplaced thumb spike and ended up changing all of paleontology.

Jeholosaurus

Jeholosaurus shangyuanensis — Han et al., 2010

🦣 **Period:** Early Cretaceous — approximately 130 to 122 million years ago (Barremian)

🦣 **Size:** Approx. 70 to 90 cm long

🦣 **Weight:** Estimated 1 to 3 kilograms

🦣 **Life expectancy:** Presumably 5 to 10 years

🦣 **Diet:** Herbivore — low vegetation, seeds, possibly insects

🦣 **Lifestyle:** Unknown; presumably agile and close to the ground

🦣 **Speed:** Unknown; likely very agile given its body size

🦣 **Habitat:** Asia — terrestrial landscapes of present-day Liaoning Province, China

Jeholosaurus shangyuanensis is one of those small herbivores that populated the undergrowth of Cretaceous China—inconspicuous, fast, ecologically indispensable, but long neglected by science. Han Fenglu and colleagues described it in 2010 based on a single specimen from the Yixian Formation in Liaoning Province—the same site that has yielded Confuciusornis, Microraptor, and numerous other animals.

The name refers to Jehol—the historical name of the region, which is used in paleontology as a collective term for the exceptionally rich Cretaceous fauna of northeastern China. Shangyuanensis refers to the exact location within this formation.

Jeholosaurus belongs to the Ornithopoda group—the same lineage from which Iguanodon and the hadrosaurs later emerged. During the Barremian, this lineage was still young and small-statured. Jeholosaurus represents an early, poorly specialized branch—bipedal, lightly built, with a simple herbivorous dentition.

What the single specimen reveals is sufficient for a rough anatomical picture, but not for far-reaching conclusions about behavior or ecology. The Yixian Formation is known for its preservation quality—feathers, soft tissue, and stomach contents are occasionally preserved there. This was not the case with the only known Jeholosaurus specimen.

In an ecosystem with Microraptor, early birds, and medium-sized theropods, an animal weighing one kilogram relied on speed and cover. That is all that can be said.

Jeholosaurus was a footnote in China's Cretaceous period—too small for headlines, too completely ignored for an animal that fought daily for survival in its ecosystem.

Kentrosaurus

Kentrosaurus aethiopicus — Hennig, 1915

🦣 **Period:** Late Jurassic — approximately 156 to 150 million years ago

🦣 **Size:** Approx. 4 to 5 m long, about 1.5 to 1.8 m at the hip

🦣 **Weight:** Approx. 320 kilograms; femur about 633 mm long

🦣 **Life expectancy:** Presumably 20 to 30 years

🦣 **Diet:** Herbivore — low vegetation, ferns, conifer shoots

🦣 **Lifestyle:** Presumably in small groups or as a solitary animal

🦣 **Speed:** Estimated 10 to 15 km/h

🦣 **Habitat:** Africa — coastal forests and floodplains of the Tendaguru Formation, present-day Tanzania

Stegosaurus gets the most attention—and rightly so, since it is larger and better known. But anyone familiar with Kentrosaurus knows that its African relative was superior in one crucial category: armament. While Stegosaurus bore broad, flat bony plates on its back, Kentrosaurus combined plates and spikes in a way that made it a far more dangerous defensive weapon. Small plates on the front of the body, long, pointed spikes on the hindquarters and tail—plus an additional pair of shoulder spikes that jutted out to the sides. A predator attacking Kentrosaurus from behind would encounter an array of bony spikes guaranteed to inflict serious injuries.

Edwin Hennig described Kentrosaurus aethiopicus in 1915 based on finds from the Tendaguru Formation in Tanzania—the same excavation site that also yielded Giraffatitan and whose fossils were recovered between 1909 and 1913 during one of the most extensive paleontological expeditions in history. The Natural History Museum in Berlin still houses the majority of this material. Twenty-seven specimens are known—a remarkably solid data set for an African dinosaur.

Spikes with Range

What distinguishes Kentrosaurus from Stegosaurus goes beyond its appearance. The shoulder spikes—a feature that is absent or only rudimentary in Stegosaurus—gave Kentrosaurus a lateral protective zone that made attacks from the flank difficult. The tail spikes were long and pointed, and the biomechanics of the tail were designed for maximum reach.

Heinrich Mallison of the Museum für Naturkunde Berlin modeled the tail movement of Kentrosaurus using computed tomography and biomechanics—with a surprising result: Kentrosaurus could whip its tail sideways with considerable force and speed, achieving a reach far greater than its body length would suggest. The spikes at the tip of the tail could generate forces capable of breaking bones. Even an Allosaurus relative, which was present as a predator in the Tendaguru Formation, had good reason to avoid Kentrosaurus from the wrong side.

As with all stegosaurids, the brain was small relative to body size. Kentrosaurus was not a strategic thinker—but an animal that reacted to an attack with a reflexive tail strike did not need complex cognition. The protective effect was passive and automatic.

As a herbivore, Kentrosaurus specialized in low vegetation. With a body weight of 320 kilograms and short forelimbs, its head was close to the ground—ferns, low conifer shoots, and ground-level leaves were the obvious food sources in the Tendaguru coastal forests. The teeth were simple and leaf-shaped, unsuited for hard material.

Kentrosaurus was a Stegosaurus with sharper spikes, more shoulder armor, and a tail that was biomechanically proven to be more dangerous than that of its more famous relative—smaller, but in a pinch, the more dangerous animal.

Kimmerosaurus

Kimmerosaurus langhami — Brown, 1981

🦣 **Period:** Late Jurassic — approximately 157 to 145 million years ago (Kimmeridgian to Tithonian)

🦣 **Size:** Estimated 3 to 5 m in length

🦣 **Weight:** Unknown

🦣 **Diet:** Carnivore — fish, squid, small marine organisms

🦣 **Reproduction:** Viviparous

🦣 **Habitat:** Europe — shallow epicontinental seas of present-day England

🦣 **Note:** Kimmerosaurus was not a dinosaur, but a plesiosaur — a marine reptile of the Late Jurassic that belongs to a distinct evolutionary lineage.

David Brown described Kimmerosaurus langhami in 1981 based on two specimens from the Kimmeridge Clay in Dorset, England—a Late

Jurassic marine rock formation named after the Kimmeridgian epoch, which in turn was named after the coastal town of Kimmeridge in Dorset. The species name honors Richard Langham, who collected the material and made it available to science.

Kimmerosaurus belongs to the family Cryptoclididae—the same family as Cryptoclidus, which we have already discussed. As a cryptoclidid, it was a long-necked plesiosaur with a small skull, numerous thin teeth, and four flippers—the classic body plan of an animal that hunted small, fast prey in open water.

Two specimens, mostly fragmentary material—that is enough for a taxonomic classification, but not for a complete anatomical picture. What the bones reveal fits a medium-sized member of its family that inhabited the shallow Jurassic seas of Europe—the same ecosystem as Cryptoclidus, possibly with overlapping hunting grounds.

The Kimmeridge Clay is one of England's most productive marine rock layers for plesiosaur finds—in addition to Kimmerosaurus, it has yielded Cryptoclidus, Muraenosaurus, and several other species. The Late Jurassic sea off England was apparently rich enough to support multiple plesiosaur species simultaneously.

The fossil record does not allow for more. Kimmerosaurus is well-documented enough to warrant its own name—but too fragmentary for deeper insights.

Kimmerosaurus is a name from the Kimmeridge Clay—two specimens, one sea, and just enough bones to show that the Jurassic oceans of Europe were teeming with life.

Kronosaurus

Kronosaurus queenslandicus — Longman, 1924

🦣 **Period:** Early Cretaceous — about 125 to 99 million years ago (Aptian to Cenomanian)

🦣 **Size:** Approximately 9 to 11 meters long

🦣 **Weight:** Estimated 10 to 12 tons

🦣 **Diet:** Carnivorous — turtles, plesiosaurs, large fish, marine reptiles

🦣 **Reproduction:** Probably viviparous

🦣 **Habitat:** Southern Hemisphere — shallow epicontinental seas of present-day Queensland, Australia, and Colombia

🦣 **Preliminary:** Kronosaurus was not a dinosaur, but a pliosaur — a subgroup of plesiosaurs with a short neck, large head, and massive body. The relationship to the long-necked plesiosaurs is real, but the design plan is fundamentally different.

Heber Longman from the Queensland Museum described Kronosaurus queenslandicus in 1924 based on fragments from Queensland — named after the Australian state where the first finds were made. The name refers to Kronos, the Greek Titan who devoured his own children — a mythological allusion to a predator that ate nearly everything it encountered. Fossils are known from Australia and Colombia, suggesting a wide distribution in the Cretaceous seas of the Southern Hemisphere.

Kronosaurus was one of the largest pliosaurs known — at nine to eleven meters long, significantly larger than a great white shark, with a skull that alone measured almost three meters. Its jaws were crocodilian in shape and lined with conical teeth up to 30cm long - built for grabbing and holding, not chewing. Whatever Kronosaurus caught, it didn't let go.

Stomach contents as direct evidence

What distinguishes Kronosaurus from many other prehistoric predators is the direct evidence of its diet. Some specimens have been found with preserved stomach contents — turtle shell remains, bones of smaller plesiosaurs, and large fish bones. This is not an indirect conclusion from tooth morphology, but fossil evidence of what this animal actually ate. Kronosaurus was at the absolute top of the food chain in its ecosystem — a predator that hunted other marine reptiles.

The four large flippers enabled a powerful underwater flying principle — not swimming like a fish, but actively rowing thru the water column. With a body weight of ten to twelve tons, Kronosaurus was not a fast hunter, but an endurance predator — an animal that overwhelmed large prey thru strength and weight, not speed.

The well-known Harvard specimen, excavated and mounted in the 1930s, was filled with plaster during preparation to bridge gaps— extending the length of the mounted skeleton to over thirteen meters and leading to decades of overestimations of its actual size. More recent analyzes correct the length to nine to 11 meters - still exceptional.

Kronosaurus ate turtles, other plesiosaurs and everything in between - known from a pliosaur whose stomach contents have directly shown who was at the top of the marine food chain in the Cretaceous.

Lambeosaurus

Lambeosaurus lambei — Parks, 1923

🦣 **Period:** Late Cretaceous — about 76 to 75 million years ago

🦣 **Size:** Approximately 9 to 15 m long, about 2.5 to 4 m at the hip height

🦣 **Weight:** Estimated 5 to 8 tons

🦣 **Life expectancy:** Presumably 20 to 30 years

🦣 **Diet:** Herbivore — coniferous trees, leaves, fruits, flowering plants

🦣 **Lifestyle:** Herd animal; social behavior suggested by skull features and find locations

🦣 **Speed:** Estimated 25 to 40 km/h

🦣 **Habitat:** Western North America — coastal forests and river valleys of present-day Alberta and possibly Baja California, Mexico

Lambeosaurus lambei

Anyone familiar with the hadrosaurids—the duck-billed dinosaurs of the late Cretaceous—knows that this group had a remarkable penchant for head adornments. Parasaurolophus wore a long tube. Corythosaurus had a flat, helmet-like crest. And Lambeosaurus? Lambeosaurus had both — or at least something that looks like a combination of an ax and a cone and does not occur a second time in the entire history of dinosaurs. A hollow crest pointing forwards, combined with a solid bony spike jutting backward. Strange, distinctive, and with a function that remains poorly understood to this day.

Lawrence Lambe was one of the most prolific Canadian paleontologists of his generation — a man who, between 1902 and his death in 1919, described an extraordinary number of dinosaur species from Alberta's badlands, laying the groundwork for what is now considered one of the richest dinosaur faunas in the world. In his honor, William Parks named this hadrosaurid in 1923, which comes from the Dinosaur Park Formation in Alberta — the same formation that has also yielded Parasaurolophus, Corythosaurus and Styracosaurus, and is now a UNESCO World Heritage Site.

Lambeosaurus was big. Very large, for a hadrosaurid. While most representatives of this family reached lengths between eight and ten meters, there are Lambeosaurus specimens that go well beyond that. A partial skeleton from Baja California in Mexico, described in the 1980s, suggests a body length of possibly 15 meters — which would make Lambeosaurus one of the largest hadrosaurids ever. Whether this specimen actually belongs to Lambeosaurus or represents a separate species is not definitively resolved in research. But even without this outlier, Lambeosaurus was an impressively massive creature.

A crest like no other

The crest of Lambeosaurus is unique in its shape. It consists of two parts: a hollow, forward-leaning main crest that sits above the eyes and whose interior is connected to the nasal passages, and a solid bony spike that protrudes backward over the skull. Together, they form a shape that, in profile, almost resembles an ax with a handle.

What the hollow front part could do is known from Parasaurolophus: resonators. Air flowing thru the nasal passages and the hollow crest produced deep, far-reaching tones — an acoustic means of communication in a world full of herd animals and predators. CT studies of the crest of Lambeosaurus, such as those conducted at the Royal Ontario Museum, show a complex system of hollows that was acoustically functional. The sound produced was likely lower and differently toned than that of Parasaurolophus — meaning that the two species remained distinguishable from one another in the same ecosystem.

The rear bone tube, on the other hand, was solid and hollow only at the base. As a resonating body, it was less suitable. It probably served to anchor muscles — specifically the neck muscles that held the large head upright — and possibly also as a visual recognition feature. An animal with this characteristic double crest was clearly recognizable as a Lambeosaurus from a distance, which was quite relevant in a herd with several similarly sized hadrosaurs.

Remarkable is how much the crest varied between individuals. Some specimens have a significantly larger front crest, others a more prominent rear spike. For a long time, this was interpreted as a species difference — different Lambeosaurus species or even different genera. Today, research is more inclined to assume that these are age and sex differences: males with larger crests, females with smaller ones, and juveniles with barely developed appendages. A pattern found in many modern animals, which explains why the variability is so great without the need to postulate a new species.

Life in the Dinosaur Park Formation

Lambeosaurus lived about 76 to 75 million years ago in an ecosystem of extraordinary biodiversity. The Dinosaur Park Formation in Alberta is one of the most productive dinosaur sites in the world — over 35 dinosaur species are known from it, including several hadrosaurids that shared the same habitat. How was this possible without the species entering into direct competition for food?

The answer probably lies in ecological specialization. Different hadrosaurids may have used different parts of the vegetation — different heights, different plant species, different microhabitats. Lambeosaurus, with its massive body and powerful jaws, was probably a generalist, processing conifer needles, leaves, and fruits alike. Its dentition was, like all hadrosaurids, equipped with dental batteries—continuously growing teeth in multiple rows that efficiently shredded tough plant material more effectively than almost any other dentition in dinosaur history.

Predators of the Dinosaur Park Formation were primarily medium-sized tyrannosaurids like Gorgosaurus libratus — smaller than T. rex, but still a serious threat to a hadrosaurid of this size. Herd behavior was the obvious answer: more eyes, more ears, and in case of doubt, the acoustic alarm system in the head that warned deep and far-reaching.

What came after Lambeosaurus were the later hadrosaurids of the Hell Creek Formation — Edmontosaurus and Anatotitan — which did without a crest and dominated in the late Cretaceous period. Why the crested hadrosaurids disappeared and the uncrested survived is an open question. Perhaps the crest was an evolutionary disadvantage in the altered ecosystems of the late Cretaceous. Perhaps it was pure chance. The fossils are silent on the matter.

Lambeosaurus sported the strangest headgear in dinosaur history — a bone ax with a built-in musical instrument — and was thus louder, more conspicuous and more enigmatic than most of its contemporaries.

Lingyuanopterus

Lingyuanopterus parvus — Wang et al., 2012

🦣 **Period:** Early Cretaceous — exact dating uncertain

🦣 **Size:** Wingspan estimated at 1 to 1.5 m — small pterosaur

🦣 **Weight:** Estimated 200 to 500 grams

🦣 **Diet:** Probably piscivorous or insectivorous

🦣 **Habitat:** Asia — Liaoning, China

🦣 **Preliminary:** Lingyuanopterus was not a dinosaur, but a pterosaur — a flying reptile that belongs to a distinct evolutionary line.

Wang Xiaolin and colleagues described Lingyuanopterus parvus in 2012 based on material from the province of Liaoning in China—the now-familiar fossil site that has provided a large portion of the known Cretaceous pterosaurs of Asia. The name refers to Lingyuan, a city in Liaoning near the find site. Parvus means small — a direct reference to the small size.

Lingyuanopterus belongs to the family Istiodactylidae—a group of medium-sized to small pterosaurs with characteristic, slightly curved teeth that resemble duck teeth and were possibly suitable for filtering or grasping small aquatic animals. The family is primarily known from England — Istiodactylus latidens from the Isle of Wight is the namesake — which makes Lingyuanopterus one of the few Asian representatives of this group and biogeographically interesting.

Little can be said about Lingyuanopterus itself. The known material is fragmentary, the stratigraphic classification is uncertain — hence the indication of an unknown period in the source data. What the bones show is enough for a family assignment, but not for a complete picture of the animal.

Lingyuanopterus is a small pterosaur from Liaoning, which is particularly interesting because it proves the existence of a family otherwise found in Europe in Asia — a biogeographical data point with wings.

Maiasaura

Maiasaura peeblesorum — Horner & Makela, 1979

- 🦣 **Period:** Late Cretaceous — about 76 to 75 million years ago (Campanian)
- 🦣 **Size:** Approximately 9 m long, about 2.5 m at the shoulder
- 🦣 **Weight:** Estimated 3.5 to 4 tons
- 🦣 **Life expectancy:** Presumably 20 to 30 years
- 🦣 **Diet:** Herbivore — leaves, needles, fruits, flowering plants
- 🦣 **Lifestyle:** Highly social herd animals with well-documented brood care behavior

🦣 **Speed:** Estimated 35 to 40 km/h

🦣 **Habitat:** Western North America — open landscapes and river valleys of present-day Montana

Maiasaura peeblesorum is the dinosaur that forced science to completely rethink dinosaur parenting behavior. Until its discovery, the image of the dinosaur as an indifferent egg-layer — lay the eggs, move on, done. Maiasaura disproved this with a single site in Montana so thoroughly that the discussion has never returned since.

Jack Horner — the same researcher who later developed the scavenger hypothesis for T. rex — and Robert Makela described Maiasaura in 1979 based on finds from the Two Medicine Formation in Montana. The name means good mother lizard — a name that has rarely been so directly justified by the fossils. The species name peeblesorum honors the Peebles family, who owned the land where the first finds were made.

What Horner and Makela found in Montana was not a single skeleton, but a breeding colony. Dozens of nests, arranged at regular intervals — each nest about two meters in diameter, circular, with a central depression for the eggs. In between, bones of young animals of various ages, eggshells, and remains of plants that may have been brought into the nests as nesting material or food for the young animals. The site, known as Egg Mountain, is still one of the most significant paleontological sites in North America today.

What the nests tell

The young animals in the nests showed worn teeth — direct evidence that they were eating before they left the nest. Worn teeth in animals that could not yet walk means: someone brought them food. A parent, a relative, any animal took care of the young in the nest. Passive breeding behavior — laying eggs and disappearing — is thus ruled out.

The nest spacing was approximately the body length of an adult animal — which means that the nests were close enough together to form a colony, but far enough apart for the adults to move. A thoughtful spatial organization that suggests social breeding behavior not unlike that of modern seabirds such as albatrosses or penguins.

