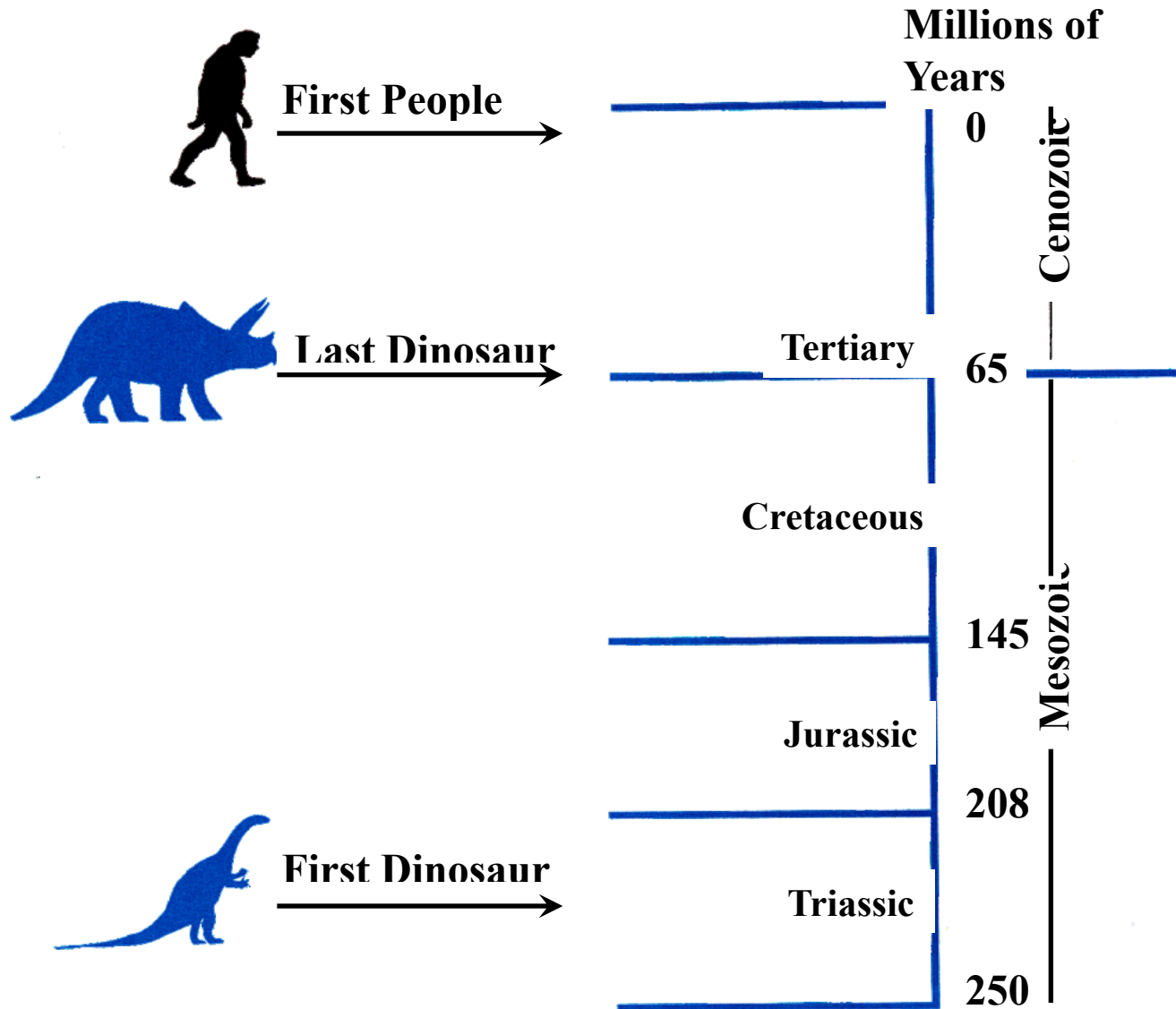
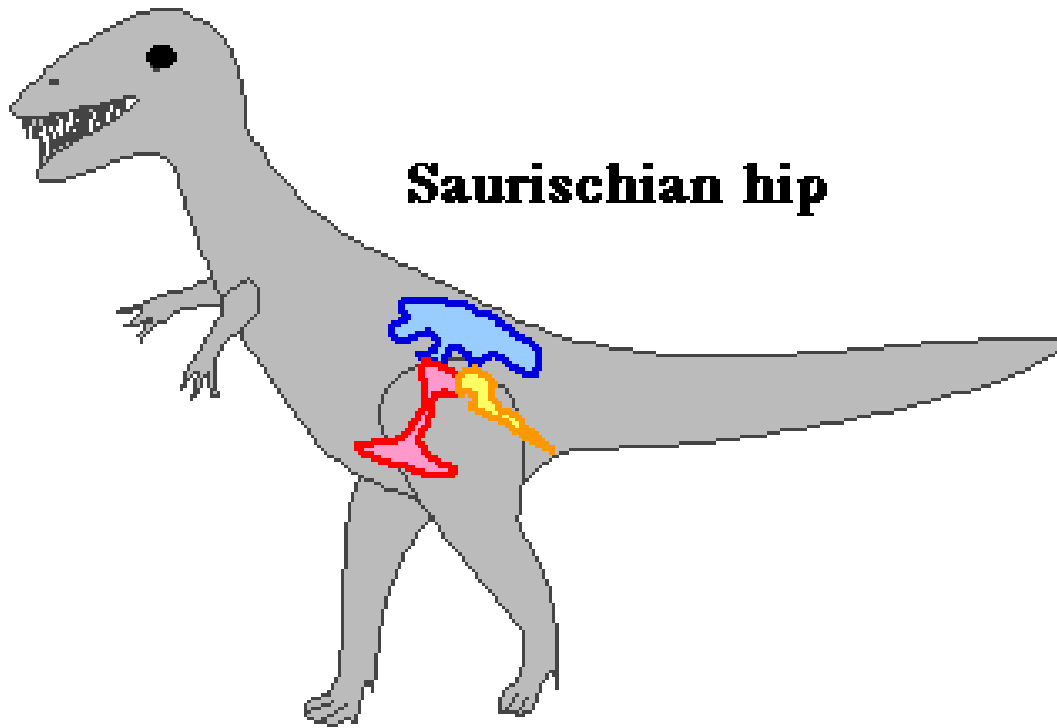


When did dinosaurs live?

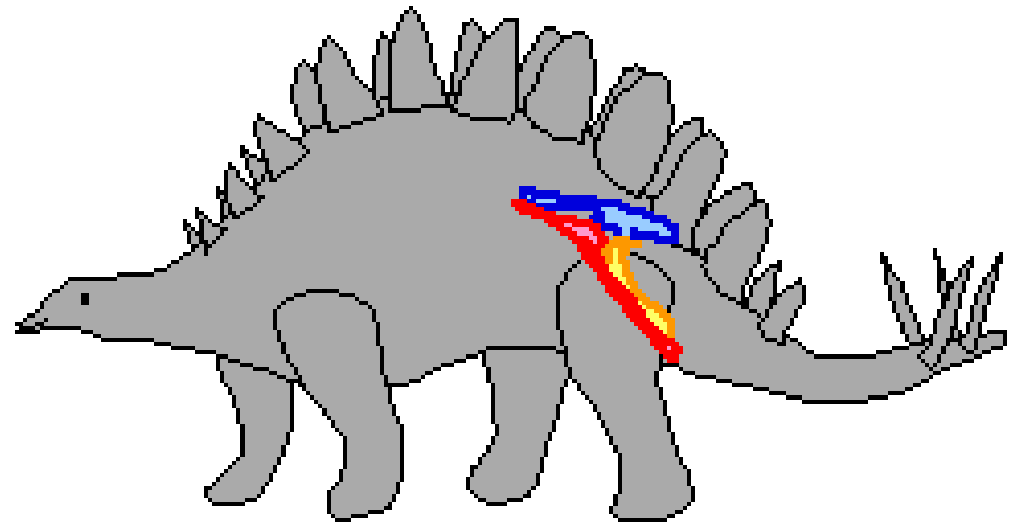


What are dinosaurs?