Egg Mountain also provided clues about the growth rate of young Maiasaura. Newborns measured about 35 centimeters — within a year they grew to around one and a half meters. That is fast, significantly faster than modern crocodiles, and fits the picture of an active, warm-blooded metabolism.

Maiasaura was a hadrosaurid without a crest — no honking sound apparatus like in Parasaurolophus, no conspicuous head structure like in Corythosaurus. What it had was a broad, slightly arched snout area — functional for grazing on vegetation, visually rather unremarkable. In a group of animals that primarily communicated thru noise and appearance, Maiasaura was the plain variant. What it lacked in visual conspicuousness, it made up for in sociability and brood care.

Herds of Maiasaura were apparently enormous. Bonebeds in Montana contain bones from thousands of individuals—estimates suggest herds reached the size of modern bison herds. Moving, feeding, and nesting in such numbers, Maiasaura herds shaped the landscape of Late Cretaceous Montana in a way comparable to modern large herbivore migrations.

Maiasaura was also the first animal ever to have its remains sent into space: in 1985, astronaut Loren Acton took a Maiasaura bone and egg on the Space Shuttle mission STS-51-F — a small but remarkable footnote in the history of this already extraordinary dinosaur.

Maiasaura gave birth to her young, cared for them in the nest, lived in herds of thousands, and was the only dinosaur to travel into space — the good mother of the Cretaceous deserves every letter of her name.

Megacephalosaurus

Megacephalosaurus eulerti — Schumacher & Everhart, 2005

- 🦣 **Period:** Late Cretaceous — approximately 95 to 90 million years ago (Cenomanian to Turonian)
- 🦣 **Size:** Approx. 7 to 8 m long
- 🦣 **Weight:** Estimated 3 to 5 tons
- 🦣 **Diet:** Carnivore — large fish, marine reptiles, possibly other plesiosaurs
- 🦣 **Reproduction:** Presumably viviparous
- 🦣 **Habitat:** North America — Western Interior Seaway, the shallow inland sea of present-day Kansas
- 🦣 **Note:** Megacephalosaurus was not a dinosaur, but a pliosaur—a short-necked, large-headed marine reptile of the Late Cretaceous that lived at the same time as the dinosaurs but belongs to a separate evolutionary lineage.

Bruce Schumacher and Michael Everhart described Megacephalosaurus eulerti in 2005 based on skull material from the Greenhorn Limestone in Kansas—a marine rock layer of the Western Interior Seaway, the shallow inland sea that divided North America from north to south during the Late Cretaceous. The name simply means "big-headed lizard"—and it fits. The skull of Megacephalosaurus was exceptionally large relative to its body size—a feature that distinguishes this species from other pliosaurs of its time and immediately gives it a distinct character. The species name honors C.C. Eulert, who collected the original material.

Megacephalosaurus belongs to the family Polycotylidae—the same short-necked plesiosaurs that include Dolichorhynchops, which we have already discussed. Both lived in the same sea, at the same time, during overlapping periods. While Dolichorhynchops was more specialized for small, fast prey—fish, squid—the massive skull of Megacephalosaurus suggests larger, more robust prey. Larger fish, other marine reptiles, possibly even smaller plesiosaurs.

The Late Cretaceous Western Interior Seaway was one of the most biologically rich marine ecosystems in Earth's history—populated by mosasaurs, giant fish like Xiphactinus, sharks, ammonites, and various plesiosaur species. Megacephalosaurus was not an apex predator in this ecosystem—Tylosaurus and other large mosasaurs surpassed it in size—but it was a formidable secondary predator.

The known material is limited to skull fragments, which restricts far-reaching conclusions about its physique and behavior. Megacephalosaurus is scientifically well-described but poorly documented—an animal remembered primarily for its striking skull.

Megacephalosaurus had the largest head of its group—a Pliosaur from Cretaceous Kansas that carved out its own niche in a sea of giants through sheer skull power.

Microraptor

Microraptor zhaoianus — Xu et al., 2000

🦣 **Period:** Early Cretaceous — about 125 to 113 million years ago (Barremian to Aptian)

- 🦣 **Size:** Approximately 40 to 80 cm long
- 🦣 **Weight:** Estimated 150 to 200 grams
- 🦣 **Life expectancy:** Presumably 5 to 10 years
- 🦣 **Diet:** Carnivore — insects, small lizards, fish, small birds
- 🦣 **Lifestyle:** Probably solitary; arboreal
- 🦣 **Speed:** Efficient in gliding flight; likely agile on the ground
- 🦣 **Habitat:** Asia — forested landscapes of present-day Liaoning and Hebei provinces, China

Microraptor zhaoianus is one of the most fascinating dinosaurs of the early Cretaceous—not because of its size, which is modest at under one kilogram in body weight, but because of an anatomy that has fundamentally changed the understanding of early bird evolution. Xu Xing of the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing and colleagues described it in 2000, and what they described was a dromaeosaurid with four feathered limbs — feathers not just on the arms, but on the hind legs down to the toes. An animal with four wings.

Over ten specimens are known from the Yixian Formation in Liaoning, many of them with exceptional preservation quality. Feathers, stomach contents, occasionally even remnants of color — the Yixian Formation provides details that are lost elsewhere. A 2012 study published in

Science by Matthew Shawkey and colleagues analyzed melanosomes in the feathers of Microraptor and came to a clear conclusion: The plumage was black with an iridescent sheen—similar to a modern starling or raven, with a shimmering luster in the light.

Four wings and the question of flight

The four-winged anatomy of Microraptor was surprising at its discovery — and in a certain sense, it still is today. Feathers on the hind legs are unknown in modern birds, but are repeatedly documented in fossil forms: Anchiornis, Pedopenna, and indeed Microraptor all show variations of this pattern. What did that mean for locomotion?

Active flight with four wings is biomechanically difficult — the hindwings would interfere with a wingbeat. Gliding flight, on the other hand, is plausible and well-modeled. Biomechanical studies, including a highly discussed paper by Sankar Chatterjee and R.J. Templin have calculated various gliding configurations. The most likely scenario: Microraptor spread its hind legs sideways, forming a kind of biplane gliding surface — stable, efficient, well-suited for short gliding phases from branch to branch.

Whether it could take off from the ground or only from elevated positions is not definitively known. The long claws on the hind legs suggest a climbing lifestyle — an animal that climbed trees and glided from there, not one that took off from the ground.

The stomach contents of several specimens provide direct evidence of its prey spectrum: fish bones, bird bones, mammal bones, lizard remains. Microraptor ate what was available - a generalist with precise claws and a dentition designed for small, fast prey.

Microraptor was black, iridescent, had four wings, and ate birds — a dromaeosaurid that lived in the treetops and blurred the lines between dinosaur and bird with every fossil.

Mistralazhdarcho

Mistralazhdarcho maggii — Vullo et al., 2012

🦣 **Period:** Late Cretaceous — approximately 84 to 72 million years ago (Santonian to Campanian)

🦣 **Size:** Estimated wingspan of 4 to 5 m

🦣 **Weight:** Estimated 10 to 20 kilograms

🦣 **Diet:** Presumably carnivorous — small vertebrates, possibly fish

🦣 **Habitat:** Europe — terrestrial and coastal landscapes of present-day southern France

🦣 **Note:** Mistralazhdarcho was not a dinosaur, but a pterosaur — a flying reptile of the Late Cretaceous that belongs to a distinct evolutionary lineage.

Romain Vullo of the University of Rennes and colleagues described Mistralazhdarcho maggii in 2012 in the Journal of Vertebrate Paleontology, based on bone fragments from the Fox-Amphoux-Meeodon Formation in Provence, southern France. The name is a combination of Mistral—the famous northwesterly wind of Provence—and Azhdarcho, the Central Asian dragon figure that serves as the type genus for this pterosaur family. The species name maggii honors Jean-Pierre Maggi, who discovered the material.

The source data cite Asia and South America as additional ranges—this is not supported by direct fossil finds of Mistralazhdarcho and likely refers to the broader family of Azhdarchidae, which did indeed occur on multiple continents. Mistralazhdarcho itself is known exclusively from southern France.

Mistralazhdarcho belongs to the Azhdarchidae—the same family as Quetzalcoatlus and Hatzegopteryx, which we have already discussed. With an estimated wingspan of four to five meters, it was a medium-sized member of this family, significantly smaller than the giants among its relatives. Research on azhdarchids increasingly points to terrestrial hunting—animals that ran on the ground and captured small vertebrates—which is plausible for Mistralazhdarcho but cannot be directly proven from the fragmentary material.

Mistralazhdarcho is scientifically interesting as biogeographic evidence: an azhdarchid in Late Cretaceous Europe that shows this family also colonized the island landscapes of the European archipelago of that time—from Romania through Hungary to Provence.

Mistralazhdarcho soared through the winds of Late Cretaceous Provence—a medium-sized azhdarchid, named after the Mistral and known from little more than a few bone fragments.

Nasutoceratops

Nasutoceratops titusi — Sampson et al., 2013

🦣 **Period:** Late Cretaceous — about 76 to 74 million years ago

🦣 **Size:** Approximately 4.5 to 5 meters long, about 1.5 to 1.8 meters at the hip height

🦣 **Weight:** Estimated 1.5 to 2.5 tons

🦣 **Life expectancy:** Presumably 20 to 30 years

🦣 **Diet:** Herbivore — low vegetation, ferns, flowering plants

🦣 **Lifestyle:** Presumably in herds; social behavior suggested by skull features

🦣 **Speed:** Estimated 15 to 25 km/h

🦣 **Habitat:** Western North America — Coastal plains and river systems of present-day Utah, Laramidia

Some dinosaurs become famous because they are huge. Others, because they are terrifying. Nasutoceratops became famous because it looks like something evolution accidentally put together — and yet it worked. An unusually short, wide snout, two powerful forward-curving horns above the eyes, and a neck shield that was remarkably large for its body size. No other ceratopsian looked like this. And that's not a coincidence.

Nasutoceratops

Nasutoceratops titusi was first described in 2013 by Scott Sampson and colleagues from the Natural History Museum of Utah in the journal Proceedings of the Royal Society B — a relatively young find that has significantly enriched research on the diversity of ceratopsids in the late Cretaceous period. The name is direct and honest: Nasuto comes from the Latin nasutus, which means big-nosed, and ceratops means horned face. Titusi is an homage to Alan Titus, the Bureau of Land Management's Utah paleontologist who has been instrumental in excavations in the Grand Staircase-Escalante region.

Nasutoceratops was found in the Kaiparowits Formation in southern Utah — a geological unit that has proven to be one of the most significant late Cretaceous fossil sites in North America over the past two decades. The region, now part of the Grand Staircase-Escalante National Monument, was a flat, river-laced coastal plain on the edge of the Western Interior Seaway about 75 million years ago. Warm, humid, lushly vegetated — an ideal habitat for herbivores of all sizes.

A nose that raises questions

The most striking part of Nasutoceratops is unmistakable: this short, highly arched snout that gives the animal an almost cartoonishly squat face. In most ceratopsids, the snout is longer and flatter. In Nasutoceratops, it is short, wide, and arched upwards — and there is no horn on the nose. That's unusual. Almost all other ceratopsids have at least one nasal horn, in some it is the dominant feature. In Nasutoceratops, it is practically completely absent.

What dominates instead are the two brow horns. They are long, slightly bent forward and outward, and their shape resembles the horns of a longhorn steer — a comparison that Sampson himself made in the original description. For a ceratopsid of this size, they are exceptionally developed. Whether they served to defend against predators or primarily had an intraspecific signaling function is not definitively known. Both are possible, both are documented in related species.

The short snout raises a functional question: Was it a disadvantage when eating? Probably not. Short, strong beaks are often a sign of specialized feeding in herbivores — for the targeted snipping of specific plant parts instead of the broad scraping of entire areas.

Nasutoceratops may have been more selective in its diet than other ceratopsids, which would have been a clear advantage in a species-rich ecosystem with many competing herbivores.

Laramidia and the Island of Giants

To truly understand Nasutoceratops, one must understand its world. The western North America of the late Cretaceous was not a contiguous landmass. The Western Interior Seaway split the continent in two from north to south. The western half — Laramidia — was a long, narrow island landscape, not much wider than today's West Coast of the U.S., but with enormous ecological diversity.

What paleontologists observe in Laramidia is both fascinating and puzzling: In the north, in present-day Alberta and Montana, different ceratopsids lived than in the south, in present-day Utah and New Mexico — even tho the distances were not particularly great and no obvious geographical barrier existed. Nasutoceratops was a southern resident of this narrow land bridge. Centrosaurus and Styracosaurus lived in the north. The overlap was minimal.

Scott Sampson and Mark Loewen developed the hypothesis of a provincial faunal division in Laramidia — different ecosystems in the north and south, perhaps separated by climate gradients, vegetation zones, or river barriers that were large enough to limit the spread of species but small enough to leave little trace in the geology. It's an elegant explanation for a striking pattern, and Nasutoceratops is one of the key pieces of evidence.

The Kaiparowits Formation, from which Nasutoceratops comes, has produced a number of other dinosaurs in addition to it, which were found exclusively in the south of Laramidia: Utahceratops gettyi, another ceratopsid, Gryposaurus monumentensis, a hadrosaurid, and Teratophoneus curriei, a small tyrannosaurid — all unique developments of the southern ecosystem. Nasutoceratops was therefore not an isolated case, but part of a whole community of animals that had developed independently from the north.

As for social behavior, the striking skull of Nasutoceratops speaks volumes — even tho direct evidence of herd behavior from the Kaiparowits Formation is scarce. Herd behavior is well documented in ceratopsids, supported by bonebeds of other species. That Nasutoceratops roamed the coastal plains of Utah alone is unlikely. The long horns as a signaling organ, the large shield as a display apparatus — both make more sense in a social context than for a loner.

Nasutoceratops looked like a ceratopsian that didn't know the rules — and thus proved that evolution in an isolated landscape takes paths that no one can predict.

Neovenator

Neovenator salerii — Hutt et al., 1996

- 🦣 **Period:** Early Cretaceous — approximately 130 to 125 million years ago (Hauterivian to Barremian)
- 🦣 **Size:** Approx. 7 to 9 m long, about 2 to 2.5 m at the hip
- 🦣 **Weight:** Estimated 1 to 2 tons
- 🦣 **Life expectancy:** Presumably 20 to 30 years
- 🦣 **Diet:** Carnivore — large sauropods, ornithopods, possibly also carrion
- 🦣 **Lifestyle:** Presumably solitary
- 🦣 **Speed:** Estimated 30 to 45 km/h

🦣 **Habitat:** Europe — terrestrial landscapes of present-day southern England and possibly France

Neovenator salerii is the best-known large predatory dinosaur of Europe's Early Cretaceous period — and at the same time one of the few for which sufficient material is available to paint a reliable picture. Steve Hutt of the Isle of Wight Museum and colleagues described it in 1996 in the journal Palaeontology, based on finds from the Wessex Formation on the Isle of Wight. The name means "new hunter"—a reference to its status as a then-newly discovered large European theropod. The species name salerii honors the Saler family, who owned the land where the fossils were found.

Two specimens are known—but the main specimen is remarkably complete by European standards: parts of the skull, vertebrae, ribs, shoulder and pelvic bones, as well as limbs. Enough to anatomically classify Neovenator with confidence and draw comparisons with related theropods.

Neovenator belongs to the family Neovenatoridae—a group of medium-sized to large theropods considered the precursors of the Carcharodontosauridae, the family that later produced Giganotosaurus and Carcharodontosaurus. Neovenator thus occupies an interesting position in the evolutionary tree: more advanced than early theropods, but more primitive than the giants of the Late Cretaceous. A link that shows how the line of large predatory dinosaurs might have originated in Europe.

Neurosensory pits—an unexpected finding

What makes Neovenator interesting beyond its mere position in the family tree is a finding published in 2013 by Andrew Cuff and Angela Milner of the Natural History Museum in London. Analysis of the skull revealed a series of pits and channels along the snout—similar to the neurosensory structures found in spinosaurids such as Baryonyx and Ceratosuchops, which suggest pressure receptors that allowed these animals to sense movement in the water.

In Neovenator, this finding was surprising. An animal of this size and body plan was not expected to be a semi-aquatic fish-eater. The authors suggested that Neovenator may have had sensitive receptors in its snout—for prey detection or for manipulating objects—without necessarily having been a water hunter. The function remains a matter of debate, but the anatomical evidence is clear.

The Wessex Formation, from which Neovenator originates, was a flat, river-crisscrossed landscape during the Early Cretaceous—similar to a modern subtropical river delta, with seasonally fluctuating water levels. Iguanodon, Hypsilophodon, and early sauropods lived in this environment—enough prey for a nine-meter-long predatory dinosaur. Neovenator was the dominant apex predator in this ecosystem, with no serious competition in its size class.

Neovenator was Europe's premier large predatory dinosaur of the Early Cretaceous—with a snout full of mysteries and a position in the family tree that led directly to the later giants of South America and North Africa.

Normannognathus

Normannognathus wellnhoferi — Buffetaut et al., 1998

- 🦣 **Period:** Late Jurassic — approximately 156 to 151 million years ago (Oxfordian to Tithonian)
- 🦣 **Size:** Wingspan unknown — only jaw fragments known
- 🦣 **Diet:** Presumably fish-eater
- 🦣 **Habitat:** Europe — coasts of present-day northern France (Normandy)
- 🦣 **Note:** Normannognathus was not a dinosaur, but a pterosaur — a flying reptile of the Late Jurassic that belongs to a distinct evolutionary lineage.

Eric Buffetaut and colleagues described Normannognathus wellnhoferi in 1998 based on a single jaw fragment from Normandy in northern France—after which the genus was named. The species name honors Peter Wellnhofer, the German pterosaur specialist whose seminal works on pterosaur anatomy remain fundamental to this day. That is all that is known: a jaw fragment, a locality, a name.

Normannognathus belongs to the family Pterodactyloidea—the short-tailed, advanced pterosaurs that dominated from the Late Jurassic onward. Exact family affiliation within the Pterodactyloidea cannot be determined with certainty from a single jaw fragment. What the fragment's morphology suggests: a cranial crest in the anterior jaw region—a feature found in several pterodactyloids and often interpreted as a signal organ.

Body size, weight, lifestyle—all unknown. The classification as a fish-eater is based on the general ecology of similar pterosaurs from the same period, not on direct evidence.

Normannognathus is scientifically relevant as a biogeographic data point—a pterodactyloid in the Late Jurassic of northern France, at a time when this group was in the process of displacing the older rhamphorhynchids. The material simply does not yield any more information.

Normannognathus is a jaw fragment from Normandy and a name—that is all that the Late Jurassic of France has left behind of this pterosaur.

Nothronychus

Nothronychus mckinleyi — Kirkland & Wolfe, 2001

- 🦣 **Period:** Middle Cretaceous — approximately 93 to 89 million years ago (Cenomanian to Turonian)
- 🦣 **Size:** Approx. 4.5 to 6 m long, about 2 m at the hip
- 🦣 **Weight:** Estimated 800 to 1,200 kilograms
- 🦣 **Life expectancy:** Unknown
- 🦣 **Diet:** Herbivore — leaves, ferns, possibly fruits
- 🦣 **Lifestyle:** Presumably solitary

🦣 **Speed:** Slow — Nothronychus was not built for speed

🦣 **Habitat:** Western North America — terrestrial landscapes of present-day New Mexico and Arizona

Nothronychus mckinleyi is one of North America’s most surprising dinosaurs — not because of its size or its teeth, but because of its ancestry. It is a therizinosaur, a member of that curious group of theropods that descended from carnivorous ancestors and evolved into herbivores. And it is the first therizinosaur found in North America—which caused quite a stir when it was described in 2001, as until then this group was considered an exclusively Asian phenomenon.