- Technically: no such thing as dinosaurs
 - Classification:
 - Class – Reptilia (reptiles)
 - Order – Archosauria
 - Suborders
 - Saurischia – lizard hips
 - Ornithischia – bird hips
- } Dinosaurs in popular sense



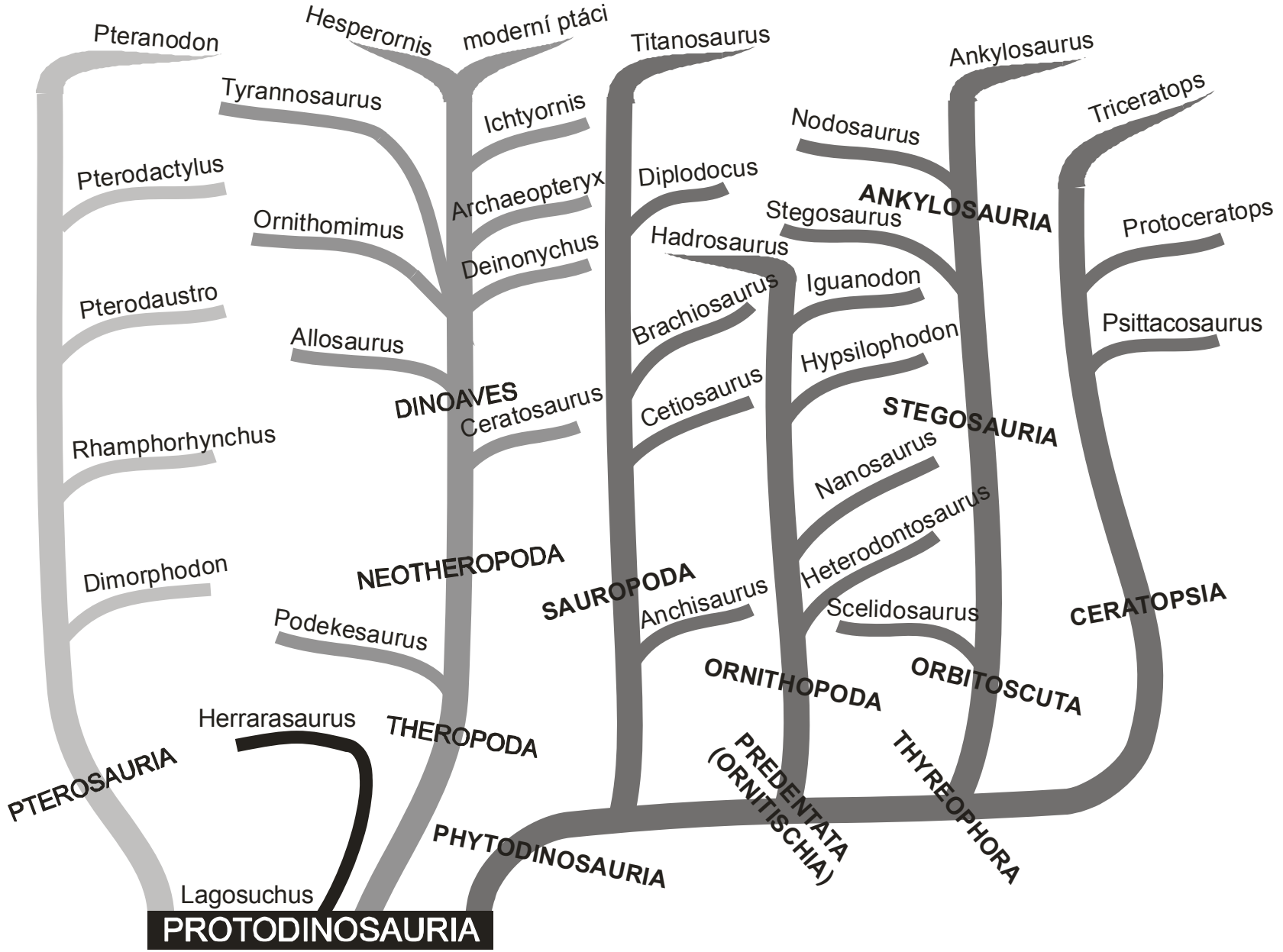
Saurischian hip



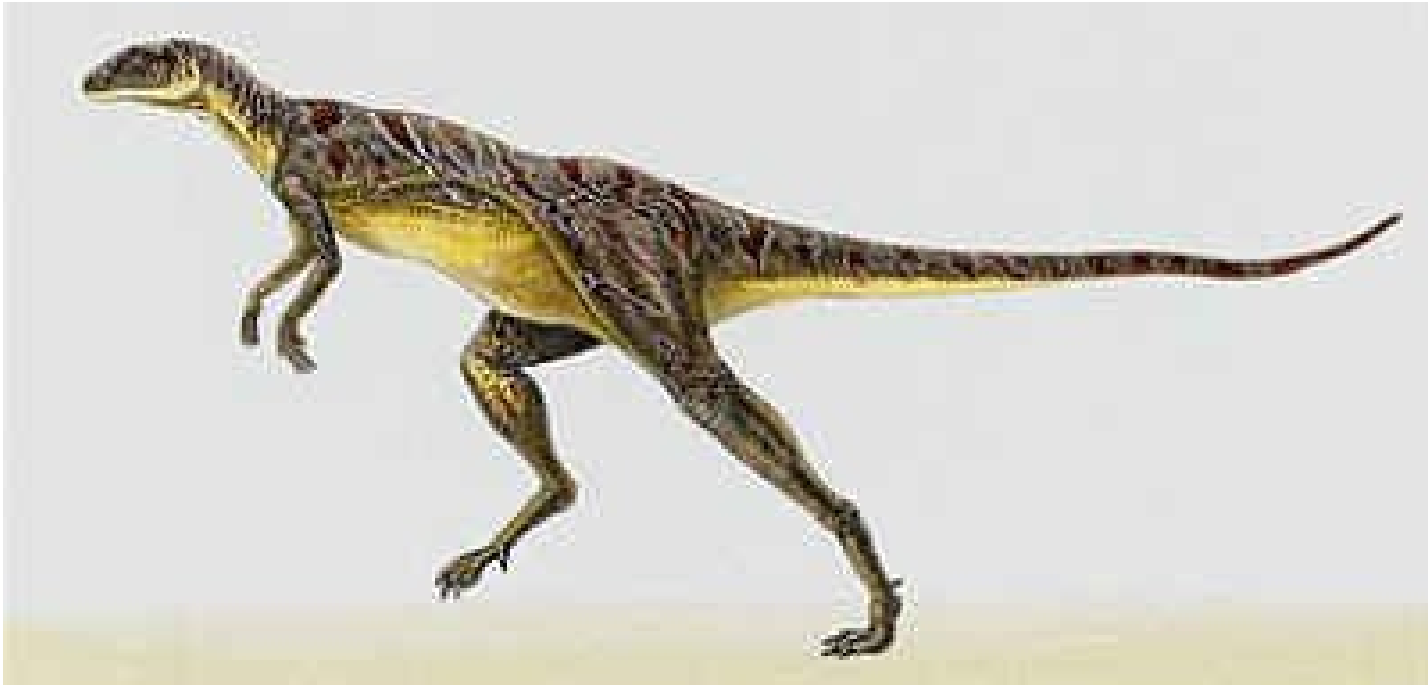
Ornithischian hip

Saurischia

Ornithischia



Skupina dinosaurů se od svých **thekodontních** předků oddělila někdy ve středním triasu. První primitivní dinosauri jsou řazeni do skupiny **Protodinosauria**. Jejich oddělení od thekodontních předků je podobně jako v případě therapsidů a savců velmi obtížné. Některými autory jsou dnes mezi první dinosaury řazeni zástupci čeledi Lagosuchidae dříve považovaní za thecodonty. I když mají ještě některé archaické znaky thekodontů dominují podle nich rozhodující znaky dinosaurů. Za prvního dinosaura je jimi považovaný **Lagosuchus talampanyensis (235 Ma)**. Tento 40-50 cm velký rychlý, vytrvalý běžec se pohyboval po zadních nohách. lovil hmyz a savce, přepadal i mláďata thekodontů. Jiní autoři za prvního dinosaura ale považují až zástupce rodu **Eoraptor a Herrerasaurus**, který se objevil až o něco později (232 Ma). Postupně se objevují i čím dál větší formy protodinosaurů reprezentované zástupci čeledi Herrerasauridae. Největší z nich Aliwalia rex dosáhla ve svrchním triasu velikosti 12 m. Ve svrchním triasu se od protodinosaurů odštěpili 3 větve - **Pterosauria** čili ptakoještěři, **Theropoda** reprezentující dravé formy dinosaurů a **Phytodinosauria** reprezentující byložravé formy dinosaurů.



Lagosuchus talampanyensis

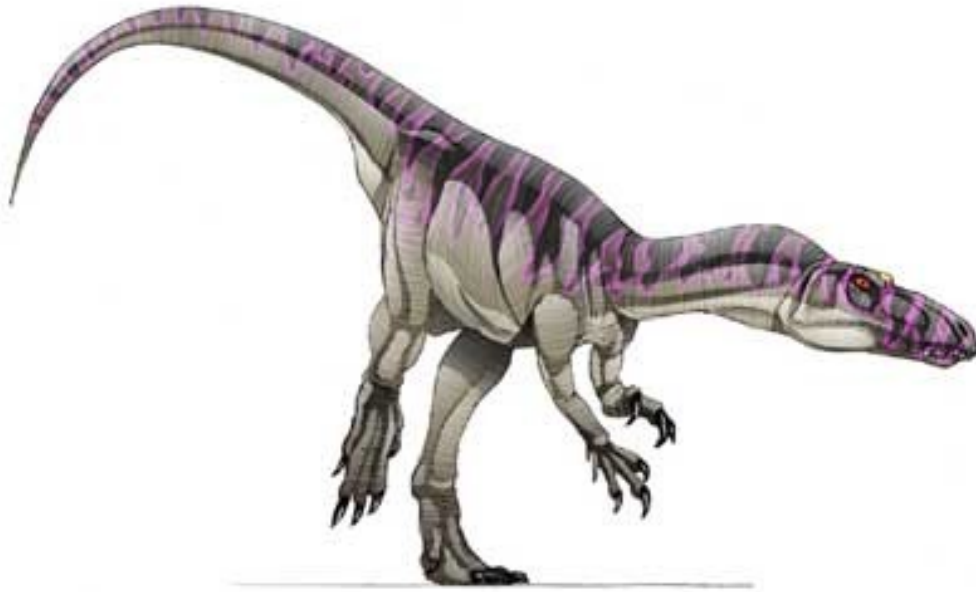


Eoraptor

A very early dinosaur, about the size of a cat.