James Kirkland of the Utah Geological Survey and Douglas Wolfe described Nothronychus based on two specimens from the Moreno Hill Formation in New Mexico—hence the genus name, which means “sluggish claw,” a reference to the long, curved arm claws of this group. The species name mckinleyi honors geologist Tom McKinley, who discovered the site.

Two specimens are known, including partially preserved skeletons that reveal the basic features of Nothronychus: a broad pelvis, short, sturdy legs, long arms with massive claws, and a small skull with leaf-shaped teeth. The overall body plan is clearly geared toward a herbivorous lifestyle—the broad pelvis suggests a large digestive tract, the claws indicate grasping and pulling down branches, and the leaf-shaped teeth point to soft plant material.

A Theropod That Changed Course

What makes Nothronychus interesting in a broader context is its position in theropod evolution. Therizinosaurs evolved from carnivorous coelurosaurs—the same group from which Velociraptor, Tyrannosaurus, and birds also emerged. At some point along this lineage, the ancestors of the therizinosaurs changed their dietary strategy—from carnivore to herbivore—and adapted their entire anatomy accordingly. Nothronychus demonstrates this transition in a North American context that was previously unknown.

How it arrived in North America has not been conclusively determined. Its closest relatives lived in Asia—Beipiaosaurus, Falcarius, and Erlikosaurus. A land bridge between Asia and North America, which was occasionally passable during the Middle Cretaceous, is the most likely explanation. Nothronychus would thus be an Asian immigrant that established itself in the coastal landscapes of western North America.

In a fauna dominated by large sauropods and early tyrannosaurids, Nothronychus was an ecological outsider—a medium-sized herbivore with a body plan that no one had expected to find in this region. The fact that it nevertheless thrived there suggests an ecological niche that other animals did not occupy as consistently.

Nothronychus was a theropod that forgot to eat meat—the first of its peculiar group in North America and proof that evolution takes paths no one can predict.

Ophthalmothule

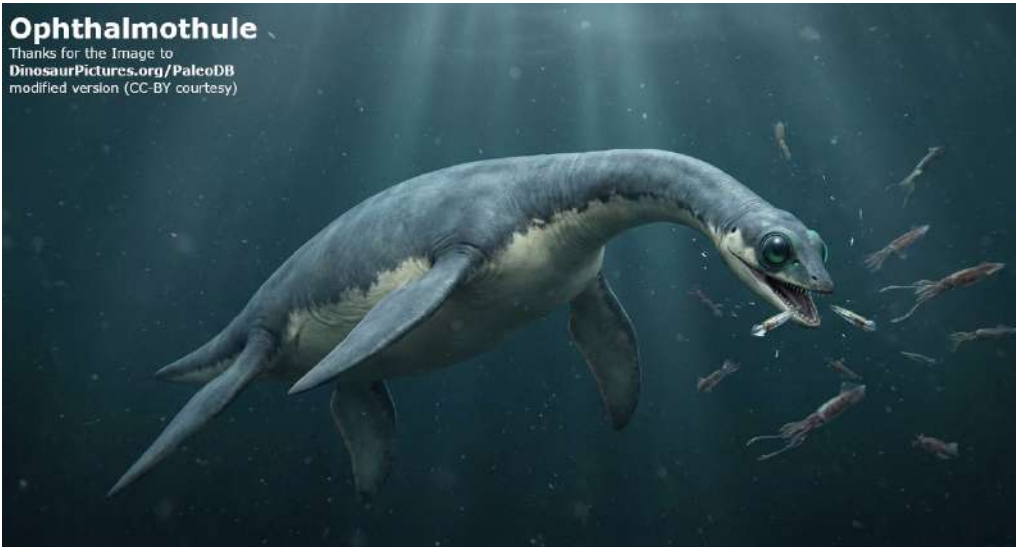
Ophthalmothule cryostea — Roberts et al., 2023

- 🦣 **Period:** Late Jurassic — exact dating within the Jurassic is uncertain
- 🦣 **Size:** Unknown — fragmentary material
- 🦣 **Diet:** Presumably carnivorous — fish, squid
- 🦣 **Reproduction:** Presumably viviparous
- 🦣 **Habitat:** Arctic — marine environment of present-day Svalbard, Norway
- 🦣 **Note:** Ophthalmothule was not a dinosaur, but a plesiosaur — a Jurassic marine reptile belonging to a distinct evolutionary lineage.

Ophthalmothule cryostea is one of the most recent plesiosaur discoveries ever — described in 2023 by Aubrey Roberts and colleagues from the Natural History Museum at the University of Oslo, based on fossils from the Arctic Svalbard Archipelago in Norway. The name is a combination of the Greek word ophthalmos, meaning “eye,” and Thule — the ancient term for the northernmost known regions of the world. Cryostea means “ice bone”—a reference to the Arctic conditions of the discovery.

What makes Ophthalmothule scientifically interesting is not just its anatomy, but where it was found. Svalbard lies far north of the Arctic Circle today—during the Jurassic period, it was also a far-northern region, albeit climatically warmer than it is today. Plesiosaurs in Arctic latitudes are no longer a rarity—Svalbard has yielded several significant finds in recent years—but every new discovery expands our understanding of a group that apparently inhabited the world’s oceans during the Jurassic and Cretaceous periods, from the tropics to polar waters.

Ophthalmothule belongs to the group of Plesiosauroidea—the long-necked forms. The fragmentary material does not allow for further conclusions. Body size, exact family affiliation, and lifestyle remain unclear based on the material known so far.



Ophthalmothule is a plesiosaur from the Arctic ice—described in 2023, little known, but further evidence that these marine reptiles inhabited literally every corner of the Jurassic oceans.

Ornatops

🦣 ***Ornatops incantatus — Hopkins & Avrahami, 2021***

- 🦣 **Period:** Late Cretaceous — approximately 79 to 75 million years ago (Campanian)
- 🦣 **Size:** Estimated 7 to 9 m long
- 🦣 **Weight:** Estimated 3 to 5 tons
- 🦣 **Life expectancy:** Unknown
- 🦣 **Diet:** Herbivore — low to medium-height vegetation, flowering plants
- 🦣 **Lifestyle:** Presumably a herd animal

🦣 **Habitat:** Western North America — coastal plains of present-day New Mexico, southern Laramidia

Ornatops incantatus is a recent discovery—described in 2021 by Caleb Marshall Hopkins and Haviv Avrahami in the journal PeerJ, based on skull material from the Menefee Formation in New Mexico. The name means "ornate head"—a reference to the striking skull architecture of this hadrosaurid. "Incantatus" refers to the Navajo Nation, whose territory overlaps with the discovery site today—a tribute to the indigenous history of this landscape.

Ornatops belongs to the family Hadrosauridae and, within that family, to the subfamily Saurolophinae—the group of massive-headed hadrosaurids lacking complex hollow crests like those of Parasaurolophus or Corythosaurus. Instead, Ornatops bore a solid bony ridge over its nasal region—conspicuous but not hollow, lacking the acoustic function of the chambered crests of its relatives.

What makes Ornatops scientifically significant is less its individual anatomy than its location. The Menefee Formation in New Mexico is part of southern Laramidia—the same geographically defined region from which Nasutoceratops, Utahceratops, and other southern endemics are known. Ornatops is thus another piece of the increasingly clear evidence for a provincial faunal division in Laramidia: the north and south developed distinct dinosaur communities that, despite their geographical proximity, barely overlapped.

The known material includes parts of the skull—enough for taxonomic classification and a rough impression of the anatomy, but not for a complete picture of the body. Ornatops is a recent discovery, and research is still in its infancy.

Ornatops is two years old, comes from New Mexico, and adds another piece to the growing mosaic of the southern Laramidian dinosaur fauna —an ornate head with a story that is just beginning to be told.

Oviraptor

Oviraptor philoceratops — Osborn, 1924

- 🦣 **Period:** Late Cretaceous — approximately 75 to 71 million years ago (Campanian to Maastrichtian)
- 🦣 **Size:** Approx. 1.5 to 2 m long, about 60 to 80 cm at the hip
- 🦣 **Weight:** Estimated 25 to 40 kilograms
- 🦣 **Life expectancy:** Presumably 10 to 20 years
- 🦣 **Diet:** Omnivore — eggs, mollusks, plants, possibly small vertebrates
- 🦣 **Lifestyle:** Presumably solitary; brood care well documented

🦣 **Speed:** Estimated 25 to 40 km/h

🦣 **Habitat:** Asia — semi-deserts and dune landscapes of present-day Mongolia

Oviraptor philoceratops bears a name that is a lie — and that is no small matter, considering it has carried it for nearly a century. Henry Fairfield Osborn of the American Museum of Natural History described it in 1924 based on a skeleton found next to a nest containing eggs. Osborn's conclusion: The animal had stolen the eggs. The name Oviraptor means "egg thief," and philoceratops means "friend of the ceratopsians"—because the eggs were initially attributed to a Protoceratops. For decades, Oviraptor was considered the dinosaur that had been caught in the act of stealing.

Then, in 1993, an American-Mongolian team found an Oviraptor skeleton in the Gobi Desert directly on top of a nest—in a posture reminiscent of brooding birds: arms outstretched, body draped over the eggs. And the eggs in the nest did not belong to a Protoceratops, but to Oviraptor itself. The supposed thief was a brooding parent protecting its own clutch. The name remained—the interpretation had done a complete 180.

Two specimens of Oviraptor itself are known, but the closely related oviraptorids are well-documented, which allows for a good overall picture of this group. The most famous of these nests, on display at the

American Museum of Natural History in New York, strictly speaking belongs to Citipati osmolskae—a closely related oviraptorid that was long confused with Oviraptor.

A toothless beak—and what it could do

What distinguishes Oviraptor anatomically is its skull. Not a single tooth—instead, a strong, horny beak with a high bony crest above it, which varied in prominence depending on the individual. The beak was strong enough to crack hard shells—mussels, crabs, possibly eggs of other species. The bone was designed to withstand considerable compressive forces, similar to the beak of modern parrots.

The claws on the forelimbs were long and curved—well-suited for grasping, less so for killing. Oviraptor was not a predator in the classical sense, but rather an opportunist: anything that was within reach and worth eating was consumed. In the semi-desert of Late Cretaceous Mongolia, flexibility in food choice was a clear survival advantage.

Oviraptor was fully feathered—like all Oviraptoridae. The feathers were not used for flight, but most likely for thermoregulation during incubation and possibly for visual communication. The crest on the skull varied greatly between individuals—almost absent in some, tall and conspicuous in others. The classic pattern for a signaling organ that communicates individual differences.

Oviraptor was once condemned as an egg thief but turned out to be a caring parent—a dinosaur whose story shows that a single new discovery can turn everything upside down.

Oxalaia

Oxalaia quilombensis — Kellner et al., 2011

- 🦣 **Time period:** Middle Cretaceous — approximately 105 to 94 million years ago (Albian to Cenomanian)
- 🦣 **Size:** Estimated 12 to 14 m long
- 🦣 **Weight:** Estimated 4 to 7 tons
- 🦣 **Life expectancy:** Unknown
- 🦣 **Diet:** Carnivore — likely fish and large vertebrates
- 🦣 **Lifestyle:** Presumably solitary; semi-aquatic
- 🦣 **Habitat:** South America — coasts and river deltas of present-day Maranhão State, Brazil

Oxalaia quilombensis is the largest known spinosaurid in South America — and thus automatically an animal in the same size class as Spinosaurus itself. Alexander Kellner of the Museu Nacional in Rio de

Janeiro and colleagues described it in 2011 in the journal Anais da Academia Brasileira de Ciências, based on a single specimen: two jaw fragments from the Laje do Corvo site in the province of Maranhão. The name refers to Oxalá, one of the most important deities of Candomblé—an Afro-Brazilian religious tradition deeply rooted in the culture of Maranhão. The species name quilombensis honors the quilombos—historical communities of freed enslaved people in Brazil that played an important historical role in this region. A naming choice with cultural depth that is rare in paleontology.

Oxalaia belongs to the family Spinosauridae and, within that family, to the subfamily Spinosaurinae—the same group as Spinosaurus itself. The jaw fragments reveal conical teeth and a snout shape that is distinctly spinosaurid, and their size suggests an animal that approached Spinosaurus in body length. At an estimated twelve to fourteen meters, Oxalaia would be one of the largest theropods in South America.

One continent, two spinosaurines

What makes Oxalaia biogeographically interesting is its location on the South American side of what was then the Atlantic Ocean. During the Middle Cretaceous, the South Atlantic was still narrow—South America and Africa were closer together than they are today, and occasional exchange of fauna was possible. Spinosaurus lived in North Africa, Oxalaia in Brazil, and both belonged to the same subfamily. This suggests a common ancestry, possibly from an ancestor that still lived on the shared Gondwana continent before South America and Africa finally drifted apart.

The formation from which Oxalaia originates formed in a coastal and delta environment—rich in fish, crocodiles, and other aquatic life, ideal for a semi-aquatic spinosaurid. What Oxalaia ate cannot be directly determined from two jaw fragments, but the analogy to Spinosaurus and Baryonyx is clear: fishing as the primary strategy, supplemented by opportunistic feeding on larger prey.

A single specimen, two jaw fragments—that is not much. But the size of the bones is unmistakable, and the taxonomic classification is solid enough to establish Oxalaia as a distinct species. What is still missing is the same as with so many South American giants: a complete skeleton to confirm the estimates.

Oxalaia was South America's answer to Spinosaurus—named after a deity, honored by a historic site of resistance, and known from little more than two jaw fragments large enough to tower over everything else.

Pachycephalosaurus

Pachycephalosaurus wyomingensis — Gilmore, 1931

🦣 **Period:** Late Cretaceous — about 70 to 66 million years ago

🦣 **Size:** Approximately 4.5 to 5 meters long, about 1.5 meters at the hip height

🦣 **Weight:** Estimated 400 to 600 kilograms

🦣 **Life expectancy:** Presumably 15 to 25 years

🦣 **Diet:** Herbivore — fruits, seeds, leaves, possibly occasionally insects or small vertebrates

🦣 **Lifestyle:** Probably solitary or in small groups; seasonal rival behavior likely

🦣 **Speed:** Estimated 25 to 40 km/h

🦣 **Habitat:** Western North America — forested highlands and river valleys of the Hell Creek Formation

There are dinosaurs where you immediately know what you're going to talk about. With Pachycephalosaurus, it's the head. More precisely: the dome. A bone layer up to 25 centimeters thick above the braincase, smooth and curved like a bowling ball, surrounded by small bone spikes and bumps at the edge. No other dinosaur looked like that. And hardly any question in paleontology has been debated as stubbornly as the one about what this dome was actually used for.

Pachycephalosaurus wyomingensis

Pachycephalosaurus wyomingensis — the name means "thick-headed lizard from Wyoming" — is the largest known representative of the pachycephalosaurids, a group of bipedal herbivores that only existed during the Cretaceous period. It was first described in 1931 by Charles Gilmore of the Smithsonian Institution, based on skull material from the Hell Creek Formation in Wyoming. That is both the problem and the fascinating thing about this animal: Almost everything we know about Pachycephalosaurus is derived from skulls and skull parts. Complete skeletons are still missing today. The rest of the body is reconstructed from related species—a solid method, but not direct observation.

What we know about the skull, however, is much more detailed. The dome is made of solid, almost solid bone — the brain beneath it was surprisingly small in relation to the size of the dome. The bony spikes around the dome varied significantly between individuals, suggesting age or sex differences. And the dome itself showed scars and lesions in some specimens, indicating repeated mechanical stress. Something regularly struck this skull. The question is just: what exactly?

Rams or flankers?

The most straightforward explanation is the one everyone knows: Pachycephalosaurus rammed its head against that of its peers, similar to how bighorn sheep do today. The thick bone cap as a shock absorber, the spikes as a species identifier, the robust neck as a power transmitter. A classic image that has appeared in documentaries and books for decades.

Then came biomechanics and made it more complicated. John Horner of the Museum of the Rockies and Mark Goodwin of the University of California published a study in 2009 that seriously questioned the head-to-head hypothesis. Their analysis of the bone structure showed that the dome's internal architecture was poorly suited for direct frontal collisions — the forces would have been unfavorably transmitted to the neck and spine. Instead, they suggested that Pachycephalosaurus used the dome laterally — flank attacks, jostling, shoving — more like a ram fight in slow motion than a full-on head-on collision.

Other researchers disagreed. Eric Snively and Jessica Theodor published a counter-study in 2011, which showed that the skull of Pachycephalosaurus was indeed biomechanically designed for frontal impacts — albeit perhaps not at maximum speed, but rather in controlled, powerful thrusts. The dispute has not been settled to this day. What both sides concede to each other: The dome was not a purely decorative organ. It was used. How exactly, remains the open question.

A third hypothesis also deserves consideration. Some researchers argue that the dome was primarily a visual signal — the larger and smoother, the more dominant the animal. Fights would have been rarer than often assumed, because the sight of the dome alone could have clarified questions of rank. This is also known from the animal world: Many animals fight less than their weapons might suggest, because display behavior is often sufficient.

Youth, Age, and a Name for Controversy

A surprising aspect of Pachycephalosaurus research concerns its development over its lifetime. Young pachycephalosaurids had flatter skulls that only developed into the characteristic dome with age. That sounds obvious — but it isn't. Because it led to one of the most provocative hypotheses in recent dinosaur research.

John Scannella and Jack Horner — the same researchers who also caused a stir with Triceratops and Torosaurus — argued in 2010 that two smaller pachycephalosaurs named Dracorex hogwartsia and Stygimoloch spinifer were not distinct species, but juvenile and subadult Pachycephalosaurus individuals. Dracorex, named after the Hogwarts dragon from Harry Potter at the request of schoolchildren who donated the fossil to the museum, had a flat skull with many spikes. Stygimoloch had a small dome and long spikes. Pachycephalosaurus had the full dome, almost without spikes.

The hypothesis: As they aged, the dome grew while the spikes receded. Dracorex became Stygimoloch, and Stygimoloch became Pachycephalosaurus. Not three species — a single animal in three life stages. Not all researchers share this view, and the debate is ongoing. But the idea is solid enough that Dracorex and Stygimoloch are no longer listed as separate species in many modern scientific publications.

Pachycephalosaurus lived until the last minute of the Cretaceous period. He belonged to the community of the Hell Creek Formation — alongside T. rex, Triceratops, and Edmontosaurus. A medium-sized herbivore in a world full of extremes. Not the strongest, not the fastest, not the most armored. But with a head that still leaves no one cold to this day.

Pachycephalosaurus had 25 centimeters of solid bone on its head — and has sparked a scientific debate that hits almost as hard as the animal itself.

Parasaurolophus

Parasaurolophus walkeri — Parks, 1922

- 🦣 **Period:** Late Cretaceous period — approximately 76 to 73 million years ago
- 🦣 **Size:** Approximately 9 to 10 m long, approximately 2.8 to 3 m hip height Weight: Estimated 2.5 to 4 tons
- 🦣 **Life expectancy:** Probably 20 to 30 years
- 🦣 **Diet:** Herbivore — conifers, cycads, leaves and shoots of flowering plants
- 🦣 **Lifestyle:** Herd animal; lived in groups, some of which were large
- 🦣 **Speed:** Estimated 15 to 21 miles per hour on two legs
- 🦣 Habitat: Western North America — coastal forests and floodplains of what is now the province of Alberta and the US state of New Mexico

There are some dinosaurs that are instantly recognizable. Parasaurolophus is one of them. This tubular bone crest, which protrudes from the back of the head — sometimes almost a meter long — is so distinctive that no other animal can be confused with it. What this crest was, what it could do, and why it evolved is one of the most fascinating questions in dinosaur research. And the answer is more surprising than most people would expect.

Parasaurolophus belongs to the Hadrosauridae family, the so-called duck-billed dinosaurs — one of the most successful dinosaur groups of the late Cretaceous period. With its broad, flat beak, robust build, and powerful hind legs, it was a typical representative of this group. What sets it apart is exclusively this crest. All other hadrosaurids either had no head ornamentation at all or significantly simpler variants. Parasaurolophus took this principle to the extreme — in the truest sense of the word.

It was first described in 1922 by William Parks of the University of Toronto, based on an almost complete skeleton from the Dinosaur Park Formation in Alberta, Canada. Since then, several specimens have been found, including juveniles with small, incompletely developed crests — an indication that the crest continued to grow throughout life and reached its full size in older animals.

An instrument made of bone

The Parasaurolophus crest is hollow. That alone would be remarkable — but what's inside is even more so. The animal's nasal passages did not simply run straight to the tip of its snout, but took a long detour: up into the crest, through the entire length of the tubular system, and back down into the throat. A respiratory tract over a meter long in places, winding through a bony crest on the head.

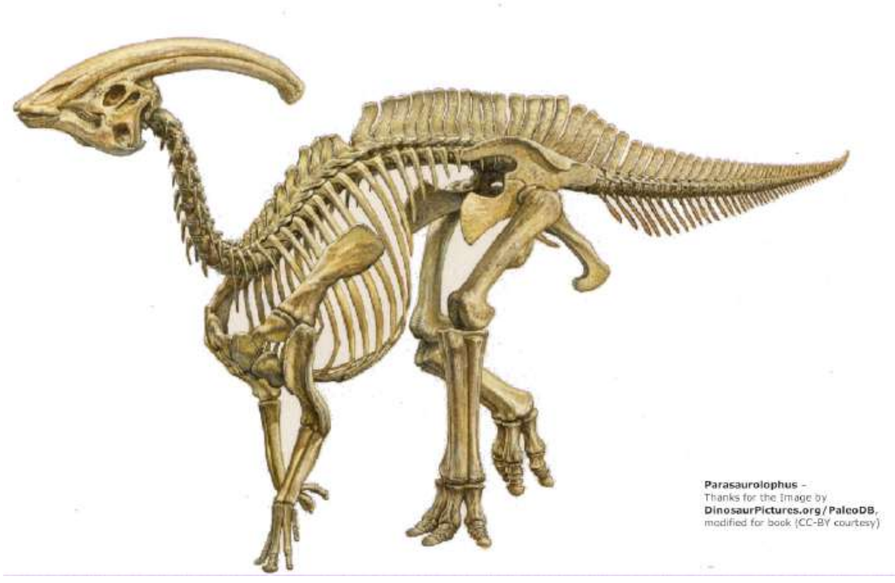
When this system was examined more closely in the 1990s by paleontologist David Weishampel and later through computer tomography studies, including at the New Mexico Museum of Natural History, a fascinating conclusion emerged: this crest functioned like a musical instrument. Air flowing through the tube-like system created resonance—deep, far-reaching tones, similar to a trombone or a didgeridoo. Computer simulations of the nasal cavity system have even reconstructed these sounds: a dull, piercing hum that would have carried over long distances through a forest.

Parasaurolophus probably communicated acoustically — and did so with an instrument that sat directly on its head. This opens up a completely different picture of this animal: not a silent herbivore wandering mindlessly through the forest, but a social creature that stayed in contact with its fellow species, sounded the alarm, signaled territorial claims, or simply maintained the cohesion of the herd. It cannot be ruled out that different individuals had differently sounding crests — and thus, in a sense, their own voice. The crest length varied considerably among the known specimens, which would have had a direct effect on the sound produced.

In addition, the crest is believed to have had another function: species recognition and possibly sexual selection. Those with larger, more conspicuous crests may have been more attractive to potential mates — a principle that is ubiquitous in the animal world, from peacock feathers to deer antlers. The crest probably served several functions at once, as is often the case with such conspicuous anatomical features.

Life in the herd

Parasaurolophus was not a loner. Fossil finds from the Two Medicine Formation in Montana and New Mexico repeatedly show several individuals of different age groups at the same site — an indication of herd behavior, possibly with family cohesion that went beyond immediate rearing.



Life in the herd had an obvious advantage: safety. The late Cretaceous period in North America was not a relaxed place. Tyrannosaurus rex roamed the same landscape, as did other large theropods. A single

Parasaurolophus, fleeing on two legs at 15 to 22 mph, was vulnerable. A herd, on the other hand, offered more eyes, more ears — and more chances to spot danger in time.

This is where the circle closes with the crest: a deep, far-reaching warning signal that alerted the entire herd in a fraction of a second was not a bad tool in a world with T. rex as a neighbor.

Parasaurolophus moved on two and four legs, depending on the situation. When feeding, it probably grazed on all fours to stay close to the vegetation. When running, it stood up and used its powerful hind legs for speed. This flexibility made it an extremely adaptable animal that could inhabit both dense undergrowth and more open landscapes.

Its diet was varied: conifers, cycads, which still dominated in the late Jurassic period, but increasingly also flowering plants, which spread rapidly in the Cretaceous period. Its teeth were perfectly equipped for this — several hundred small teeth arranged in batteries that were continuously renewed. This allowed Parasaurolophus to efficiently chew even hard plant material without worn teeth becoming a problem. A replacement system that would earn the admiration of any dentist.

Parasaurolophus carried a musical instrument on its head — and used it to do the most important thing in a world full of predators: stay connected to its herd.

Pachyrhinosaurus

Pachyrhinosaurus canadensis — Sternberg, 1950

🦣 **Period:** Late Cretaceous — approximately 73 to 69 million years ago (Campanian to Maastrichtian)

🦣 **Size:** Approx. 6 to 8 m long, about 2 m at the hip

🦣 **Weight:** Estimated 2.5 to 4 tons

🦣 **Life expectancy:** Presumably 20 to 30 years

🦣 **Diet:** Herbivore — low to medium-height vegetation, flowering plants, ferns

🦣 **Lifestyle:** Distinctly gregarious — well documented by mass fossils

🦣 **Speed:** Estimated 20 to 28 km/h

🦣 **Habitat:** Western North America and Alaska — coastal plains and river valleys of present-day Alberta and subarctic regions of Alaska

Pachyrhinosaurus is the ceratopsid without a nasal horn — and that is its most striking feature. While Triceratops, Styracosaurus, and Centrosaurus bore long, pointed horns in various arrangements, Pachyrhinosaurus instead had a massive, flat bony plate on its nose—a so-called nasal frill or boss, rough and uneven like a worn stone. Not a horn, but a bony pad. What exactly it was used for remains a subject of debate to this day.

Charles Sternberg described Pachyrhinosaurus canadensis in 1950 based on finds from Alberta. The name means “thick-nosed lizard”—direct and apt. Thirteen specimens are known, including material from three different species: in addition to Pachyrhinosaurus canadensis, there is also Pachyrhinosaurus lakustai from Alberta and Pachyrhinosaurus perotorum from Alaska. This geographic range—from Alberta to the subarctic regions of Alaska—makes Pachyrhinosaurus one of the most widely distributed ceratopsids in North America.

The Alaska finds are particularly noteworthy. The northernmost known occurrence of Pachyrhinosaurus was in regions that, while warmer in the Late Cretaceous than they are today, still experienced seasonally dark winters with possible periods of frost. The fact that

Pachyrhinosaurus inhabited these latitudes suggests an adaptability that was unusual among ceratopsids.

The Horn and Its Function

The bony growth on the nose of Pachyrhinosaurus is the subject of the most debate in research. It is well-suited as a fighting tool—head-to-head butts, similar to those of musk oxen today, would have worked with this flat, robust bony pad. The surface shows scars and irregularities that indicate repeated mechanical stress. At the same time, it cannot be ruled out that the bony protrusion served as a display organ—possibly covered in keratin in the living animal, giving it a more striking appearance than the bare bones suggest.

Above the eyes, many Pachyrhinosaurus individuals bore additional bumps and short horn-like projections that varied considerably between species and individuals. The neck frill bore long spines—arranged differently depending on the species. Overall, despite the lack of a nasal horn, Pachyrhinosaurus was anything but plain.

The mass discoveries—bonebeds in Alberta containing the remains of hundreds of individuals—impressively demonstrate herd behavior. Pachyrhinosaurus migrated in large groups, possibly seasonally between southern wintering grounds and northern summer habitats. The Alaskan populations may have been part of such migration routes

—an arctic-adapted ceratopsid that covered distances exceptional among dinosaurs.

Pachyrhinosaurus was the ceratopsid that abandoned the horn and instead bore a bony boss—more robust, adaptable, and widespread than most of its horned relatives, extending as far as the subarctic regions of Alaska.

Pterodactylus

Pterodactylus antiquus — Cuvier, 1809

- 🦣 **Period:** Late Jurassic — approximately 150 to 148 million years ago (Tithonian)
- 🦣 **Size:** Wingspan approx. 50 cm to 1.5 m — depending on age and specimen
- 🦣 **Weight:** Estimated 1 to 5 kilograms
- 🦣 **Diet:** Carnivore — fish, insects, small vertebrates
- 🦣 **Lifestyle:** Presumably solitary; coastal and lakeshore areas
- 🦣 **Habitat:** Europe and Africa — coastal regions and lagoons of present-day Bavaria and Tanzania

🦣 **Note:** Pterodactylus was not a dinosaur, but a pterosaur—a flying reptile of the Late Jurassic that belongs to a distinct evolutionary lineage.

Pterodactylus antiquus is the pterosaur—the one whose name became the generic term for all flying reptiles of the Mesozoic era, even though it represents only one of hundreds of known species. Georges Cuvier described it in 1809 based on a fossil from the Solnhofen Limestone in Bavaria—the same site that yielded Archaeopteryx. The specimen had already been described in 1784 by Cosimo Alessandro Collini, who thought it was a marine animal—Cuvier was the first to recognize that it was a flying reptile. A realization that hardly anyone was willing to believe at the time.

Twelve specimens are known, all from the Solnhofen Limestone or the related Tendaguru Formation in Tanzania. The state of preservation of the Bavarian finds is exceptional—impressions of soft tissues, flight membranes, and occasionally even throat pouch structures are preserved. What these finds revealed caused confusion for decades: The specimens varied considerably in size and skull shape, leading to the description of over thirty different Pterodactylus species. Today, only one species is considered valid—Pterodactylus antiquus—and the size differences are interpreted as age differences within the same species. Small specimens are juveniles; large ones are adults.

The name that became too famous

The real problem with Pterodactylus is that its name became too well-known. Pterodactylus—or, in the popular spelling, Pterodactyl—is, for most people, synonymous with any flying dinosaur from prehistoric times, regardless of species, family, or geological period. Quetzalcoatlus is called a Pterodactyl. Pteranodon is called a Pterodactyl. Rhamphorhynchus is called a Pterodactyl. None of these are Pterodactylus. The real Pterodactylus was a small to medium-sized animal with a wingspan of no more than one and a half meters—not an airplane-sized giant, not a terrifying beast, but an agile coastal dweller that hunted fish and insects.

The skull was long and narrow, with a low bony crest in some specimens—possibly a characteristic of adult males. Teeth were present only in the front part of the jaw. The flight membrane, as in all pterodactyloids, was stretched between the greatly elongated fourth finger and the body—the characteristic body plan of this group, which enabled active wing flapping.

What Pterodactylus ate is partially evidenced by stomach contents in some specimens: small fish, possibly insects. Both were abundant in the shallow lagoons of the Solnhofen coastal landscape. A generalist hunter that fed opportunistically—no specialist, no giant, but apparently extraordinarily successful in its habitat.

Pterodactylus gave its name to the entire group, but was itself an unspectacular coastal hunter the size of a heron—paleontology's most famous misunderstanding.

Quetzalcoatlus

Quetzalcoatlus northropi — Lawson, 1975

🦣 **Period:** Late Cretaceous — approximately 72 to 66 million years ago (Maastrichtian)

🦣 **Size:** Wingspan approx. 10 to 11 m; height at the ground approx. 3 m — as tall as a giraffe

🦣 **Weight:** Approx. 200 to 250 kilograms

- 🦣 **Diet:** Carnivore — likely not a fish-eater; hunted small vertebrates on land
- 🦣 **Lifestyle:** Presumably solitary; capable of flight and active on the ground
- 🦣 **Habitat:** Western North America — inland landscapes and river plains of present-day Texas
- 🦣 **Note:** Quetzalcoatlus was not a dinosaur, but a pterosaur—a flying reptile of the Late Cretaceous period belonging to a distinct evolutionary lineage.

Douglas Lawson discovered the first bones in 1971 in Big Bend National Park in Texas and described Quetzalcoatlus northropi in 1975. The genus name honors Quetzalcóatl—the feathered serpent of Aztec mythology, one of the most significant deities of Mesoamerica. The species name northropi honors Jack Northrop, the aircraft engineer and founder of the Northrop Corporation, who developed flying-wing aircraft—a tribute to the animal's extraordinary aerodynamics. Six specimens are known, including the giant original specimen and smaller individuals that may belong to a separate species.

With a wingspan of ten to eleven meters, Quetzalcoatlus is the largest known flying animal in Earth's history—or at least one of them, since Hatzegopteryx from Romania reached comparable dimensions. An animal with this wingspan, standing on the ground, would reach the shoulder height of a giraffe. This is not a metaphor—it is the actual body height of a standing Quetzalcoatlus on its four limbs.

Not a fish-eater—a land predator with wings

The classification as a fish-eater, which older sources occasionally use, is now largely outdated. Mark Witton of the University of Portsmouth and Darren Naish have argued in several influential studies that large azhdarchids like Quetzalcoatlus were terrestrial predators—animals that ran on the ground, hunted small to medium-sized vertebrates, and used their long necks to pick up prey from the ground, similar to a modern marabou or saddle-billed stork. The anatomy supports this: short metatarsal bones suited for running on land, a skull lacking the beak geometry typical of fish-hunting, and fossil sites far from coasts or large bodies of water.

A body weight of about 200 to 250 kilograms—the source data cites around 26 kilograms, which could correspond to a juvenile or an older estimate—is exceptionally low for an animal of this wingspan. The bones of Quetzalcoatlus were hollow tubes with paper-thin walls, less than two millimeters thick in some areas. This extremely lightweight construction was essential for an animal of this size to fly at all—and it explains why complete Quetzalcoatlus skeletons are so rare. Bones of this wall thickness rarely survive fossilization.

How Quetzalcoatlus took off has long been debated from a biomechanical perspective. The current prevailing view: a powerful leap using all four limbs simultaneously—front and hind legs together, in an explosive upward thrust. Once airborne, Quetzalcoatlus used thermals and updrafts for efficient gliding over long distances.

Quetzalcoatlus lived at the same time as T. rex and Triceratops—on the very last day of the Cretaceous period, right up until the impact 66 million years ago, it was part of the same ecosystem. The largest flying animal in Earth's history and the most famous predatory dinosaur, at the same time, in the same place. A detail that should not be missing from any textbook.

Quetzalcoatlus had the wingspan of a small airplane, the height of a giraffe, and bones thinner than paper—the largest flying animal that ever lived walked on the ground and ate whatever lay beneath it.

Rahonavis

Rahonavis ostromi — Forster et al., 1998

🦣 **Time period:** Late Cretaceous — approximately 70 to 66 million years ago (Maastrichtian)

🦣 **Size:** Approx. 70 cm long — about the size of a crow

🦣 **Weight:** Estimated 100 to 200 grams

🦣 **Life expectancy:** Presumably 5 to 10 years

🦣 **Diet:** Carnivore — insects, small vertebrates, possibly carrion

🦣 **Lifestyle:** Presumably solitary

🦣 **Habitat:** Madagascar — terrestrial landscapes of the Late Cretaceous

Rahonavis ostromi is one of those animals where the debate over the boundary between dinosaurs and birds becomes particularly heated. Catherine Forster of George Washington University and colleagues described it in 1998 in the journal Science — based on fossils from the Maevarano Formation in northwestern Madagascar. The name comes from Malagasy: rahona means threat or cloud, and avis is Latin for bird. The species name ostromi honors John Ostrom, the paleontologist who, with his description of Deinonychus, established the modern view of the dinosaur-bird connection.

What Rahonavis was—a flying bird, a feathered dinosaur, or both—remains unclear to this day. Its anatomy is ambiguous in a way that has led to significant debate in the research community.

Sickle claw and wing buds—a contradiction

Rahonavis had an erect sickle claw on its second toe—the same feature that defines Velociraptor, Deinonychus, and all other dromaeosaurids. That alone would be sufficient to classify it as a dromaeosaurid. At the same time, the forearm bones show quill knobs—feather attachment points that suggest large, asymmetrical flight feathers, as found in flight-capable birds. An animal with a sickle claw and flight feathers.

The original description by Forster and colleagues classified Rahonavis as an early bird—close to Archaeopteryx, but more primitive than modern birds. Later analyses reached different conclusions: some studies view it as a dromaeosaurid with secondarily developed flight feathers, others as a true bird at the base of avian evolution. The problem is that the known material is fragmentary—no complete skull, no complete forelimbs—which complicates phylogenetic analyses.

What is certain: Rahonavis was likely capable of flying, or at least gliding. Its wing architecture was designed for that purpose. At the same time, it walked on two legs and actively hunted on the ground—the sickle-shaped claw is not a passive feature, but a hunting tool.

Madagascar in the Late Cretaceous was an island world with its own faunal evolution—isolated enough to produce distinct evolutionary lineages that had no counterparts on the mainland. Rahonavis lived alongside the abelisaurid Majungasaurus and the strange sauropod Rapetosaurus—a community that clearly demonstrates how islands steer evolution in unexpected directions.

Rahonavis had the sickle-shaped claw of a raptor and the wing feathers of a bird—an animal from Madagascar that so thoroughly blurred the line between the two groups that science still cannot clearly draw it today.

Rebbachisaurus

Rebbachisaurus garasbae — Lavocat, 1954

🦣 **Period:** Middle Cretaceous — approximately 113 to 94 million years ago (Albian to Cenomanian)

🦣 **Size:** Approx. 18 to 20 m long, about 6 to 7 m at the hip Weight: Estimated 10 to 20 tons

🦣 **Life expectancy:** Presumably 50 to 80 years

🦣 **Diet:** Herbivore — conifers, ferns, flowering plants

🦣 **Lifestyle:** Presumably in small groups

- 🦣 **Speed:** Estimated 8 to 12 km/h
- 🦣 **Habitat:** North Africa — terrestrial landscapes of present-day Morocco and Algeria

Rebbachisaurus garasbae is one of the few sauropods known from the Middle Cretaceous of North Africa — and it belongs to a family that was geographically more widespread than long assumed. René Lavocat described it in 1954 based on finds from the Kem Kem Formation in Morocco—a site that has become known in recent decades as one of the most species-rich predatory ecosystems of the Cretaceous. Five specimens are known, none of them complete, which makes estimates of body size uncertain.