It is believed that **Herrerasaurus** was one of the earliest dinosaurs. Its body shape suggests that this dinosaur was a very fast hunter, and that it could turn quickly from side to side.



Aliwalia rex

Length: 38 ft. (12 m)

Height: 12 ft. (3.5 m)

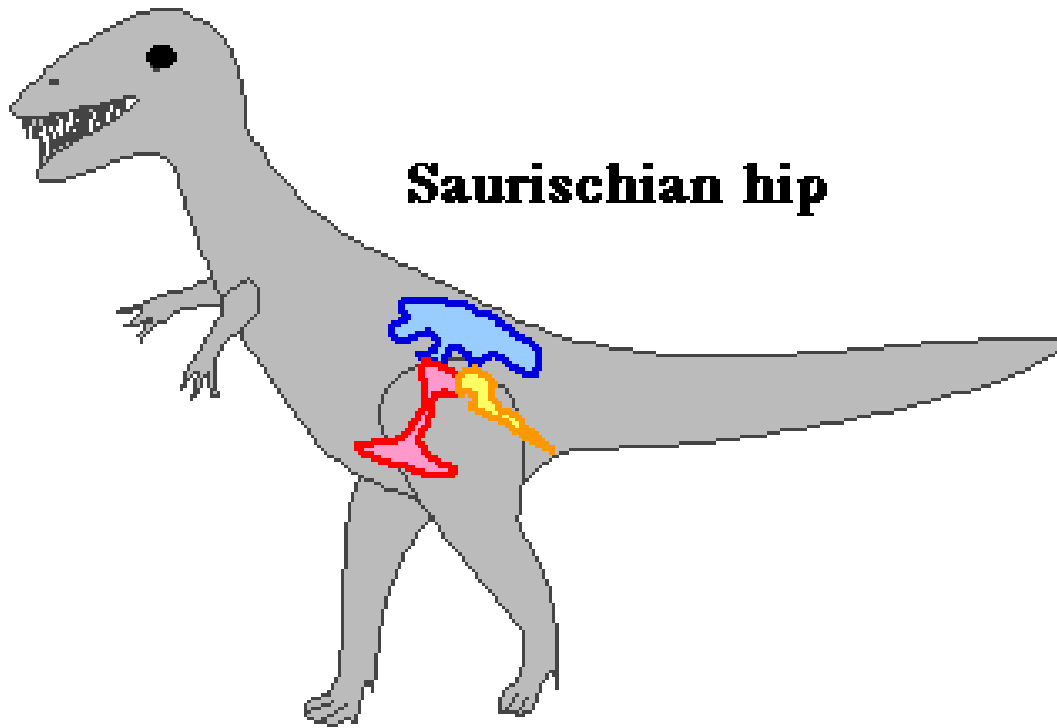
Weight: 1.5 tons (1,400 kg)

Time: Late Triassic - 220 MYA

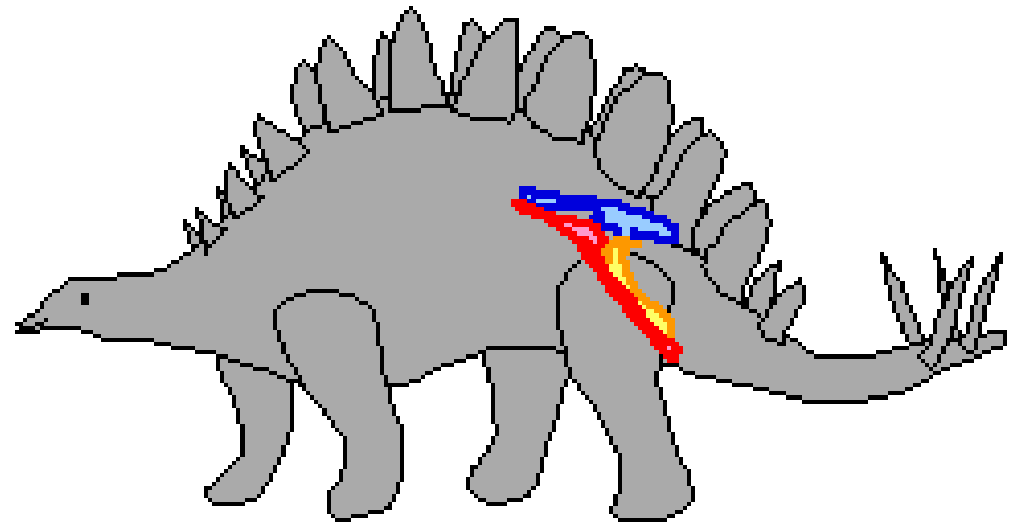
Location: Africa

Order Saurischia

- Characterized by 3 part hip structure similar to that of lizards

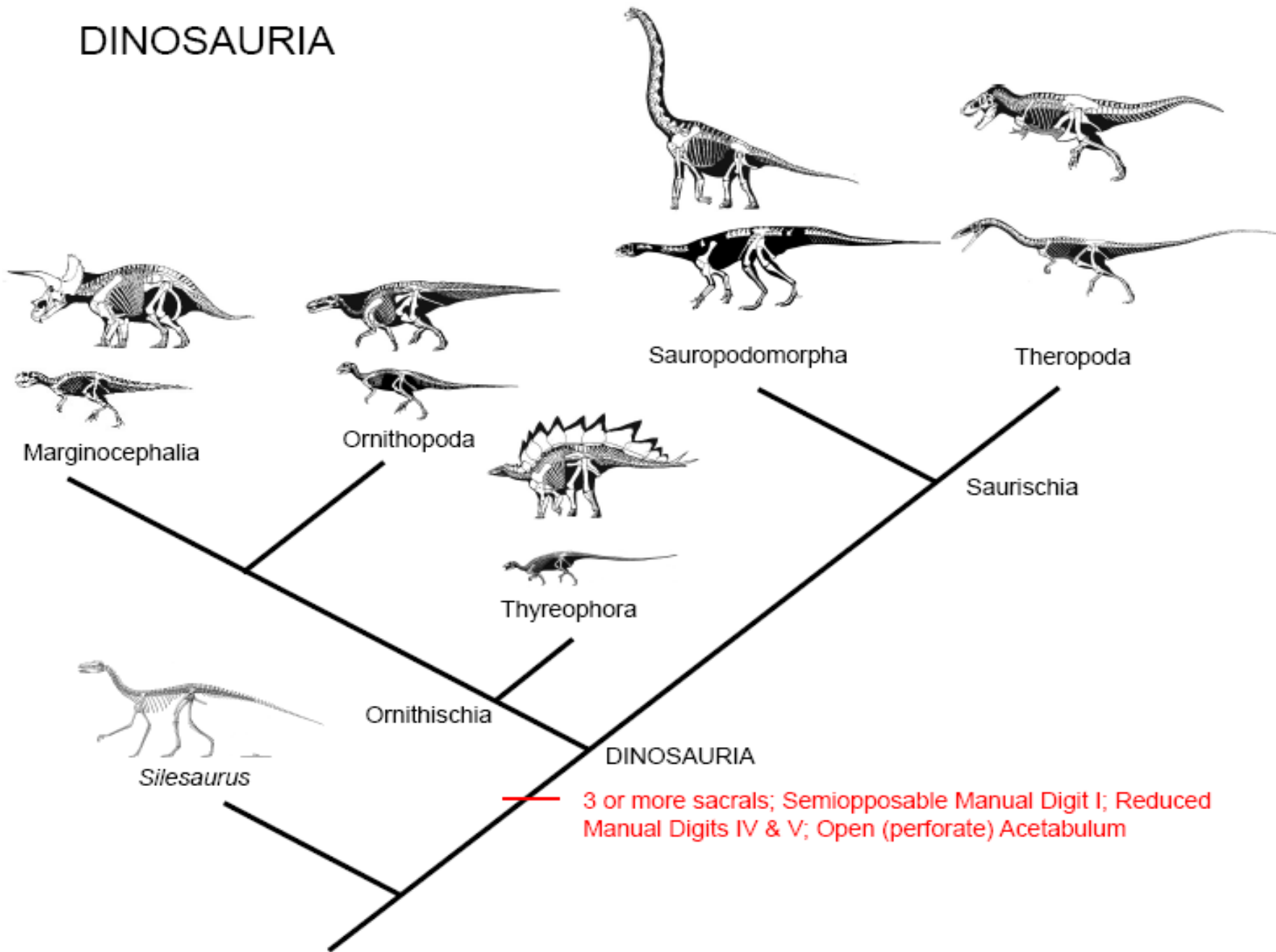


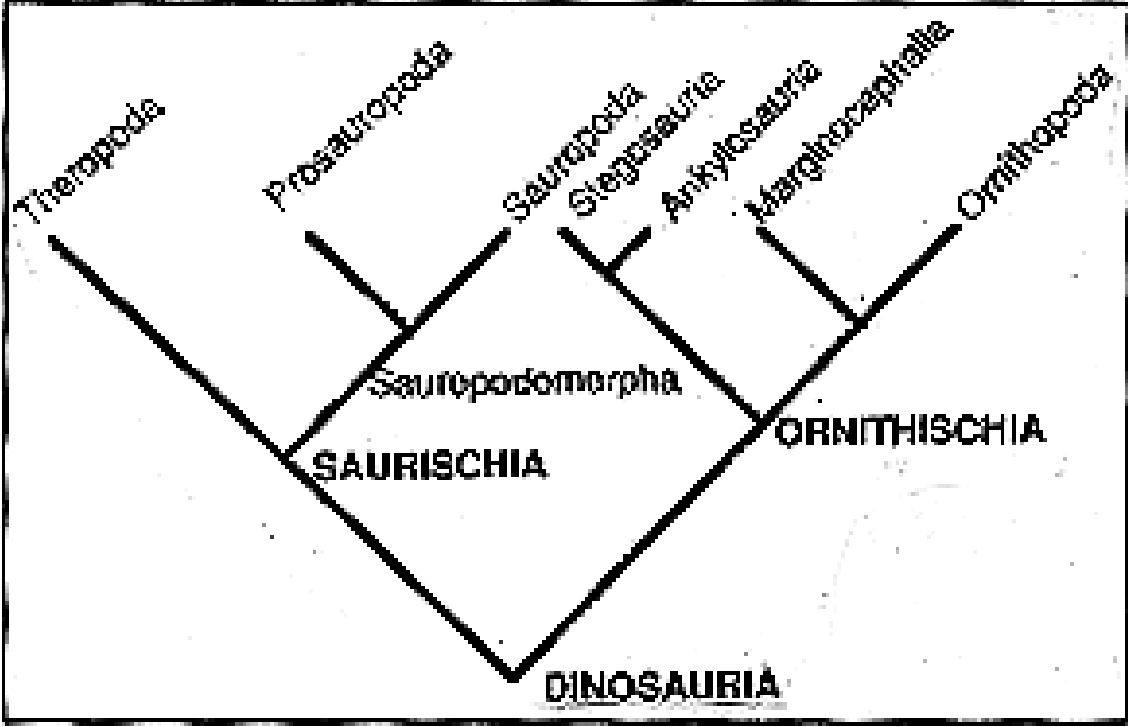
Saurischian hip

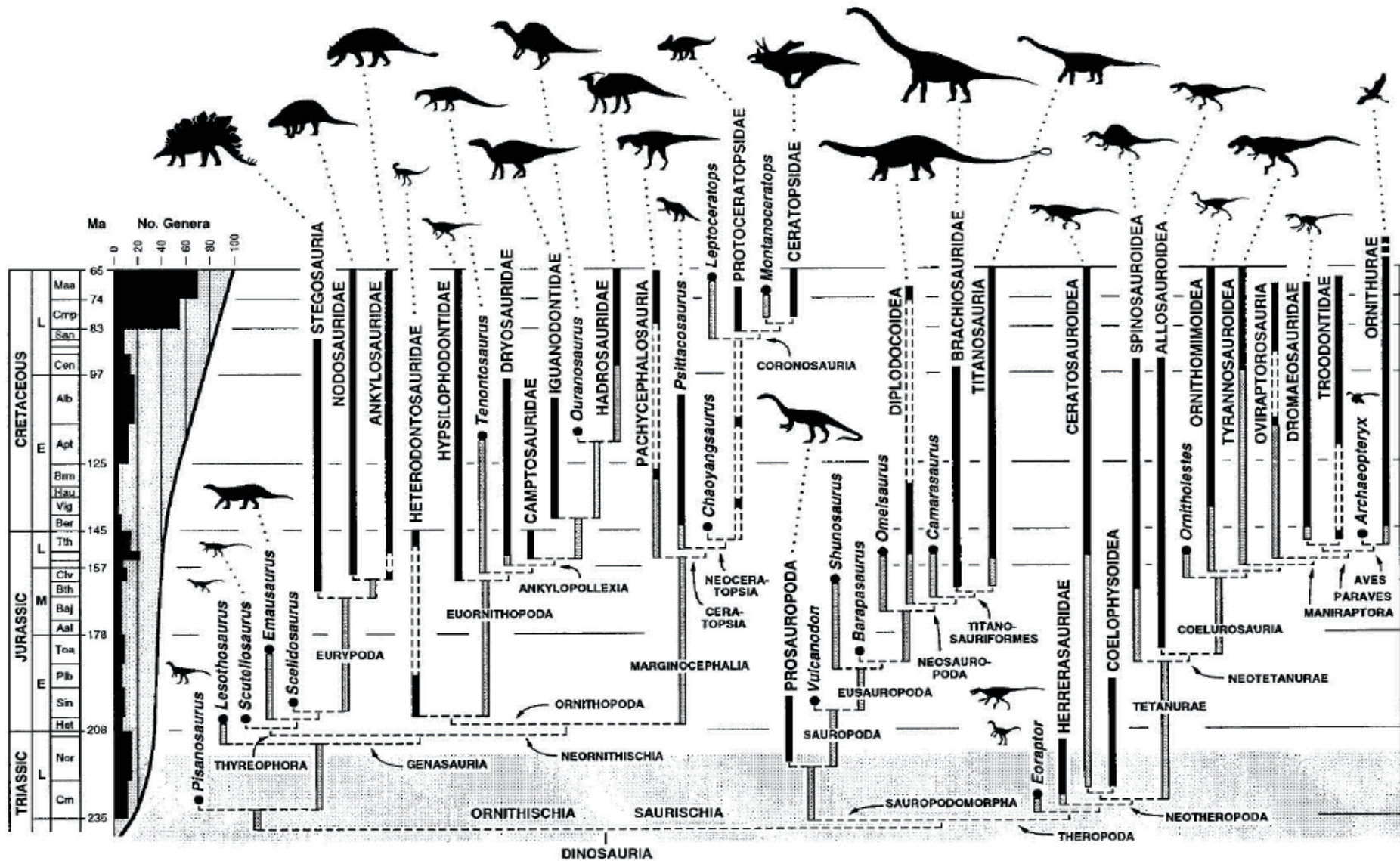


Ornithischian hip

DINOSAURIA



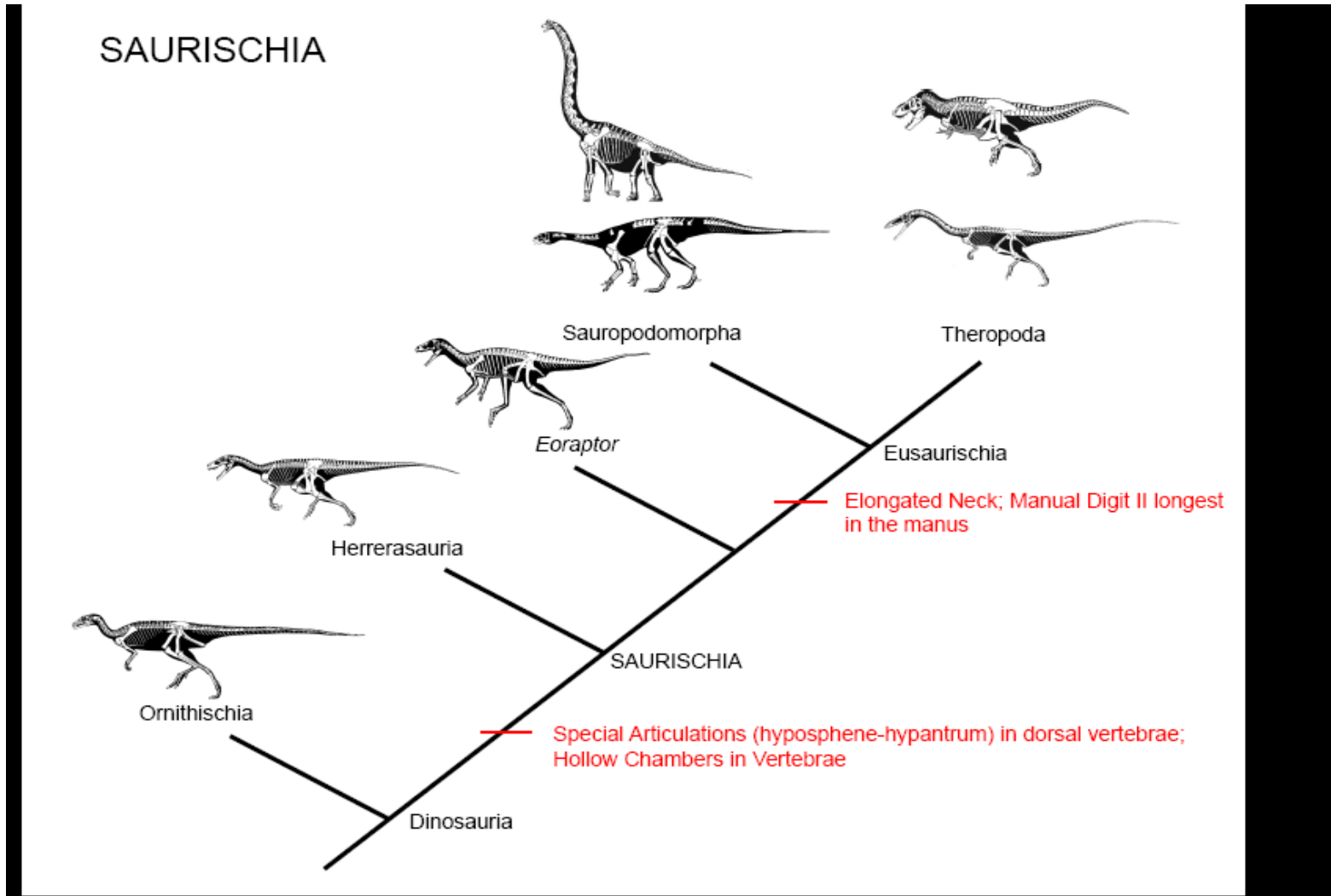




Další velkou skupinou dinosaurů, která se od ostatních skupin výrazně lišila stavbou pánve jsou **Ornithischia**, čili ptakopánevní dinosauri. Zatímco prosauropodi a theropodi měli stavbu pánve podobnou svým plazím předkům u ptakopánevních došlo k stočení stydké kosti dozadu. Byl to nutný vývoj, protože předchůdci ptakopánevních dinosaurů se pohybovali po dvou a tato změna umožnila vytvoření nového střevního prostoru. Značný střevní prostor byl vzhledem k nedokonalému zpracování potravy v čelistech nutností u všech byložravých forem.

Order Saurischia

Characterized by 3 part hip structure similar to that of lizards



Who were the Theropods

Theropoda