Rebbachisaurus belongs to the family Rebbachisauridae—a group of diplodocid sauropods that, unlike their North American relatives such as Diplodocus and Apatosaurus, lived primarily on the southern continents: South America, Africa, and possibly Europe. This distribution suggests an origin in southern Gondwana, from where the family spread in various directions.

What distinguishes Rebbachisaurus anatomically are elongated spinous processes on the dorsal vertebrae—not as extreme as in Spinosaurus, but distinct enough to form a visible dorsal crest. Its function is unclear, as is often the case with such structures: thermoregulation, display apparatus, muscle attachment—all known hypotheses apply.

The ecosystem of the Kem Kem Formation was the same one in which Carcharodontosaurus and Spinosaurus lived—a species-rich river delta of the Middle Cretaceous with an exceptional concentration of predators. Rebbachisaurus was the herbivore component of this environment—a large herbivore that stabilized the balance of an ecosystem we know today primarily through its predators.

Related forms in South America—Nigersaurus, Limaysaurus—show how widespread this family was. Nigersaurus from Niger, a close relative, is known for its unusually broad, forward-facing skull, which functioned like a biological lawnmower. Whether Rebbachisaurus had a similar feeding anatomy cannot be reliably determined from the fragmentary material.

Rebbachisaurus lived in an ecosystem famous primarily for its predators—and yet it was there, large enough to make even Carcharodontosaurus exercise caution.

Regnosaurus

Regnosaurus northamptoni — Mantell, 1848

🦣 **Period:** Early Cretaceous — approximately 136 to 130 million years ago (Hauterivian to Barremian)

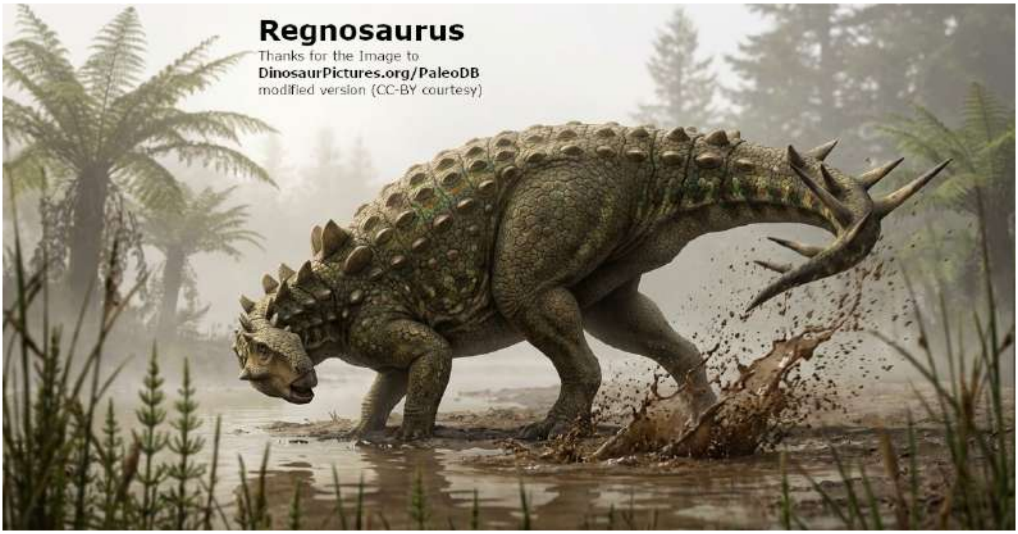
- **Size:** Unknown — only a fragment of the lower jaw is known
- **Weight:** Unknown
- **Diet:** Herbivore
- **Habitat:** Europe — terrestrial landscapes of present-day southern England

Gideon Mantell — the same country doctor from Sussex who discovered Iguanodon — described Regnosaurus northamptoni in 1848 based on a single lower jaw fragment from the Hastings Bed in East Sussex. The name refers to the Regni, a Celtic tribe that inhabited the area of present-day Sussex in ancient times. The species name honors the Marquess of Northampton, who made the fossil available to science.

That was all. A jaw fragment, described in 1848, and nothing new since then.

Regnosaurus is classified as a stegosaurid—a relative of Stegosaurus and Kentrosaurus, meaning an armored herbivore with presumably characteristic dorsal plates. This classification is based on the morphology of the jaw fragment, which can be compared to known stegosaurid jaws. Nothing more can be said. Body size, weight, lifestyle, appearance—all unknown.

Regnosaurus is considered a nomen dubium—a name based on material that does not allow for reliable distinction from other stegosaurids. A single lower jaw is simply too little to reliably identify an animal. Whether Regnosaurus was a distinct species or corresponds to an already known stegosaurid cannot be determined without new material.



Southern England during the Early Cretaceous, at the time of Regnosaurus, was a riverine landscape—the same environment as that of Iguanodon, Baryonyx, and Neovenator. A stegosaurid in this ecosystem would not be a surprise, but a single jawbone is certainly not proof.

Regnosaurus is a jaw fragment, a Celtic folk name, and an open question—that is all that Early Cretaceous England has left behind of this stegosaurid.

Revueltosaurus

Revueltosaurus callenderi — Hunt, 1989

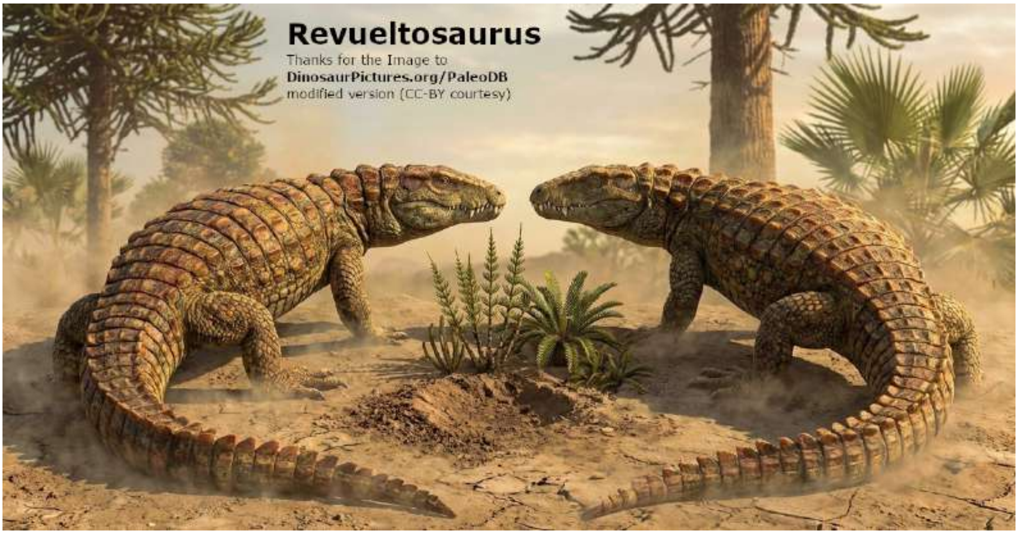
🦣 **Period:** Late Triassic — approximately 220 to 210 million years ago (Norian)

🦣 **Size:** Estimated 1 to 2 m long

🦣 **Weight:** Unknown

🦣 **Diet:** Originally classified as herbivorous — now disputed

🦣 **Habitat:** Western North America — terrestrial landscapes of present-day Texas, Arizona, and New Mexico



Revueltosaurus callenderi is a prime example of how dangerous it is to use isolated teeth as the basis for taxonomic classifications. Adrian Hunt described the animal in 1989 based on tooth fossils from the Chinle Formation in New Mexico — and classified it as an early ornithischian, i.e., a bird-hipped dinosaur. The teeth had a leaf-shaped, serrated morphology reminiscent of herbivorous dinosaurs. For nearly a decade and a half, Revueltosaurus was considered early evidence of ornithischians in the Late Triassic of North America.

Then, in 2004, William Parker of Petrified Forest National Park in Arizona found more complete skeletal material—and the classification collapsed entirely. The new bones clearly showed that Revueltosaurus was not a dinosaur, but an archosaur of a different kind—likely an early relative of crocodiles or a distinct archosaur lineage that has no living representatives today. The leaf-shaped teeth had evolved independently —a classic example of convergent evolution, in which unrelated animals develop similar characteristics.

What Revueltosaurus ate remains uncertain following the reclassification. The teeth still suggest a herbivore, but without a complete skull and other skeletal parts, no definitive conclusion can be drawn. Body size can also only be roughly estimated.

The case of Revueltosaurus is instructive in paleontology: Teeth alone are often not a reliable characteristic for phylogenetic classification—all too often, evolution has developed similar solutions to similar problems in unrelated lineages.

Revueltosaurus was considered a dinosaur for fifteen years—until a more complete skeleton showed that it never had been, thereby producing one of the most instructive errors in Triassic paleontology.

Rugocaudia

Rugocaudia cooneyi — Trexler & Curl, 2010

- 🦣 **Period:** Early Cretaceous — approximately 130 to 125 million years ago (Barremian)
- 🦣 **Size:** Unknown — fragmentary material
- 🦣 **Weight:** Unknown
- 🦣 **Diet:** Herbivore
- 🦣 **Habitat:** Western North America — terrestrial landscapes of present-day Montana

Rugocaudia cooneyi is one of those dinosaurs about which little can be said—not because of a lack of research, but because of a lack of material. David Trexler and Robert Curl described it in 2010 based on tail vertebrae from the Cloverly Formation in Montana—a site that has also yielded Deinonychus and early sauropods. The name means "wrinkled tail"—a reference to the unusually textured surface of the tail vertebrae, which is the diagnostic feature of this species. The species name cooneyi honors Patrick Cooney, who supported the excavations.

Rugocaudia is classified as a sauropod—a large, four-legged herbivore. Its exact family classification within the sauropods cannot be determined with certainty from tail vertebrae alone. Body size, weight, skull shape, dietary details—all are unknown. Tail vertebrae provide reliable insights into local anatomy and allow for a rough taxonomic classification, but nothing more.

The Cloverly Formation originated in a river and floodplain landscape of the Early Cretaceous—a habitat suitable for sauropods of this size, in which Rugocaudia, as a herbivore, played an obvious ecological role.

The material simply does not reveal anything more.

Rugocaudia is a wrinkled tail vertebra from Montana—enough for a name, not enough for a story.

Ruixinia

Ruixinia zhangi — Wang et al., 2020

- 🦣 **Period:** Early Cretaceous — approximately 125 to 120 million years ago (Aptian)
- 🦣 **Size:** Approx. 1 to 1.5 m long
- 🦣 **Weight:** Estimated 2 to 5 kilograms
- 🦣 **Life expectancy:** Presumably 5 to 10 years
- 🦣 **Diet:** Herbivore — low vegetation, seeds, possibly insects
- 🦣 **Habitat:** Asia — terrestrial landscapes of present-day Liaoning Province, China

Wang Xiaolin and colleagues described Ruixinia zhangi in 2020 based on a single specimen from the Yixian Formation in Liaoning Province—

the now-familiar site that, thanks to its exceptional preservation quality, has yielded a large portion of China's known feathered dinosaurs and early birds. The genus name honors the Ruixin School in the region, while the species name zhangi honors a local patron of paleontology.

Ruixinia belongs to the Ornithopoda group—the same herbivorous dinosaur lineage from which Iguanodon and the hadrosaurids later emerged. In the early Aptian, this group was represented in northeastern China by several small forms—Ruixinia joins this community of small, ground-dwelling herbivores that populated the understory of the Yixian ecosystems.

Measuring one to one and a half meters in length, Ruixinia was a small animal—lightly built, presumably agile, and bipedal. In an ecosystem inhabited by Microraptor, early birds, and medium-sized theropods, speed and cover were the obvious survival strategies.

A single specimen, described in 2020—research on Ruixinia is in its very infancy. What the specimen reveals is sufficient for taxonomic classification and a rough anatomical picture, but not for deeper conclusions about behavior or ecology.

Ruixinia is a small herbivore from Cretaceous China—freshly described, barely known, and another building block in the ever-expanding picture of the Yixian fauna.

Saltasaurus

Saltasaurus loricatus — Bonaparte & Powell, 1980

Period: Late Cretaceous — approximately 70 to 66 million years ago (Maastrichtian)

Size: Approx. 12 to 14 m long, about 3 to 4 m at the hip

Weight: Estimated 6 to 8 tons

Life expectancy: Presumably 50 to 80 years

Diet: Herbivore — conifers, flowering plants, cycads

Lifestyle: Presumably in herds; breeding colonies well documented

Speed: Estimated 8 to 12 km/h

Habitat: South America — open landscapes and river plains of present-day Salta Province, Argentina

Saltasaurus loricatus surprised paleontologists twice. The first time because of its body armor—something no one had expected in sauropods until its discovery. The second time because of a nesting site that provided a completely new picture of how titanosaurs gave birth to their young.

José Bonaparte and Jaime Powell described Saltasaurus in 1980 based on finds from the Lecho Formation in the Argentine province of Salta—after which the animal was named. The source data cite only one specimen, but the material in the original description included several individuals, and later finds from the same formation have significantly expanded our understanding. Saltasaurus belongs to the group of Titanosauria—the line of sauropods that dominated the late Cretaceous period on nearly every continent.

At twelve to fourteen meters in length, Saltasaurus was comparatively compact for a titanosaur—no Argentinosaurus, no Dreadnoughtus. What it lacked in size, it made up for in other ways.

Bones in the Skin

When Bonaparte and Powell analyzed the Saltasaurus fossils, they found something unexpected: small, oval bone plates—so-called osteoderms—that had grown into the skin. Some of them were smooth and flat, others bore a central bony spike. Together, they formed a kind of flexible body armor that covered the back and flanks of Saltasaurus.

This was a sensation. Until then, sauropods had been considered unarmored—their sheer body size was supposed to be protection enough. Saltasaurus showed that at least some titanosaurs had developed an additional means of protection. Whether this armor was effective against predators—specifically the abelisaurids, which served as the top predators in South America—or whether it served other functions remains unclear. But its existence fundamentally changed our understanding of sauropods.

Following the discovery, osteoderms were found in several other titanosaurids—suggesting that Saltasaurus was not an isolated case, but rather a representative of a group in which body armor was more widespread than long assumed.

A nesting site with a thousand eggs

The second major discovery related to Saltasaurus came in 1997—and this time from a different province in Argentina. Luis Chiappe of the Natural History Museum of Los Angeles County and colleagues investigated a site in Auca Mahuevo in the province of Neuquén, which turned out to be one of the most significant dinosaur nesting sites in the world: thousands of titanosaur eggs, spread over an area of several hectares, many of them containing preserved embryos inside.

The eggs were attributed to Saltasaurus or a close relative—precise species identification is always uncertain with egg finds, but the geographical and temporal proximity, as well as the consistency of embryonic characteristics, support this. What Auca Mahuevo reveals: Titanosaurs laid their eggs in colonies, on flat, open terrain, in large numbers. The eggs were comparatively small—about the size of a melon—which means that the young were born tiny and had to grow over many years before reaching the safety of their adult size.

There is no evidence of parental care in the sense of active brooding or feeding of the young for Saltasaurus—the sheer size of an adult titanosaur makes actively sitting on the eggs implausible. But the colony size and the regularity of the nesting sites suggest a social breeding behavior that went beyond merely laying eggs and moving on.

Saltasaurus was the armored sauropod—smaller than many relatives, but with bony armor on its back and a nesting site that showed titanosaurs did not leave their young to chance.

Saltriosaurus

Saltriosaurus zanellai — Dal Sasso et al., 2018

- 🦣 **Period:** Early Jurassic — approximately 198 to 191 million years ago (Sinemurian)
- 🦣 **Size:** Estimated 7 to 8 m long
- 🦣 **Weight:** Estimated 800 to 1,500 kilograms
- 🦣 **Life expectancy:** Unknown
- 🦣 **Diet:** Carnivore — likely large prosauropods and other reptiles
- 🦣 **Lifestyle:** Likely solitary
- 🦣 **Habitat:** Europe — terrestrial landscapes of present-day northern Italy

Saltriosaurus zanellai is scientifically significant for one reason alone: It is the oldest known Tetanurae—the oldest representative of that large group of theropods from which Allosaurus, Spinosaurus, T. rex, and birds later emerged. At nearly 200 million years old, it pushes the known origin of this lineage back considerably.

Cristiano Dal Sasso of the Museo di Storia Naturale di Milano and colleagues described Saltriosaurus in 2018 in the journal PeerJ—based on fossils that had been discovered as early as 1996 by a quarry worker named Angelo Zanelli near Saltrio in Lombardy. The species name honors Zanelli, who reported the find, rather than overlooking him. The fossils sat in the museum for years before a complete scientific description was possible.

The known material includes parts of the forelimbs, foot bones, and a few other fragments—no skull, no complete skeleton. It is sufficient for a body size estimate of seven to eight meters, but not for a complete anatomical picture.

The oldest of its kind

Saltriosaurus's place in the Early Jurassic is geologically and evolutionarily significant. Nineteen-eight million years ago, the mass extinction at the Triassic–Jurassic boundary had only just been survived. The ecological niches left vacant by the extinction were just being repopulated. Saltriosaurus shows that the Tetanurae—the most advanced group of theropods—were already actively shaping this phase of ecological renewal earlier than previously documented.

Early Jurassic northern Italy was not an alpine landscape at that time, but a flat coastal area on the edge of the Tethys Sea—warm, humid, and crisscrossed by rivers. In this environment, Saltriosaurus was likely the dominant large predator of its time and region, with no serious competition in the same size class.

The bones show bite marks—from another animal, possibly a crocodilian relative. This is indirect evidence that Saltriosaurus did not remain unnoticed for long after its death.

Saltriosaurus is the oldest known Tetanurae—a predatory dinosaur from the Early Jurassic of Italy that demonstrates that the lineage from Allosaurus to T. rex stretches back nearly 200 million years.

Shamosaurus

Shamosaurus scutatus — Tumanova, 1983

🦣 **Period:** Early to Middle Cretaceous — approximately 125 to 100 million years ago (Aptian to Cenomanian)

🦣 **Size:** Approx. 6 to 7 m long, about 1.5 m at the hip

🦣 **Weight:** Estimated 2 to 3 tons

🦣 **Life expectancy:** Presumably 20 to 30 years

🦣 **Diet:** Herbivore — low vegetation, ferns, flowering plants

🦣 **Lifestyle:** Presumably solitary

🦣 **Speed:** Estimated 8 to 12 km/h

🦣 **Habitat:** Asia — terrestrial landscapes of present-day Inner Mongolia, China

Tatjana Tumanova of the Paleontological Institute of the Russian Academy of Sciences described Shamosaurus scutatus in 1983 based on two specimens from Mongolia—the name refers to the Shamo Desert, the Mongolian name for the Gobi. Scutatus means "shielded"—a direct reference to the body armor.

Shamosaurus belongs to the family Ankylosauridae—the same club-tailed armored dinosaurs that include Euoplocephalus, which we have already discussed. What makes Shamosaurus interesting within this family is that it is one of the oldest known ankylosaurids in Asia. Dating back up to 125 million years, it is one of the earliest representatives of its family—and thus provides insights into a phase of Ankylosauria evolution that is still poorly understood.

Two specimens are known, including skull material that allows for reliable taxonomic classification. The skull was broad and triangular—typical of ankylosaurids—with a body armor of osteoderms that protected the back and flanks. A tail club is not definitively attested for Shamosaurus, but as an ankylosaurid, it was likely equipped with one.

What makes the picture of Shamosaurus interesting in a broader context: The Early Cretaceous in Asia was a time when the Ankylosauria evolved from primitive forms into the highly specialized armored dinosaurs of the Late Cretaceous. Shamosaurus represents an early stage in this evolution—more advanced than the most primitive ankylosaurs, but not yet as fully specialized as Euoplocephalus or Ankylosaurus.

Shamosaurus was one of the earliest ankylosaurids in Asia—an armored herbivore from the Gobi that demonstrates how far back this family

extends and how early the armored dinosaurs developed their characteristic form.

Shantungosaurus

Shantungosaurus giganteus — Hu, 1973

- 🦣 **Period:** Late Cretaceous — approximately 73 to 66 million years ago (Maastrichtian)
- 🦣 **Size:** Approx. 14 to 17 m long, about 4 to 5 m at the hip
- 🦣 **Weight:** Estimated 12 to 16 tons
- 🦣 **Life expectancy:** Presumably 30 to 40 years
- 🦣 **Diet:** Herbivore — conifers, leaves, flowering plants
- 🦣 **Lifestyle:** Presumably in herds
- 🦣 **Speed:** Estimated 15 to 25 km/h
- 🦣 **Habitat:** Asia — coastal plains and riverine landscapes of the present-day provinces of Shandong, Hebei, and Shaanxi, China

Shantungosaurus giganteus is the largest known hadrosaurid—and thus the largest known bipedal animal in Earth's history. With a length of up to seventeen meters and a weight of possibly sixteen tons, it surpassed even large sauropods in body mass without utilizing their quadrupedal design. A herbivore of this size is unparalleled in its group throughout the entire history of dinosaurs.

Hu Chengzhi of the Chinese Academy of Sciences’ Institute of Vertebrate Paleontology and Paleoanthropology described Shantungosaurus giganteus in 1973 based on fossils from Shandong Province—after which the animal was named. Four specimens are known, including material that allowed for the reconstruction of a nearly complete skeleton. The mounted skeleton at the China Geological Museum in Beijing is considered one of the most impressive dinosaur skeletons in Asia.

Shantungosaurus belongs to the subfamily Saurolophinae—the same crested hadrosaurids that include Edmontosaurus, the largest North American representative of this group. While Edmontosaurus remained between nine and thirteen meters in length, Shantungosaurus significantly exceeded that. Why the Asian branch of this family reached such proportions is not fully explained—possibly the specific ecosystems of the Late Cretaceous in eastern China played a role, with abundant food and selective pressure favoring large body size.

Size as a Strategy

What does it mean to weigh sixteen tons and still walk on two legs? The biomechanics of an animal of this magnitude are considerably more complex than those of smaller hadrosaurids. Shantungosaurus's hind legs were massive—its femurs, the thigh bones, are among the largest known theropod and ornithopod bones of all. When feeding, Shantungosaurus likely grazed on all fours—its head close to the vegetation, its forelimbs serving as support. When running, it stood upright and used its enormous hind legs for propulsion.

With this body mass, Shantungosaurus was not a realistic target for most predators of its time—at least not as a healthy adult. In eastern China during the Late Cretaceous, Zhuchengtyrannus magnus, which we have already discussed, was the dominant large predator—even on the scale of T. rex. Whether Zhuchengtyrannus attacked a fully grown Shantungosaurus or waited for juveniles and weakened animals cannot be directly proven. However, the pattern is familiar from comparable predator-prey systems: even a nine-ton tyrannosaurid would be well advised to wait when facing a healthy sixteen-ton animal.

The dentition of Shantungosaurus, as with all hadrosaurs, consisted of tooth batteries—several hundred small teeth in continuously regrowing rows that efficiently ground down hard plant material. Given the energy requirements of an animal of this size, eating was not a side activity, but the central task of every day.

Shantungosaurus was the largest herbivore ever to walk on two legs—a sixteen-ton hadrosaurid from Late Cretaceous China, next to which even Edmontosaurus looks like a medium-sized animal.

Shanweiniao

Shanweiniao cooperorum — O'Connor et al., 2009

- 🦣 **Time period:** Early Cretaceous — approximately 125 to 120 million years ago (Aptian)
- 🦣 **Size:** Approx. 20 to 30 cm body length — very small bird
- 🦣 **Weight:** Estimated 50 to 150 grams
- 🦣 **Diet:** Presumably insectivorous or piscivorous
- 🦣 **Habitat:** Asia — coastal and lake regions of present-day Hebei Province, China

Brief note on classification: Shanweiniao was not a dinosaur in the strict sense, but an early bird—an Enantiornithes, a member of the bird group that dominated the skies during the Cretaceous period and became completely extinct by the end of that era.

Jingmai O'Connor of the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing and colleagues described Shanweiniao cooperorum in 2009 in the journal Proceedings of the Royal Society B, based on fossils from the Jiufotang Formation in Hebei. The name means "fan-tailed bird"—a reference to the characteristic tail structure that serves as the diagnostic feature of this species. The species name cooperorum honors the Cooper family, who supported the research.

What distinguishes Shanweiniao from other early birds of its time is its tail. The tail feathers were arranged in a fan-like pattern—a configuration that is common in modern birds but was still unusual in the early Cretaceous. This finding was relevant to research on tail evolution in birds: it shows that fan-like tail structures emerged earlier than long assumed, and that different bird lineages may have developed this configuration independently of one another.

Shanweiniao belongs to the group of Enantiornithes—the so-called counter-birds, which were globally widespread during the Cretaceous but, unlike the ancestors of modern birds, became extinct at the end of the Cretaceous. They still had claws on their wings and other primitive features, but were true fliers—active flight, not gliding.

Shanweiniao was an early bird with a modern fan-shaped tail—a small fossil from Hebei that demonstrates how rapidly bird evolution progressed in the early Cretaceous.

Styracosaurus

Styracosaurus albertensis — Lambe, 1913

- 🦣 **Period:** Late Cretaceous period — approximately 75 to 72 million years ago
- 🦣 **Size:** Approximately 5 to 5.5 m long, approximately 1.8 m hip height
- 🦣 **Weight:** Estimated 2.5 to 3 tons
- 🦣 **Life expectancy:** Probably 20 to 30 years
- 🦣 **Diet:** Herbivore — low vegetation, ferns, cycads, flowering plants
- 🦣 **Lifestyle:** Probably in herds; possibly seasonal migration
- 🦣 **Speed:** Estimated 20 to 28 km/h
- 🦣 **Habitat:** Western North America — coastal forests and river plains of what is now the province of Alberta, Canada

There are many striking faces among the horned dinosaurs of the Cretaceous period. But Styracosaurus stands out even in this group. While Triceratops scores with three distinctive horns, Styracosaurus wore a neck frill that looks as if evolution decided to really go overboard this time. Six long bone spears protrude from the edge of the frill toward the rear — plus a striking horn on the nose, which would be impressive on its own. The overall picture is so extraordinary that one inevitably asks: What was the point of all this?

Styracosaurus albertensis was first described in 1913 by Canadian paleontologist Lawrence Lambe, based on finds from the Dinosaur Park Formation in what is now Alberta. The name means “spiny lizard” — and it fits. The Royal Tyrrell Museum in Drumheller, Alberta, which houses one of the world's most important dinosaur collections, has studied and exhibited several specimens of this species. Alberta remains the center of Styracosaurus research to this day, and for good reason: the Dinosaur Park Formation is one of the most fossil-rich layers of the late Cretaceous period.

Styracosaurus lived about 75 to 72 million years ago in a landscape that bore little resemblance to today's Alberta in terms of climate. At that time, the region was a humid, river-crisscrossed coastal lowland on the edge of the western inland sea that divided North America from north to south at that time. Lush vegetation, warm climate, abundant water. A world that was ideal for herbivores in every respect.

The shield that was not armor

The most striking part of Styracosaurus is undoubtedly the neck frill with its six long bone spears. Instinct tells us: this is a weapon, armor, a protective shield against predators. Science says: probably not. At least not primarily.

The neck frill of ceratopsians — to which Styracosaurus belongs — was usually thin and crisscrossed with blood vessels. It would have been of little use as protection against the bite of a tyrannosaurid. What it could do, however, was attract attention. Stand out strongly. Studies on the morphology of ceratopsian shields, including work by Andrew Farke of the Raymond Alf Museum of Paleontology in California, consistently suggest that the shield and horns served primarily for intraspecific communication — recognizing conspecifics, impressing rivals, and possibly choosing mates.

A larger, more symmetrical shield with longer spears signaled strength and health. Those with the more impressive headgear had to fight less. This is a principle that runs through the entire animal kingdom — from deer antlers to peacock feathers. In the case of Styracosaurus, it was just particularly spectacular. The fact that the shield also contributed to thermoregulation — as a blood-supplied surface that could give off or absorb heat — is another hypothesis that cannot be ruled out.

The nasal horn, on the other hand, was more robustly built and quite suitable as a weapon. At up to 57 centimeters long, it was long enough to cause serious damage to an attacking predator. Whether Styracosaurus actively used it for defense or whether it was also primarily a display apparatus has not been conclusively clarified. Probably both — depending on the situation.

A graveyard full of Styracosaurus

One of the most fascinating finds related to Styracosaurus is not a single skeleton, but an entire collection. At the so-called Styracosaurus bonebed site in Alberta, the remains of dozens of individuals were discovered at the same location — juveniles and adults mixed together, different age groups, a single large bone deposit.

Styracosaurus

Such bonebeds are formed in various ways. One possibility is that a herd was surprised by a flood while crossing a river and perished. Another is that animals from different herds used the same watering hole and died there over a long period of time. What the bonebed most likely shows is herd behavior. Styracosaurus was not a loner. It lived in groups — presumably larger groups that migrated, fed, and responded to threats together.

This is an important finding. A herd of Styracosaurus advancing together toward an attacker posed a completely different threat than a single animal. Even Tyrannosaurus rex, which lived in the same region and may have overlapped with Styracosaurus at times, would probably have kept its distance from a closed group of these spiked animals. Numbers protect — and Styracosaurus had clearly understood how to use them.

It fed on ground-level vegetation: ferns, cycads, and low flowering plants, which spread rapidly during the Cretaceous period. Styracosaurus' beak was sharp and designed for cutting plant material, with molars behind it for efficient grinding. It had teeth that were specialized for low, hard vegetation — and found plenty of it every day in the lush river landscape of Alberta.

Styracosaurus looked like the result of evolution that had decided not to do things by halves — proving that the most striking head in the room isn't always the most dangerous, but it's almost always the most memorable.

Spinosaurus

Spinosaurus aegyptiacus — Stromer, 1915

- **Period:** Middle Cretaceous — approximately 99 to 93 million years ago
- **Size:** Approximately 14 to 15 m long, approximately 4 to 5 m hip height
- **Weight:** Estimated 7 to 20 tons (estimates vary greatly depending on the study)
- **Life expectancy:** Probably 30 to 40 years
- **Diet:** Carnivore — mainly fish, but also large reptiles and possibly other dinosaurs
- **Lifestyle:** Probably solitary; semi-aquatic
- **Speed:** Probably efficient in water; rather slow and clumsy on land

🦣 **Habitat:** North Africa — coastal regions, river mouths, extensive river deltas in present-day Egypt, Morocco, and Niger

Spinosaurus is the dinosaur that won't leave anyone alone. Not researchers, not the public, and certainly not paleontologists, who have been arguing for over a century about what this animal actually was, how it lived, and what it looked like. What is certain is that Spinosaurus aegyptiacus was most likely the longest carnivorous dinosaur that ever lived. Longer than T. rex. Longer than Giganotosaurus. Perhaps the largest land predator in the history of the Earth — although the term “land predator” no longer quite fits Spinosaurus. For this dinosaur was, at least at times, not purely a land animal.

The history of its exploration begins with a tragedy. German paleontologist Ernst Stromer von Reichenbach described Spinosaurus in 1915 based on bones he had excavated in Egypt in 1912. The originals were stored in the Paleontological Museum in Munich — until the night of April 24-25, 1944, when a British bomber attack hit the museum and destroyed the fossils. For decades, Spinosaurus was thus primarily a name, supported by drawings and descriptions, but with little tangible material. It was only new discoveries in Morocco and Niger, which began in the 1990s and were published in 2014 in a groundbreaking study by paleontologist Nizar Ibrahim of the University of Detroit in the journal Science, that brought Spinosaurus back into the spotlight — and turned almost everything we thought we knew upside down.

Spinosaurus lived about 99 to 93 million years ago in a North Africa that had little in common with today's Sahara. At that time, the region was an extensive river delta crisscrossed by waterways, lined with mangrove forests, warm, humid, and rich in aquatic life. It was a habitat that was ideal for a specialized fisher.

The sail that raises questions

The most striking feature of Spinosaurus is the dorsal structure — elongated spinous processes of the vertebrae that grew up to 1.8 meters high and formed a kind of sail or hump, depending on which reconstruction you believe. The function of this structure is still not clearly understood, and the discussion about it is almost as old as the discovery itself.

Was it a sail for thermoregulation — raised in the sun to absorb heat, or turned into the wind to cool down? Was it a hump similar to that of a bison, filled with fat reserves for lean times? Or was it primarily a display apparatus to impress conspecifics and intimidate competitors? All three hypotheses have supporters, but none has prevailed. What the structure certainly was, however, was unmissable. A full-size Spinosaurus with its sail erect must have been a sight to behold, one that burned itself into the memory.

Then there is the skull. Long, narrow, with conical teeth designed not for crushing but for grasping — a profile strongly reminiscent of modern crocodiles and clearly indicating a diet of fish. The tip of the snout probably had pressure receptors similar to those of crocodiles, which could sense movement in the water. Spinosaurus therefore hunted not only with its eyes, but possibly also with its senses — an ability that is considerably more useful in the murky waters of a river delta than sharp vision.

A dinosaur that went into the water

The truly revolutionary discovery came in 2014 with the study by Nizar Ibrahim and his team. The newly found bones from Morocco showed short, powerful hind legs, a flattened foot with broad toes, and above all: extremely dense, compact bones without the cavities that kept the bones light in most dinosaurs. Dense bones are a classic feature of animals that live in water — they serve as ballast and make it easier to dive and swim in the current. The conclusion was clear: Spinosaurus was a semi-aquatic animal that spent a significant part of its life in the water.

Spinosaurus –
Thanks for the Image by
DinosaurPictures.org/PaleoDB,
modified for book (CC-BY courtesy)

A follow-up study by the same team, published in Nature in 2020, added to this: analysis of the tail vertebrae showed that Spinosaurus had a rudder-like, laterally flattened tail — built for propulsion in water, not for balancing on land. This is an anatomical feature that had not been known in any other dinosaur until then. So Spinosaurus didn't just swim occasionally, it was designed for it.

What this meant for its behavior: On land, Spinosaurus, with its short hind legs and enormous weight, was probably a clumsy animal that moved sluggishly. In the water, however, it was in its element — a predator that could catch fish several meters long, which were abundant in Cretaceous North Africa. The coelacanth relative Mawsonia, for example, a giant fish up to three meters long, shared the same habitat and was probably one of its preferred prey species.

It cannot be ruled out that Spinosaurus occasionally attacked other dinosaurs — Spinosaurus teeth have been found in sauropod bones. But there is much to suggest that it was not a classic large predator like T. rex, which actively pursued land mammals and other dinosaurs, but rather a highly specialized fish eater that found its niche in the water and consistently filled it.

Research on Spinosaurus is far from complete. Every new find from North Africa changes the picture a little. What remains is the portrait of an animal that defies categorization — too large for a fish eater, too water-bound for a classic theropod, too enigmatic for a simple explanation.

Spinosaurus was the largest carnivorous dinosaur in the history of the Earth — and at the same time the strangest: a giant that went into the water and was truly at home there.

Tapejara

Tapejara wellnhoferi — Kellner, 1989

- 🦣 **Period:** Early Cretaceous — approximately 112 to 109 million years ago (Aptian)
- 🦣 **Size:** Wingspan approx. 1.5 to 2 m
- 🦣 **Weight:** Estimated 1 to 3 kilograms
- 🦣 **Diet:** Probably fruits, possibly also fish and insects
- 🦣 **Lifestyle:** Presumably solitary
- 🦣 **Habitat:** South America — coastal and forested landscapes of present-day Ceará, Brazil

🦣 **Note:** Tapejara was not a dinosaur, but a pterosaur — a flying reptile of the Early Cretaceous that belongs to a distinct evolutionary lineage.

Alexander Kellner of the Museu Nacional in Rio de Janeiro described Tapejara wellnhoferi in 1989 based on a single specimen from the Santana Formation in the Brazilian province of Ceará—a site that, due to its exceptional preservation quality, has yielded a large portion of the known South American pterosaurs. The name comes from the Tupi language and roughly means "the old gentleman"—a reference to the ancient dignity attributed to the animal at first sight. The species name wellnhoferi honors Peter Wellnhofer, the German pterosaur specialist.

Tapejara belongs to the family Tapejaridae—a group of short-snouted, high-crested pterosaurs that were widespread in South America and Asia during the Early Cretaceous. What makes this family instantly recognizable is the skull crest: in Tapejara wellnhoferi, a bony frontal crest above the snout, complemented by a soft-tissue crest that likely extended far back on the living animal. Reconstructions show a striking, semicircular crest—one of the most visually distinctive head profiles among all known pterosaurs.

A Frugivore with Wings

Its classification as a frugivore—a fruit-eater—is unusual among pterosaurs and makes Tapejara a unique case. The short, sturdy beak, lacking the long grasping teeth typical of fish-eaters, actually fits better with an animal that ate soft fruits or seeds than with an active fish hunter. Modern toucans—also with large, lightweight beaks and striking head structures—are occasionally cited as a functional analogy.

Whether Tapejara ate exclusively fruit or opportunistically also consumed fish and insects cannot be conclusively determined from a single specimen without preserved stomach contents. But the beak structure is clear enough to establish the fruit-eater hypothesis as the most plausible dietary strategy—and thus to mark Tapejara as an ecological exception among pterosaurs.

The skull crest was most likely highly vascularized and possibly brightly colored—a signaling organ for intraspecific communication, mate selection, or species recognition. In an animal the size of a large pigeon with a crest that exceeded the height of the skull, the visual impact was considerable.

Tapejara was a pterosaur with the crest of a toucan and the beak of a fruit-eater—a quiet outsider in a group full of fish-eaters, flying its own path through the Cretaceous period of Brazil.

Tehuelchesaurus

Tehuelchesaurus benitezii — Rich et al., 1999

- 🦣 **Period:** Late Jurassic — approximately 157 to 145 million years ago (Kimmeridgian to Tithonian)
- 🦣 **Size:** Approx. 15 to 20 m long
- 🦣 **Weight:** Estimated 15 to 25 tons
- 🦣 **Life expectancy:** Presumably 50 to 80 years
- 🦣 **Diet:** Herbivore — conifers, ferns, cycads
- 🦣 **Lifestyle:** Presumably in small groups
- 🦣 **Speed:** Estimated 8 to 12 km/h

🦣 **Habitat:** South America — terrestrial landscapes of present-day Chubut Province, Patagonia

Thomas Rich of the Museum Victoria in Melbourne and colleagues described Tehuelchesaurus benitezii in 1999 in the Journal of Vertebrate Paleontology, based on a single specimen from the Cañadón

Calcáreo Formation in the Argentine province of Chubut. The name honors the Tehuelche—the indigenous people of Patagonia who inhabited the region long before the first paleontologist set foot there. The species name benitezii honors Heriberto Benítez, who discovered the fossils.