Rozdělení Theropodů na **Carnosauria** a **Celurosauria** je umělé, podobně jako bychom rozdělili velké dravé savce do jedné skupiny a malé do druhé skupiny. Ukazuje se, že malé jurské formy měly bližší vztahy k velkým jurským theropodům než k malým křídovým formám, které naopak měly blíže k tyranosaurům.

Velcí masožraví **Carnosauria**, kteří se objevili v juře do křídly přežívají jen vzácně. Většina z nich měla shodnou stavbu těla - pohyb po zadních nohách, velká lebka s prostorem pro objemnou ústní dutinu. Velké ostěe špičaté zuby - každý z nich byl na přední a zadní straně opatřen pilovitým ostřím. Velkou hlavu vyvažoval svalnatý ocas.

Earliest forms of Coelurosauria of Triassic

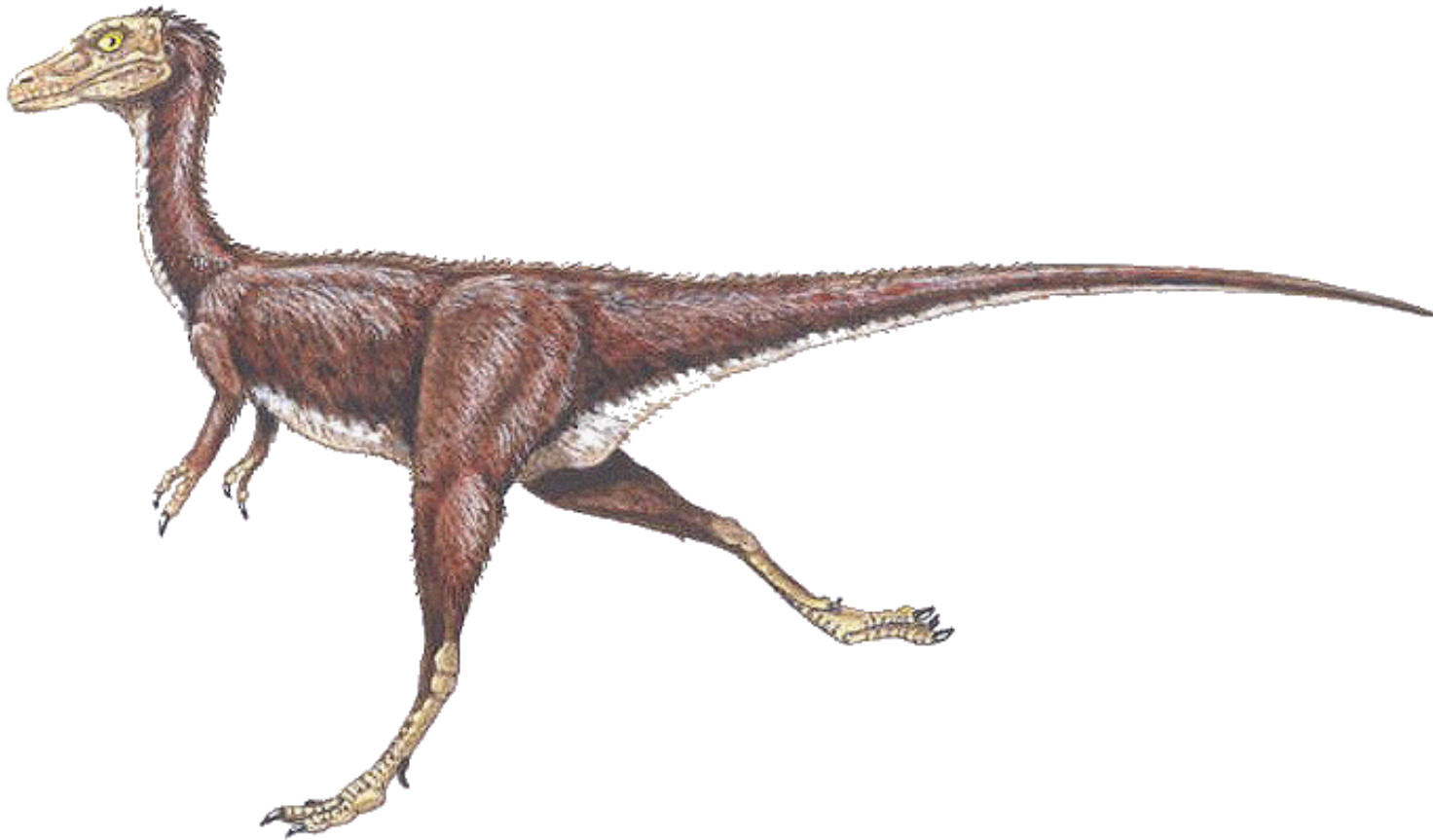


Coelophysis was a small (about 1 m), compact dinosaur that lived about 210 million years ago. It was a quick and agile hunter that had hollow bones and a hole-ridden skull, which helped to reduce its weight and increase its speed. Some fossils have been found with other small Coelophysis bones inside, and at first, it was thought that Coelophysis might have given birth to live young. It is now believed, however, that it was probably a cannibal that occasionally devoured its own young.

Typical Coelurosauria: Saltopus



Svrch trias-spodní Jura,



Compsognathus longipes - with feathers

Weight: 6 pounds (3 kilos) Length: 3 feet (1 m) Late Jurassic 155 - 145 MYA Where found: Bavaria, Germany

Archaeopteryx



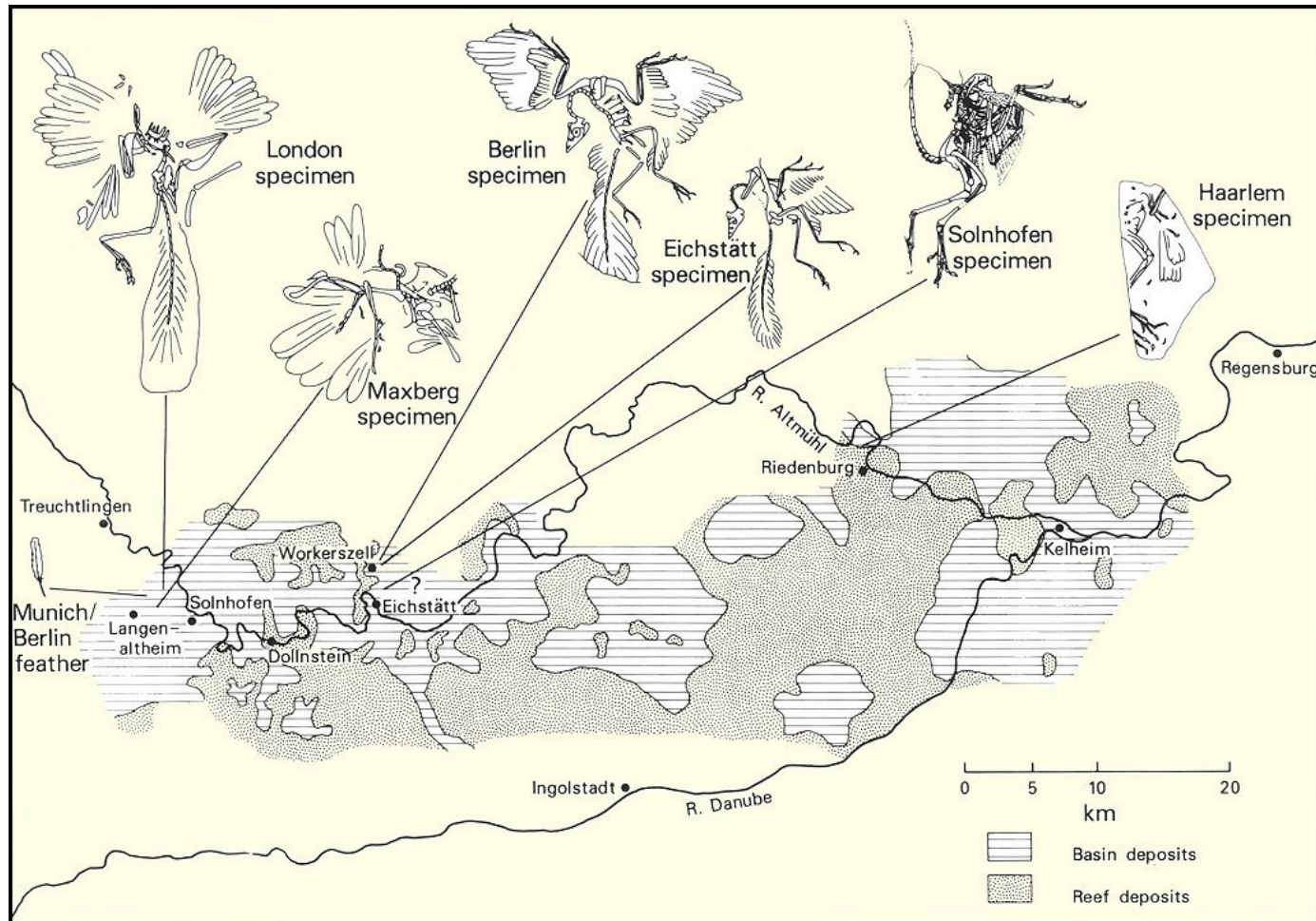
Fossil



Maybe...?

Where are Archaeopteryx found?

Mostly in Germany



Cretaceous Coelurosaurs

- Some species became very specialized

Velociraptor (Jurassic Park)



Image Credit: Todd Marshall





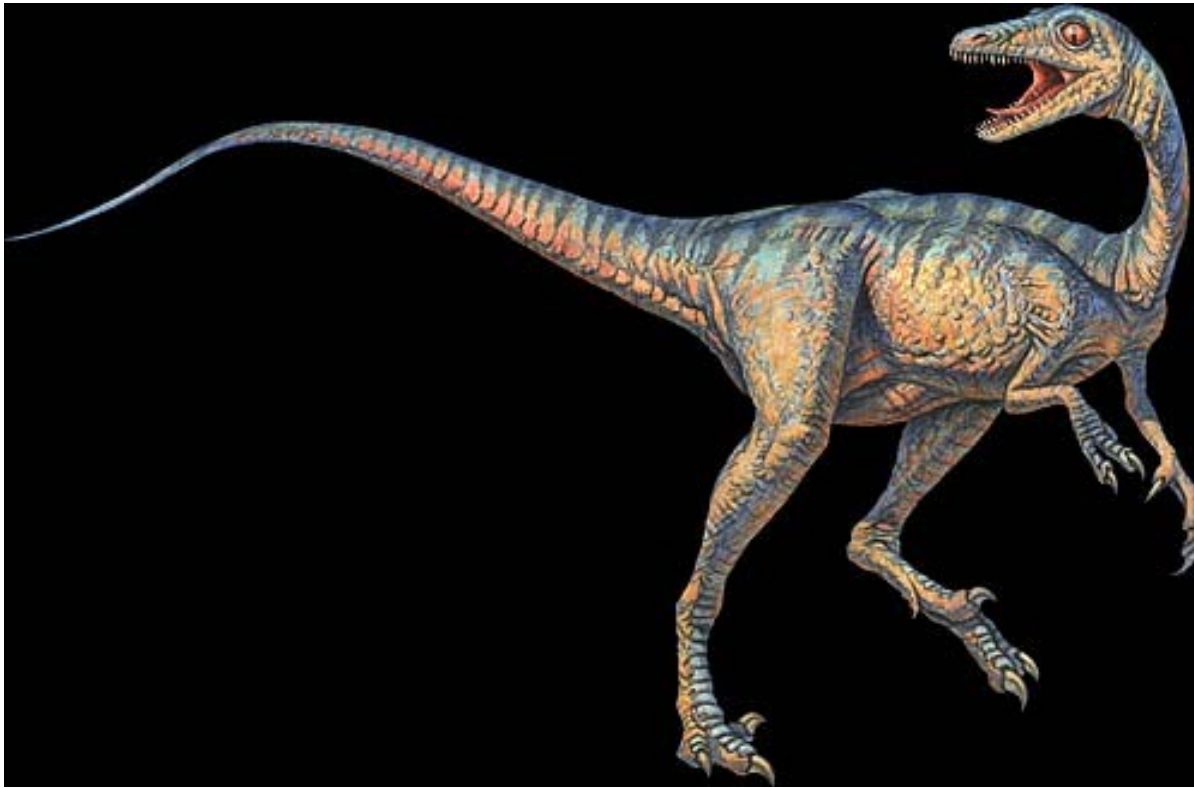
Deinonychus

Or?





Deinonychus 3-4 m, stř. křída



Genus Name: **Troodon**
("wounding tooth")
Type Species: * *T. formosus*
(Leidy, 1856)
Length: 2 meters
Weight: 100-125 pounds
Time: Late Cretaceous
Place:
Canada, Mexico, United States,
Tadzhikistan,

Uzbekistan
Diet: meat-eater (carnivore)

Troodon was a small but deadly hunter. Unlike most dinosaurs, its big eyes faced partly forward, probably giving Troodon the same kind of binocular vision used by modern predators like cats. Opposable fingers enabled it to grasp its prey, something few other dinosaurs could do. The second toe on each foot had a large slashing claw like those carried by raptors. Finally, the ratio of its brain weight to its body weight was greater than that of almost any other dinosaur.

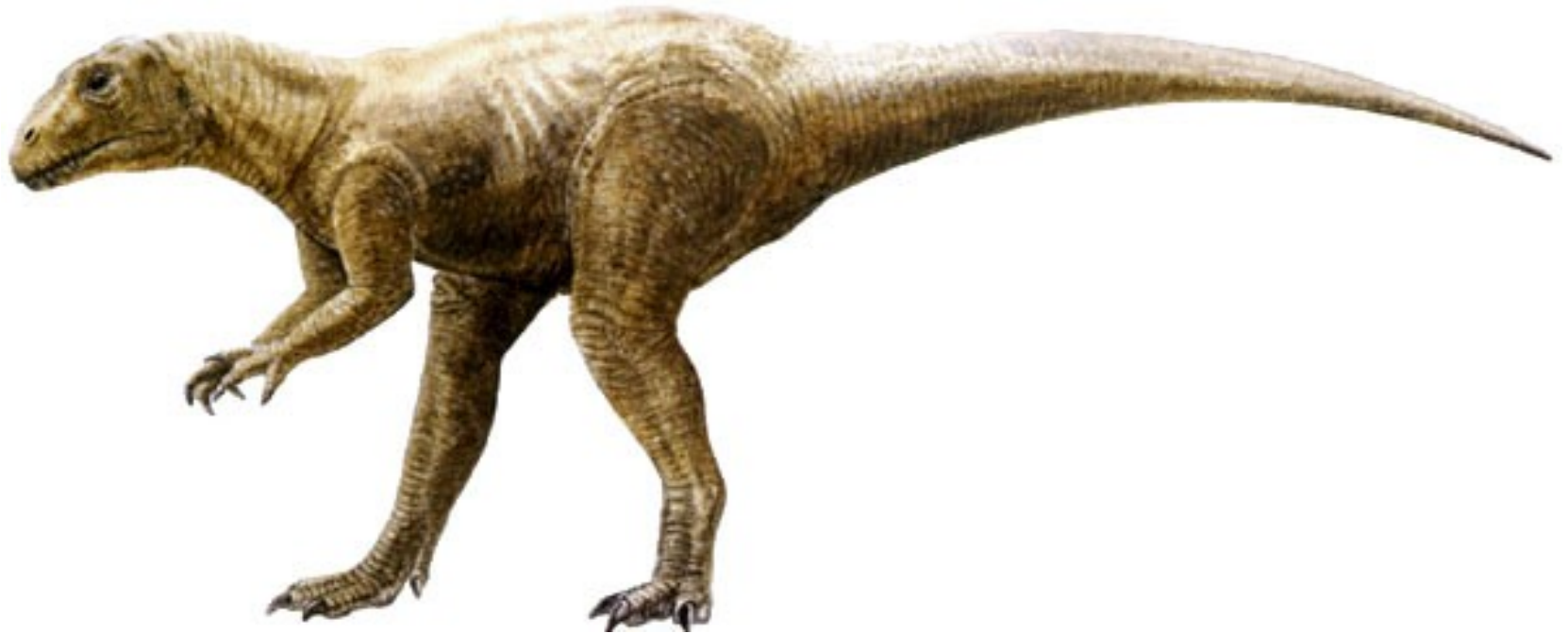
2nd Theropod Group

- Flesh-like spectacular forms
- Famous because of their starring role in Japanese movies