Tehuelchesaurus belongs to the Sauropoda group, but its exact family affiliation is debated. Various analyses have classified it as a basal Titanosauriformes—that is, as an early representative of the lineage that later gave rise to the Titanosauria—or as a representative of another basal sauropod group. A single specimen without a complete skull makes this classification difficult.

What the known material reveals: a large sauropod with well-preserved vertebrae and limb bones that make a length of fifteen to twenty meters plausible. The vertebral structure is central to the taxonomic discussion—it exhibits features compatible with both basal Titanosauriformes and other groups, keeping the debate open.

Patagonia in the Late Jurassic was a productive ecosystem—rich in sauropods of various groups, some of which lived contemporaneously with Tehuelchesaurus. As a large herbivore, Tehuelchesaurus occupied a niche supported by the abundant vegetation of Patagonia's riverine landscapes at that time.

One specimen, one formation, one open taxonomic question. Tehuelchesaurus is described with sufficient detail to be considered a distinct species—but too fragmentary to have the final word.

Tehuelchesaurus bears the name of the indigenous people of Patagonia and remains as taxonomically open as the steppe where it was found—a Jurassic sauropod awaiting a more complete discovery.

Thalassomedon

Thalassomedon haningtoni — Welles, 1943

Period: Late Cretaceous — approximately 95 to 93 million years ago (Cenomanian to Turonian)

Size: Approx. 12 to 13 m long — of which about 6 m is neck

Weight: Estimated 5 to 8 tons

Diet: Carnivore — fish, squid, small marine organisms

Reproduction: Viviparous

Habitat: North America — Western Interior Seaway, the shallow inland sea of present-day Colorado and Kansas

Note: Thalassomedon was not a dinosaur, but a plesiosaur — a marine reptile of the Late Cretaceous period belonging to a distinct evolutionary lineage.

Samuel Welles described Thalassomedon haningtoni in 1943 based on specimens from the Greenhorn Limestone in Colorado—the same marine rock formation that also yielded Megacephalosaurus. The name means "lord of the sea"—from the Greek thalassa for "sea" and medon for "ruler." The species name haningtoni honors H.W. Haningtoni, who collected the material. Two specimens are known, including a remarkably complete skeleton that provides detailed insights into its anatomy.


Thalassomedon plesiosaur hunting Squid

Thalassomedon belongs to the family Elasmosauridae—the same family as Elasmosaurus, which we have already discussed. As an elasmosaurid, it was a long-necked plesiosaur with a small skull, numerous thin teeth, and four large flippers. With a neck about six meters long and 62 cervical vertebrae, it wasn't quite as extreme as Elasmosaurus with its 72, but it was in the same anatomical league.

What makes the complete skeleton of Thalassomedon particularly valuable: gastroliths were found in the stomach area—swallowed stones that the animal had actively ingested. Over 250 polished pebbles, weighing several kilograms in total. These stones likely served as ballast—they helped Thalassomedon control its neutral buoyancy and remain at the desired water depth, similar to how modern crocodiles swallow stones to stay more stable in the water. They may also have aided digestion by mechanically grinding food—a principle that birds use today with their gizzard stones.

The discovery site in the Greenhorn Limestone places Thalassomedon in the Western Interior Seaway—the shallow, warm inland sea that divided North America during the Late Cretaceous. This sea was rich in fish, ammonites, and other marine life, but also in predators: mosasaurs began to dominate the seaway during this period. Thalassomedon lived on the cusp of this change—at a time when plesiosaurs still dominated, but mosasaurs were already catching up.

Its hunting strategy was the same as Elasmosaurus': a long neck as a precision tool, a small head for quick positioning, and teeth as a gripping cage for fish and squid. A predator that did not overwhelm with speed, but with reach and precision.

Thalassomedon was the lord of the sea with a six-meter neck, 250 gastroliths, and a complete skeleton—one of the best-preserved elasmosaurids and a direct window into the Late Cretaceous Western Interior Seaway.

Torosaurus

***Torosaurus latus* — Marsh, 1891**

- ✓ **Period:** Late Cretaceous — approximately 68 to 66 million years ago
- ✓ **Size:** Approximately 7.5 to 9 m long, approximately 2.2 m hip height
- ✓ **Weight:** Estimated 6 to 8 tons
- ✓ **Life expectancy:** Presumably 30 to 40 years
- ✓ **Diet:** Herbivore — low to medium-height vegetation, ferns, flowering plants
- ✓ **Lifestyle:** Probably in small groups or solitary
- ✓ **Speed:** Estimated 9.3 to 12.4 miles per hour
- ✓ **Habitat:** Western North America — river plains and coastal forests of the Hell Creek Formation

Torosaurus is a dinosaur with an identity problem. Not because it is mysterious or poorly documented — but because a scientific hypothesis that caused a stir in 2010 claimed outright that it did not exist. Torosaurus, according to the thesis, is not a separate animal, but simply a fully grown Triceratops. Two names for one and the same species. The debate that ensued continues to this day — and it is one of the most entertaining controversies that paleontology has produced in recent decades.

For a long time, Torosaurus was simply what it is: an impressive ceratopsid from the late Cretaceous period, living at the same time as T. rex and Triceratops in the Hell Creek Formation, with one of the largest skulls ever measured in a land animal. Othniel Charles Marsh described it in 1891 based on two fragmentary skulls from Wyoming. The name means “pierced lizard” — an allusion to the large openings in the neck frill, known as parietal fenestrae, which are the most striking feature of this animal.

It is precisely these openings that are at the heart of the controversy. Triceratops has a massive, closed neck frill without such windows. Torosaurus has a significantly larger, thinner frill with two distinctive openings. In 2010, John Scannella and Jack Horner from the Museum of the Rockies published a hypothesis in the journal PLOS ONE that Triceratops remodeled its frill during its lifetime — and that Torosaurus was simply Triceratops in its old age. Not a separate animal, but an old Triceratops.

A shield that grows — or doesn't

The hypothesis was clever and based on real observations. Dinosaur bones do change with age. Young animals have different bone structures than old ones, and in ceratopsids, the neck shield is a particularly dynamic element — it grows, changes shape, becomes thicker or thinner. Scannella and Horner argued that all known Torosaurus specimens were adults, while Triceratops is known to exist at all ages. This was no coincidence, they said, but an indication that every old Triceratops became a Torosaurus.

The opposition was not long in coming. Nicholas Longrich of Yale University and Daniel Field published a counter-study in the same year that pointed out fundamental problems with the hypothesis. The crucial point: Triceratops and Torosaurus were never found at the same site in the same rock layers, which would be expected if the two animals were identical. In addition, some Torosaurus specimens show bone structures that indicate incomplete growth — which is difficult to explain if Torosaurus is supposed to be the final stage of a fully grown Triceratops.

Where does the research stand today? The majority of paleontologists continue to treat Torosaurus as a separate species. Scannella and Horner's hypothesis has not been disproved, but it has not gained acceptance either. Torosaurus lives on — at least in the textbooks.

Torosaurus latus

The largest skull of all time

What is easily overlooked in all this controversy is the most remarkable thing about Torosaurus: its skull. With a total length of up to 2.77 meters, it is the largest known skull of a land animal in the entire history of the Earth. Not that of T. rex. Not that of Spinosaurus. But that of Torosaurus. The Natural History Museum in Washington and several other institutions house parts of this extraordinary skull structure, and anyone who has ever stood in front of a reconstructed specimen immediately understands why.

Similar to other ceratopsids, the shield itself was thin and crisscrossed with blood vessels — unsuitable as protective armor, but all the more effective as a display apparatus. The two openings in the shield were probably covered with skin in the living animal and possibly brightly colored. A fully grown Torosaurus with a full shield must have been a sight to behold, even in a world full of extraordinary animals.

Two short horns above the eyes and a longer nasal horn completed the picture. The horns of Torosaurus were shorter overall than those of Triceratops — which fits with the theory that the two animals pursued different ecological strategies, or represent different stages of development of the same species. Depending on which side of the debate you believe.


Tyrannosaurus Rex - Illustration: DinosaurPictures.org/PaleoDB, modified for book layout (CC-BY courtesy)

Torosaurus shared its habitat with some of the most famous dinosaurs in Earth's history. T. rex roamed the same river plains. Edmontosaurus moved in herds through the coastal forests. Ankylosaurus moved slowly through the undergrowth. It was the last, most species-rich phase of dinosaur history — 66 million years ago, just a few hundred thousand years before the end. Torosaurus witnessed the extinction. It was one of the last of its kind.

Torosaurus had the largest skull ever possessed by a land animal — and yet, to this day, people still question whether it ever existed.

Triceratops

Triceratops horridus — Marsh, 1889

🦣 **Period:** Late Cretaceous period — approximately 68 to 66 million years ago

🦣 **Size:** Approximately 8 to 9 m long, approximately 2.5 to 3 m hip height

🦣 **Weight:** Estimated 8 to 12 tons

🦣 **Life expectancy:** Probably 30 to 40 years

🦣 **Diet:** Herbivore — low to medium-height vegetation, ferns, cycads, flowering plants

🦣 **Lifestyle:** Probably solitary or in small groups; not a particularly gregarious animal

🦣 **Speed:** Estimated 12 to 18 miles per hour

🦣 **Habitat:** Western North America — river plains, coastal forests, and open landscapes of the Hell Creek Formation

Some animals are so iconic that we forget how extraordinary they actually were. Triceratops is one of them. Three horns, a powerful neck frill, a body the size of an elephant — the image is so firmly embedded in our collective memory that hardly anyone looks twice. But it's worth taking a closer look. Because Triceratops was not only an impressive animal. It was one of the most successful herbivores in the entire history of dinosaurs, a contemporary of T. rex, and present until the

last day of the Cretaceous period. No other dinosaur had as much of an impact on the final phase of this epoch as it did.

Triceratops was first described in 1889 by Othniel Charles Marsh, based on horn fragments from Colorado. Marsh initially thought the first finds were the remains of an unusually large bison — a mistake that was quickly cleared up when more complete skulls turned up. Since then, Triceratops has enjoyed a scientific career that few other dinosaurs have achieved: dozens of complete or nearly complete skeletons, finds in several US states and Canadian provinces, and a history of research that continues to this day. According to an estimate by the Smithsonian Institution National Museum of Natural History, Triceratops is one of the most frequently found dinosaurs in the Hell Creek Formation.

The species Triceratops horridus — the name means "horrible three-horned lizard," which can be taken quite literally — was not the only one of its genus. Triceratops prorsus, a second species with a slightly different skull geometry, also lived in the Hell Creek Formation, possibly at a different time. Whether both species existed at the same time or whether one evolved from the other is the subject of ongoing research.

Three horns and a shield — what exactly were they for?

The question of the function of the horns and neck shield in Triceratops is as old as the discovery itself. And it is more complicated to answer than one might think. The long horn above each eye reached a length of up to one meter in adult animals — sturdily built, with a bony base and a keratin coating in the living animal, similar to the horns of modern cattle. The shorter nasal horn was more robust and shorter. All three horns were clearly suitable as weapons.

Triceratops

There is direct evidence of their use. Bite marks clearly originating from T. rex have been found on several Triceratops skeletons — and conversely, injuries matching Triceratops horns have been documented on T. rex bones. A Triceratops skull from the Hell Creek Formation, examined at the Denver Museum of Nature and Science, shows healed T. rex bite marks above the eye area — the animal survived the attack. This is not a fossil coincidence. It is evidence of real conflicts between two of the most famous dinosaurs in Earth's history.

At the same time, horns and shields most likely also served for intraspecies communication. Studies of the shield surface, including those by Andrew Farke of the Raymond Alf Museum of Paleontology, show scratches and injury patterns that indicate fights between individual Triceratops — head to head, horns locked, similar to how deer fight today. The one with the larger, healthier shield and longer horns dominated. The one who dominated mated. Evolution in its purest form.

The neck shield itself was massive and closed in Triceratops — unlike in the related Torosaurus, which, as is well known, has been a topic of debate. It was crisscrossed by a rich network of blood vessels, indicating active blood flow. Whether it served to regulate body temperature, was used as a color display, or both, has not been conclusively determined. It was probably more colorful and conspicuous in the living animal than dry fossils suggest.

Life Next to T. rex

Triceratops and T. rex shared the same habitat, the same geological formation, and the same time period. That's a fact that can be easily forgotten when looking at the two animals in isolation. In the reality of the Hell Creek Formation 67 million years ago, they were neighbors — and occasionally direct opponents.

For T. rex, Triceratops was an attractive but dangerous prey. Attractive because of the sheer mass of meat. Dangerous because of the horns, the shield, and the weight. An adult Triceratops turning to face an attacker and presenting its horns would not have been an easy target. Juveniles and old or weakened animals were more vulnerable - and that is exactly what the hunting pattern of large predators has been throughout the ages.

Triceratops und T. rex

What Triceratops ate was ground-level vegetation. Its body structure — low-set head, strong neck, broad beak — was optimal for grazing on ferns, low flowering plants, and palms. The beak was sharp and designed for slicing plant material, the molars behind it for efficient grinding. Similar to hadrosaurids, the teeth were continuously renewed — a system that was simply necessary for an animal that processed large amounts of tough vegetation daily.

Triceratops went extinct 66 million years ago — along with T. rex, the hadrosaurs, and nearly all other non-avian dinosaurs. He was there until the very end. No dinosaur lasted longer in the Cretaceous, none represented its final phase more completely.

Triceratops was the last great herbivore of a dying world — armored, horned and present to the end, as if made for this very finale.

Tuojiangosaurus

Tuojiangosaurus multispinus — Dong et al., 1977

- ✔ **Period:** Late Jurassic — approximately 157 to 145 million years ago (Kimmeridgian to Tithonian)
- ✔ **Size:** Approx. 6 to 7 m long, about 2 m at the hip
- ✔ **Weight:** Estimated 700 kilograms to 1 ton
- ✔ **Life expectancy:** Presumably 20 to 30 years
- ✔ **Diet:** Herbivore — low vegetation, ferns, conifer shoots
- ✔ **Lifestyle:** Presumably solitary or in small groups
- ✔ **Speed:** Estimated 8 to 12 km/h
- ✔ **Habitat:** Asia — riverine landscapes and forests of present-day Sichuan Province, China

Dong Zhiming of the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing and colleagues described Tuojiangosaurus multispinus in 1977 based on a single specimen from the Shangshaximiao Formation in Sichuan Province—the same formation that yielded Agilisaurus and has proven to be one of China's most productive Jurassic sites. The name refers to the Tuojiang River, which flows through the region. Multispinus means “many-spined”—a reference to the numerous pairs of plates along the back.

Tuojiangosaurus belongs to the family Stegosauridae—the same group as Stegosaurus from North America and Kentrosaurus from Africa. As an Asian representative of this family, it is one of the most complete known stegosaurids in China and thus an important data point for understanding the global distribution of this group in the Late Jurassic.

What distinguishes Tuojiangosaurus from Stegosaurus is the number and shape of the dorsal plates. The name multispinus says it all: Tuojiangosaurus bore more pairs of plates than Stegosaurus—a total of about fifteen pairs along its back, smaller and more pointed than the broad, flat plates of its North American relative. Four spikes were located on the tail—the classic thagomizer arrangement that served as a defensive weapon in all stegosaurids.

The Shaximiao Formation developed in a humid riverine landscape—similar to the Morrison Formation in North America, which produced both Stegosaurus and Allosaurus during the same period. In China, Tuojiangosaurus filled the role of a medium-sized herbivore that grazed close to the ground and relied on passive defense via spikes and plates. Predators of its time in the Shaximiao Formation are less well known than their North American counterparts, but early megalosaurids and other theropods were present.

The complete specimen—now on display at the Chongqing Museum of Natural History—is one of the most impressive stegosaurid skeletons in Asia and has made Tuojiangosaurus one of the best-known Chinese dinosaurs, even though it receives less international attention than its North American relatives.

Tuojiangosaurus was Asia's answer to Stegosaurus—slightly smaller, with more and sharper plates, and rare evidence that stegosaurids had taken over not only North America and Africa but also China by the Late Jurassic.

Tyrannosaurus Rex

Tyrannosaurus rex — Osborn, 1905

🦣 **Period:** Late Cretaceous — approx. 68 to 66 million years ago

🦣 **Size:** Up to 12.3 m long, approx. 3.8 m tall at the hip

🦣 **Weight:** Estimated 8 to 14 metric tons (varies by specimen and study)

🦣 **Lifespan:** Probably 25 to 30 years

🦣 **Diet:** Carnivore — large prey animals, likely also carrion

🦣 **Lifestyle:** Likely solitary; possibly loose social structures

🦣 **Top Speed:** Estimated 17 to 25 km/h

🦣 **Habitat:** Western North America — floodplains, river valleys, forested lowlands

The name alone is enough. Tyrannosaurus rex — the tyrant lizard king. No other dinosaur has burned itself so deeply into our collective imagination, and for good reason. T. rex was not just large. It was the culmination of 165 million years of dinosaur evolution, a predator refined by time into something close to perfect for its environment. When people picture a dinosaur, they picture this one. And yet, for all its fame, T. rex continues to surprise us.

It lived during the very last chapter of the Cretaceous, between roughly 68 and 66 million years ago, in what is now the western United States and Canada. The Hell Creek Formation in Montana, the Dakotas, and Wyoming has produced more T. rex specimens than anywhere else —

around 50 individuals in total, ranging from juveniles to fully grown adults. That number sounds modest, but in paleontological terms it

TYRANNOSAURUS REX

makes T. rex one of the best-documented large predators in the fossil record. We know the shape of its brain cavity, the growth rings in its bones, the structure of its inner ear, and in a handful of cases even traces of its soft tissue.

The basic numbers are staggering. At up to 12.3 meters in length and nearly four meters at the hip, T. rex was the largest land predator of its time in North America. The skull alone could measure over 1.5 meters — wider at the back than it was tall — and was packed with teeth that, according to research published by paleontologist Gregory Erickson of Florida State University, could exert a bite force of up to 57,000 newtons. That is the highest bite force measured or estimated for any terrestrial animal. The teeth themselves were not blade-like, as in many other theropods, but thick, almost banana-shaped in cross-section — built not to slice but to crush.

The Arms Question Nobody Can Stop Asking

Those tiny front limbs. They are perhaps the most talked-about detail of any dinosaur, and they have confused and amused scientists for over a century. T. rex had arms roughly the length of an adult human's, ending in two-fingered hands — all attached to an animal the size of a city bus. For a long time, the standard line was that the arms were vestigial, essentially useless remnants of a larger-limbed ancestor. But that view has shifted.

The arm bones of T. rex are actually extremely robust — heavily muscled, with attachment sites suggesting enormous strength. An adult T. rex could likely curl several hundred kilograms with each arm. The question is not whether those arms were powerful. The question is what they were for. Current hypotheses include holding prey close to the body during feeding, helping the animal push itself up from a lying position, or assisting during mating. None of these explanations has been conclusively proven, and the arms of T. rex remain one of the most entertaining open questions in the field.