Teratosaurus

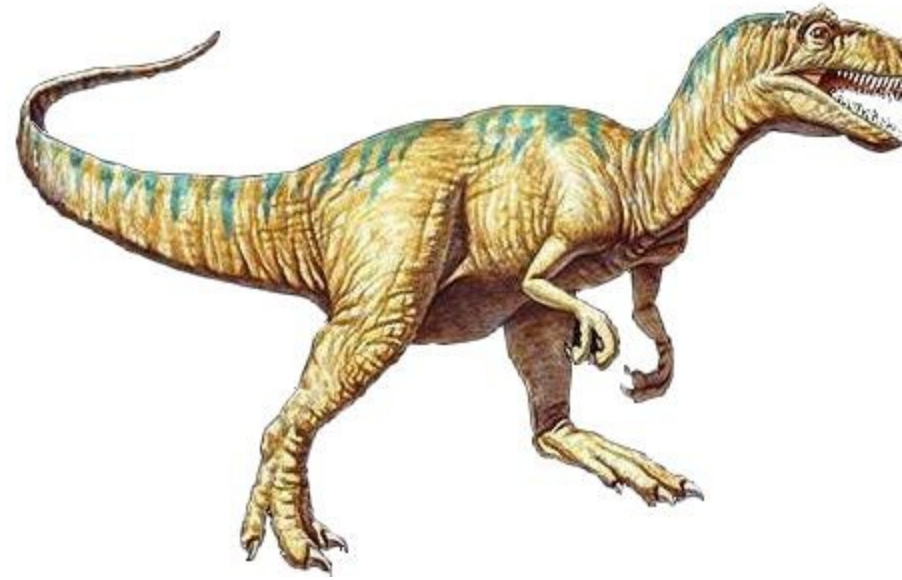
Earliest species – Triassic, 6 m



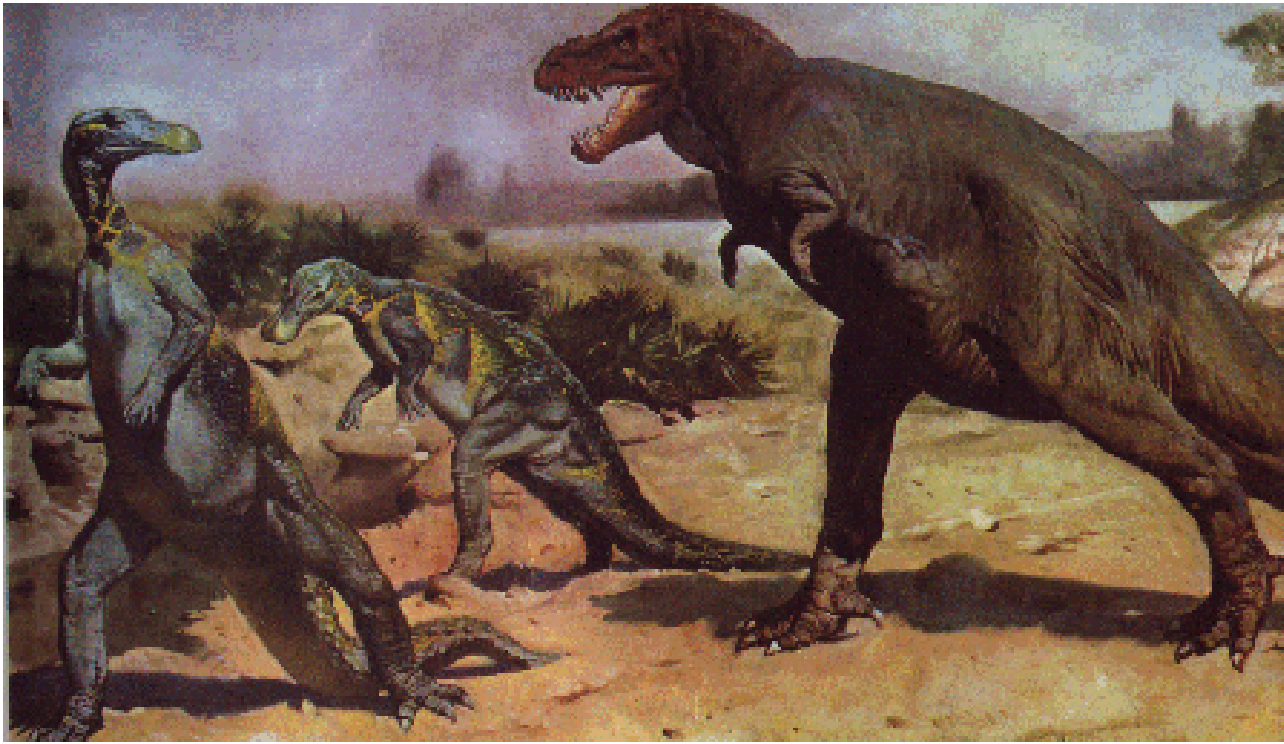
Teratosaurus



Allosaurus was a powerful predator that walked on two powerful legs, had a massive tail, a bulky body, and heavy bones. Its arms were short and had three-fingered hands with sharp claws that were up to 6 inches (15 cm) long. Allosaurus was up to 38 feet long (12 m) and 16.5 feet tall (5 m). It weighed about 1400 kg. An Apatosaurus vertebrae was found with Allosaurus tooth marks etched into it, evidence of an ancient Allosaurus attack. Allosaurus was a very common, and was the biggest meat-eater in North America during the late Jurassic period. It may have faced competition from the meat-eating Ceratosaurus.



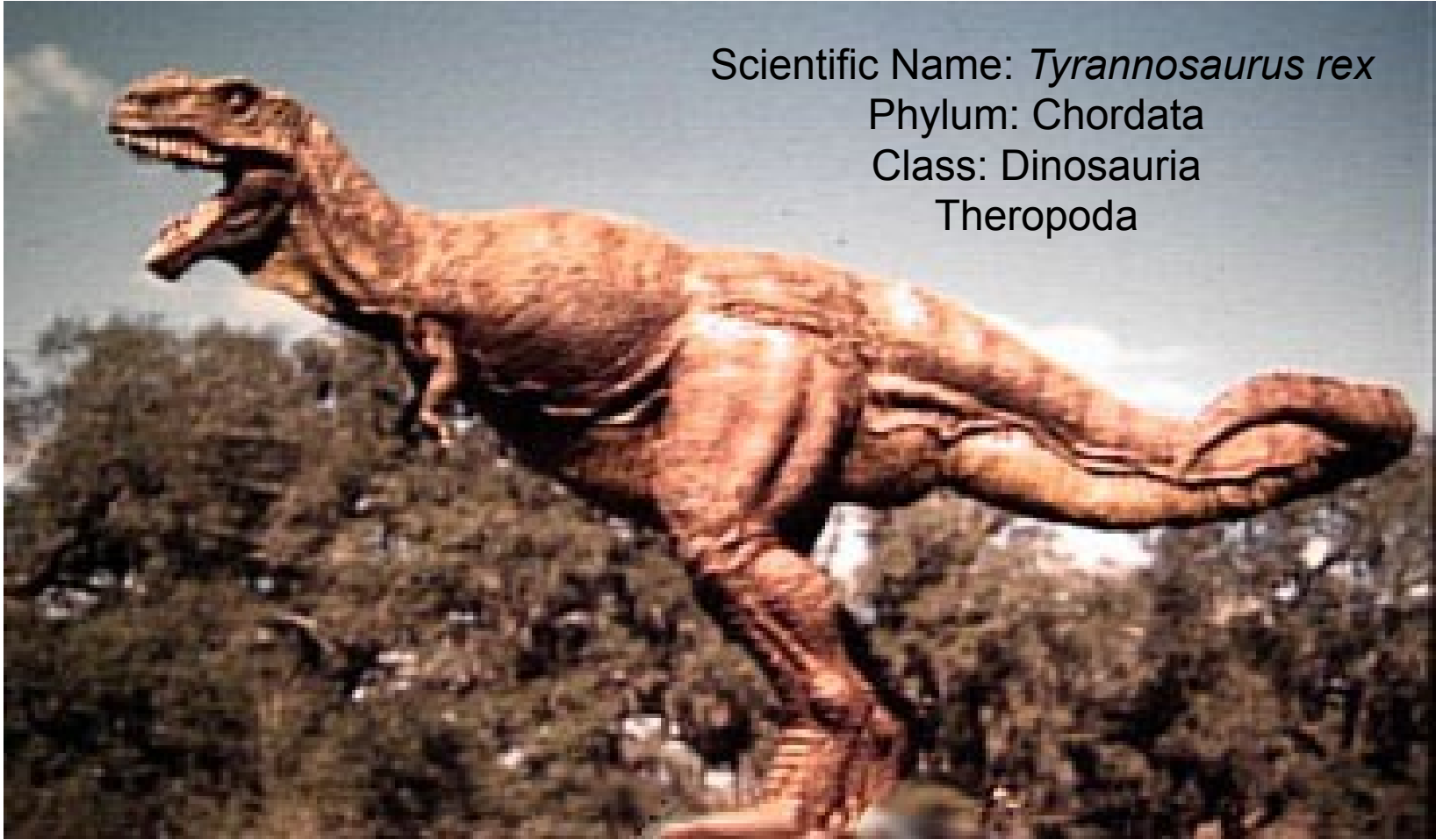
Tyrannosaurides (T-Rex)