The legs, by contrast, tell a clearer story. T. rex was a biped, walking upright on two powerful hind limbs, with a long, heavy tail serving as a counterbalance to the massive head. Estimates of its walking and running speed have shifted dramatically over the decades. Early reconstructions imagined T. rex as a swift, active chaser. More recent biomechanical models, including a widely discussed 2021 study by William Sellers and colleagues published in PLOS ONE, suggest a top speed of around 17 to 25 kilometers per hour — a fast walk or moderate trot rather than a full sprint. Faster movement would have put dangerous stress on the leg bones. T. rex did not need to be the fastest animal in its world. It only needed to be faster than what it was chasing.

Hunter, Scavenger, or Both? The Debate That Refuses to Die

Few paleontological arguments have attracted as much public attention as the question of whether T. rex was an active hunter or primarily a scavenger. Jack Horner of the Museum of the Rockies became the most vocal champion of the scavenger hypothesis, pointing to the relatively small eyes of T. rex, its heavily built body, and its extraordinary sense of smell as signs of an animal built to find and consume carcasses rather

T. Rex

than run down live prey. The olfactory bulbs of T. rex, visible in endocasts of the skull, were proportionally enormous — among the largest of any dinosaur.

The counter-evidence, however, is compelling. Healed bite wounds found on the bones of Edmontosaurus and Triceratops — healed, meaning the prey animal survived the attack and lived on afterward — are hard to explain if T. rex only ate animals already dead. Tooth marks from T. rex on the bones of large prey match patterns typical of active predators, not passive scavengers. The current consensus, supported by most researchers working on large theropod ecology, is that T. rex was an opportunist: a predator that actively hunted when the opportunity arose and took advantage of carrion whenever it was available. In other words, it behaved much like lions and hyenas do today — flexible, practical, and entirely uninterested in what category a paleontologist might put it in.

One of the most remarkable windows into T. rex biology came in 2005, when Mary Schweitzer of North Carolina State University announced the discovery of soft tissue preserved inside the femur of a T. rex specimen from the Hell Creek Formation. Blood vessel structures, flexible material resembling collagen, and what appeared to be cell-like structures had survived 68 million years of fossilization. The find was controversial and remains debated, but it opened a new field of inquiry: molecular paleontology, the study of biological molecules preserved in ancient bone. If the findings hold up to continued scrutiny, they promise a future in which we may know far more about T. rex biochemistry than anyone imagined possible.

As for what it looked like in life — the picture has changed considerably from the classic scaly green monster of old films. Recent research, including studies on the distribution of feathers among theropods, suggests that T. rex probably had scaly skin across much of its body, particularly on the flanks and back, based on direct skin impressions. Whether it retained patches of proto-feathers on its head, neck, or elsewhere is less certain. Juveniles may have been more fully feathered than adults, a pattern seen in some modern birds. And the color? Impossible to say with certainty. But given what we know about vision in theropods — which was likely quite good, possibly including color perception — it would not be surprising if T. rex was more visually striking than decades of gray and green reconstructions suggested.

T. rex vanished 66 million years ago in the asteroid impact that ended the Cretaceous. It had existed as a species for only about two million years — a short run by dinosaur standards, but long enough to become the most famous animal in the history of life on Earth.

T. rex was not the biggest, not the fastest, and not the oldest — but no predator in Earth's history combined raw power, sensory acuity, and evolutionary refinement quite like the tyrant king.

Unaysaurus

Unaysaurus tolentinoi — Leal et al., 2004

Period: Late Triassic — approximately 228 to 208 million years ago (Carnian to Norian)

Size: Approx. 1.5 to 2.5 m long, about 70 cm at the hip

Weight: Estimated 70 to 130 kilograms

Life expectancy: Unknown

Diet: Herbivore — low vegetation, ferns, soft plant shoots

Habitat: South America — terrestrial landscapes of present-day Rio Grande do Sul Province, Brazil

Leal and colleagues described Unaysaurus tolentinoi in 2004 in the journal Anais da Academia Brasileira de Ciências, based on a single specimen from the Caturrita Formation in the southern Brazilian state of Rio Grande do Sul. The name comes from the Tupi language—unay means “black water,” a reference to a local river. The species name tolentinoi honors Tolentino Marafiga, who discovered the fossils.

Unaysaurus belongs to the Plateosauridae group—the same family as Plateosaurus from Europe, which lived around the same time and exhibited similar anatomical features. This relationship is biogeographically significant: In the Late Triassic, Pangaea was still largely connected, and early sauropodomorphs—the precursors of the later giant sauropods—were able to spread across the entire supercontinent. Unaysaurus and Plateosaurus represent two endpoints of this spread—South America and Europe—and their anatomical similarity attests to their close evolutionary relationship.

Measuring one to two and a half meters in length, Unaysaurus was a small to medium-sized herbivore—still a far cry from the giants that its lineage would produce in the Cretaceous. It was bipedal, with long forelimbs that could be used both for walking and for grasping vegetation. Its teeth were leaf-shaped and adapted for soft plant material—not a highly developed chewing apparatus, but a simple, functional system for an animal in an ecologically open world.

The Caturrita Formation originated in a late Triassic riverine landscape—a time when dinosaurs were just beginning to establish themselves as dominant land animals but were still competing with rhynchosaurs, early crocodilian relatives, and other reptilian groups. In this early ecosystem, Unaysaurus was a herbivore lacking the body size that later protected sauropods—speed and vigilance were the obvious survival strategies.

Unaysaurus was an early sauropodomorph from the Triassic of southern Brazil—related to Plateosaurus from Europe and living proof that Pangaea held dinosaurs closer together than continents do today.

Utahraptor

Utahraptor ostrommaysi — Kirkland et al., 1993

Period: Early Cretaceous — approximately 130 to 125 million years ago (Barremian to Aptian)

Size: Approx. 5 to 7 m long, about 1.5 to 2 m at the hip

Weight: Estimated 300 to 500 kilograms

Life expectancy: Presumably 15 to 25 years

Diet: Carnivore — large sauropods, ornithopods, possibly also carrion

Lifestyle: Presumably solitary or in small groups

Speed: Estimated 25 to 40 km/h

Habitat: Western North America — riverine landscapes and open plains of present-day Utah and Colorado

Utahraptor ostrommaysi is the dromaeosaurid that Jurassic Park should have used. When the film hit theaters in 1993 and depicted the

Velociraptor as a man-sized predatory dinosaur, it was artistic license—the real Velociraptor was only about the size of a turkey. Then, that same year, James Kirkland, Robert Gaston, and Donald Burge described a dromaeosaurid from Utah that actually matched the dimensions of the film's creature. The irony was impossible to miss: reality had caught up with fiction, in the very same year.

The species name ostrommaysi honors both John Ostrom—the paleontologist who scientifically established the avian ancestry of dinosaurs with Deinonychus—and film producer Steven Spielberg, who incorporated the name of his production company's financier into it. An unusual combination of scientific history and pop culture that continues to this day.

Two specimens are known—including a significant find from the Cedar Mountain Formation in Utah, discovered in 2001, which contains extensive skeletal material that has not yet been fully published. Research on Utahraptor is thus still ongoing.

The largest sickle claw of any known dromaeosaurid

What distinguishes Utahraptor from all other known dromaeosaurids is simply its size—and with it, the scale of its sickle claw. The erect claw on the second toe reached a length of up to 24 centimeters in adult animals—almost twice as long as that of Deinonychus, its next-largest North American relative. An animal with this claw, weighing 500 kilograms and standing on long, powerful hind legs, posed a fundamentally different threat than a Velociraptor.

The function of the sickle claw was the same as in all dromaeosaurids: not a cutting tool, but a gripping tool. Biomechanical analyses, comparable to those conducted for Deinonychus, suggest that Utahraptor used its claw to anchor itself to its prey—much like a large bird of prey uses its talons. The jaws then did the actual killing.

There is no direct evidence of what Utahraptor hunted. The Cedar Mountain Formation was home to early sauropods, ornithopods, and other dinosaurs—prey of various sizes. An animal weighing 500 kilograms could realistically attack other dinosaurs of similar or slightly larger body mass. Whether it engaged in group hunting is speculative—the evidence is too sparse to make definitive statements.

Utahraptor was fully feathered—like all dromaeosaurids. Given its size and weight, it was thus the largest known feathered animal that could not fly. A predator the size of a lion, with feathers, sickle claws, and the basic body plan of a Velociraptor—only five times as large.

Utahraptor was the real Jurassic Park raptor—man-sized, heavy, with a 24-centimeter sickle claw, and discovered in the very year the movie was released, as if evolution had been primed for the joke.

Velociraptor

Velociraptor mongoliensis — Osborn, 1924

🦣 **Period:** Late Cretaceous period — approximately 75 to 71 million years ago

🦣 **Size:** Approximately 1.8 m long, approximately 50 to 60 cm hip height Weight: Estimated 7 to 15 kilograms

🦣 **Life expectancy:** Probably 15 to 20 years

🦣 **Diet:** Carnivore — small vertebrates, lizards, small mammals, possibly carrion

🦣 **Lifestyle:** Probably solitary or in loose groups; not a pack hunter

🦣 **Speed:** Estimated 15 to 25 miles per hour

🦣 **Habitat:** Central Asia — dry semi-deserts and dune landscapes of present-day Mongolia and China

Velociraptor Illustration: DinosaurPictures.org/PaleoDB, modified for book (CC-BY courtesy)

Hardly any other dinosaur is as well known — and hardly any other is so consistently misrepresented. The velociraptor from the Jurassic Park film series, which looks an adult human in the eye, fights with a doorknob, and hunts in coordinated packs: that is a fabrication. The real velociraptor was about the size of a turkey, weighed between seven and fifteen kilograms, and was most likely completely feathered. It was still a remarkable animal — just for different reasons than Hollywood would have us believe.

The scientific name Velociraptor mongoliensis means "fast predator from Mongolia." It was named in 1924 by Henry Fairfield Osborn, then president of the American Museum of Natural History in New York, after finds from the Gobi Desert. Since then, Mongolia has repeatedly yielded spectacular Velociraptor fossils, including one of the most famous single fossils in all of paleontology: the so-called Fighting Dinosaurs, a specimen that was fossilized while attacking a Protoceratops — both animals preserved in the embrace of death, probably buried by a collapsing sand dune.

Velociraptor lived about 75 to 71 million years ago in a world not unlike today's Mongolia in terms of climate: hot, dry, characterized by dunes and semi-deserts, crisscrossed by occasional watercourses. No lush jungles, no dense forests. A barren, harsh landscape — and just the right environment for an agile, fast hunter that relied not on mass but on precision.

The claw that changed everything

What really makes Velociraptor famous among experts is not its size, but a single anatomical feature: the sickle-shaped claw on the second toe of its hind foot. It was upright — i.e., lifted off the ground when running — sharp and up to 6.5 centimeters long in an adult animal. For a long time, it was considered a slashing tool: according to the classic idea, the velociraptor jumped on its prey, held it with its front arms and slashed its belly with this claw.

More recent studies have called this picture into question. Biomechanical analyses, including those by paleontologist Phil Manning of the University of Manchester, suggest that the claw was not structurally suited to cutting through soft tissue. It was more of a holding tool — built to anchor itself in the prey, hold it down, and press it down while the bite did the actual damage. A similar hunting pattern is seen today in hawks and eagles, which fix their prey with their claws and then kill it. Velociraptor as a feathered, climbing, grasping hunter — that is the current picture, and it is frankly more fascinating than the movie version.

The forearms of Velociraptor are also remarkable. They were long, flexible, and bore so-called feather quills on the bones — attachment points for feathers, as found in birds today. This finding, published in 2007 by Alan Turner and colleagues from the American Museum of Natural History in the journal Science, is direct anatomical evidence that Velociraptor had feathers. It couldn't fly with them — its arms were too short for functional wings. But the feathers could have served to regulate body temperature, to shovel during incubation, or simply to communicate with other members of the species.

The myth of the pack hunter

Jurassic Park has created an image that persists: velociraptors as highly intelligent, coordinated pack animals that develop strategies and set traps. It's a great movie image. It has little to do with reality.

There is no direct evidence of group behavior in velociraptors. Fossil finds from Mongolia show almost exclusively individual animals. The aforementioned fossil of the fighting dinosaurs shows a velociraptor attacking a protoceratops alone — an animal that significantly exceeded it in weight. This suggests either considerable courage or a predator that was accustomed to hunting alone and knew its own abilities well.

As far as intelligence is concerned, the velociraptor's brain was actually relatively large in proportion to its body size compared to many other dinosaurs. However, it would be premature to draw direct conclusions about problem-solving abilities or social strategies from this. Modern birds — the direct descendants of theropods — display an enormous range of cognitive abilities, and some are actually remarkably intelligent. Whether Velociraptor belonged to this group cannot be deduced from the fossils alone.

What Velociraptor ate is also interesting. With a maximum body weight of 15 kilograms, large sauropods or adult ceratopsids were simply not realistic prey. It probably hunted small mammals, lizards, insects, and possibly small dinosaurs. The fossil of the fighting dinosaurs suggests that it also attacked animals that were larger than itself — but whether this was the norm or a risky exception remains unclear.

Velociraptor belongs to the Dromaeosauridae family, a group of small to medium-sized, feathered theropods that are closely related to birds. Its closest known relative is Deinonychus antirrhopus from North

America — a slightly larger animal whose discovery in the 1960s by John Ostrom of Yale University shook up the entire field of paleontology and put the theory of warm-blooded, bird-like dinosaurs on a solid scientific footing for the first time.

Velociraptor itself died out 66 million years ago, like all non-avian dinosaurs. What survived from its lineage now sits in every tree and sings — birds are its heirs, and in a sense, Velociraptor never really disappeared.

The real velociraptor was not a movie hero, but a feathered, precise solo hunter — smaller than a sheepdog, but with a claw that continues to occupy paleontologists to this day.

Zhuchengtyrannus

Zhuchengtyrannus magnus — Hone et al., 2011

Period: Late Cretaceous — about 73 to 66 million years ago (Maastrichtian)

Size: Estimated 11 to 12 m long, about 3.5 to 4 m at the hip height

Weight: Estimated 6 to 9 tons

Life expectancy: Presumably 25 to 35 years

Diet: Carnivore — large hadrosaurs, possibly also carrion

Lifestyle: Probably a loner

Speed: Estimated 20 to 30 km/h

Habitat: Asia — river plains and coastal landscapes of present-day Shandong Province, China

Zhuchengtyrannus magnus — the great tyrant of Zhucheng. The name says it all. Named after the Chinese city of Zhucheng in the province of Shandong, which has proven to be one of the most significant dinosaur sites in Asia in recent decades, "magnus" simply describes the size: big. Very big.

David Hone from University College Dublin and colleagues described Zhuchengtyrannus in 2011 in the journal Cretaceous Research — based on a single specimen: a partially preserved upper and lower jaw. Little material, but enough. The bones are so large that they can only belong to one of the largest known tyrannosaurids. With an estimated length of eleven to twelve meters and a weight of possibly nine tons, Zhuchengtyrannus was in the size range of T. rex — possibly even slightly heavier than its North American relative.

Zhuchengtyrannus belongs to the family Tyrannosauridae and is the largest known tyrannosaurid in Asia. This is remarkable because for a long time, T. rex was considered to have no Asian counterpart in its size class. Tarbosaurus bataar from Mongolia — also a large Asian tyrannosaurid — was somewhat smaller. Zhuchengtyrannus fills this gap and shows that late Cretaceous Asia was indeed capable of producing predators on T. rex dimensions.

Zhucheng — a city full of giants

What makes the site special is the context. Zhucheng has delivered an extraordinary concentration of dinosaur bones in recent decades — including thousands of hadrosaurid bones, primarily from Shantungosaurus giganteus, one of the largest known hadrosaurids ever, reaching up to fifteen meters in length and possibly weighing sixteen tons. Zhuchengtyrannus and Shantungosaurus lived in the same ecosystem, at the same time. The relationship is the same as between T. rex and Edmontosaurus in North America: a huge herbivore, a huge predatory dinosaur, the same habitat.

Whether Zhuchengtyrannus actively hunted Shantungosaurus or mainly benefited from carrion cannot be inferred from a single jaw fragment. The tooth morphology—as far as can be discerned from the preserved material—fits that of a typical tyrannosaurid: robust, banana-shaped teeth designed for crushing bones and tearing flesh.

One single specimen is a thin data base. But the bones are big enough, distinct enough, and well enough documented to establish Zhuchengtyrannus as a separate species. What is still missing: a complete skeleton that confirms or corrects the estimates. Zhucheng is still being excavated - it is quite possible that this tyrant has not yet had his last word.

Zhuchengtyrannus was Asia's answer to T. rex — a jaw fragment big enough to reorder the entire hierarchy of Asian predatory dinosaurs.

Zigongosaurus

Zigongosaurus fuxiensis — Hou et al., 1976

- ✔ **Period:** Late Jurassic — approximately 161 to 155 million years ago (Callovian to Oxfordian)
- ✔ **Size:** Approx. 14 to 18 m long, about 4 to 5 m at the hip
- ✔ **Weight:** Estimated 10 to 15 tons
- ✔ **Life expectancy:** Presumably 50 to 80 years
- ✔ **Diet:** Herbivore — conifers, ferns, cycads
- ✔ **Lifestyle:** Presumably in small groups
- ✔ **Speed:** Estimated 8 to 12 km/h
- ✔ **Habitat:** Asia — riverine landscapes of the Shaximiao Formation, present-day Sichuan Province, China

Hou Lianhai and colleagues described Zigongosaurus fuxiensis in 1976 based on material from the Shaximiao Formation in Sichuan Province—named after the city of Zigong, which today considers itself the dinosaur capital of China and is home to the Zigong Dinosaur Museum, one of the most significant dinosaur museums in Asia. The species name fuxiensis refers to the Fuxi River in the region.

With 24 known specimens, Zigongosaurus is one of the most commonly found sauropods in China—which is no surprise given that the Shaximiao Formation is one of the most productive Jurassic sites worldwide. In addition to Zigongosaurus, this formation has yielded Tuojiangosaurus, Agilisaurus, and several other species, and is considered the Chinese equivalent of North America's Morrison Formation.

Zigongosaurus belongs to the Mamenchisauridae—a family of long-necked sauropods known for their extremely elongated necks and found exclusively in Asia. Mamenchisaurus, the namesake of this family, had a neck that accounted for nearly half of its total length—a proportion that is exceptional even among sauropods. Whether Zigongosaurus possessed the same extreme proportions cannot be fully reconstructed from the available material, but its family affiliation points in that direction.

The taxonomic history of Zigongosaurus is complicated. Various analyses have assigned it to different families—sometimes as a Mamenchisauridae, sometimes as a basal eusauropod. With 24 specimens, there should actually be enough material for a clear classification, but the quality of the individual finds varies considerably, and complete skulls are largely missing. The current majority opinion leans toward the Mamenchisauridae, though the question is not yet considered settled.

In the Shaximiao Fauna, Zigongosaurus was the large herbivore—an animal that utilized the tree canopies of Sichuan's Jurassic forests and lived in a region that was wetter and greener back then than present-day China. Predators of its time in this formation are less well documented than in the Morrison Formation, but early theropods were present.

With 24 specimens, Zigongosaurus is one of the most common sauropods in China—and yet so taxonomically controversial that a city full of dinosaur museums has not yet been able to fully classify it.


Zigongosaurus