The **Tyrannosaurus Rex** ("tyran lizard"), who try to attack, here, a **Trachodon** ("duck beak"), was one of the biggest bipeds having ever existed : its length was about 12 meters and its height about 5 meters. His teeth in forms of knives helped him to cut up the fleshes. The **Trachodon**, although of a similar size, was without defence against this kind of ennemy : his alone hope must be water where he could swim. The **Trachodon** had a long skull and a flat muzzle.

And T-Rex

Scientific Name: *Tyrannosaurus rex*
Phylum: Chordata
Class: Dinosauria
Theropoda



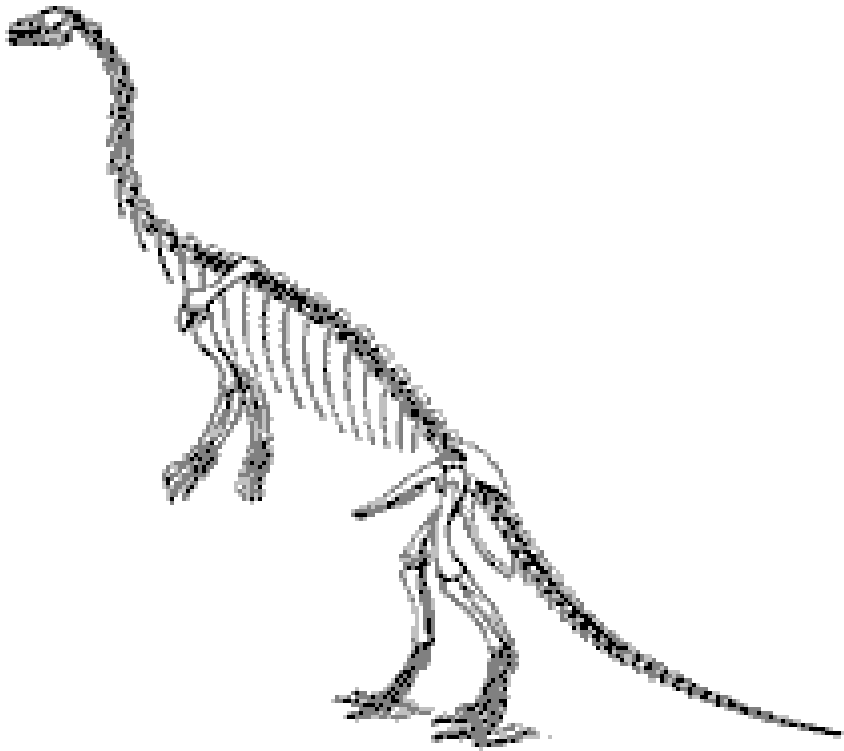


Nález 130 milionů let staré lebky a dalších částí kostry spolu s otisky jasně dokládajícími opeření, který se povedl čínským paleontologům ve vyhlášené lokalitě Liaoning, je nejstarším nálezem ostatků dinosaura ze skupiny tyranosaurů. Vyhynulý tvor dostal jméno **Dilong paradoxus**. Jménem „dilong“ byl ve staré Číně označován drak, jméno paradoxus odráží fakt, že u tyranosaurů by peří čekal jen málokdo. Dinosaurus byl velký asi jako větší pes a byl to zdatný masožravec. Na rozdíl od svého mnohem většího a slavnějšího následníka druhu *Tyranosaurus rex* měl ještě plně vyvinuté přední končetiny, takže si jimi mohl přidržovat potravu

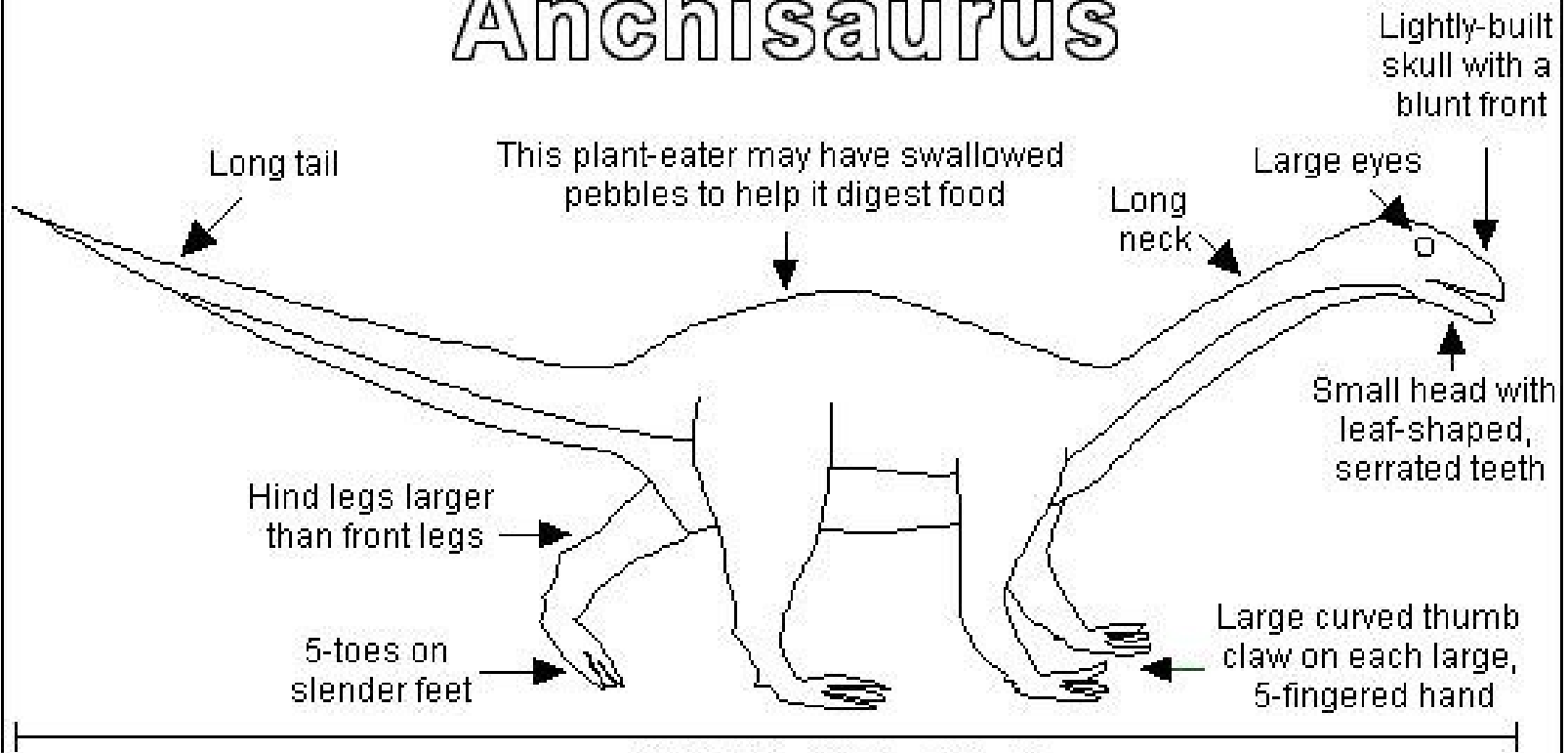
Sauropodomorpha



Prosauropoda



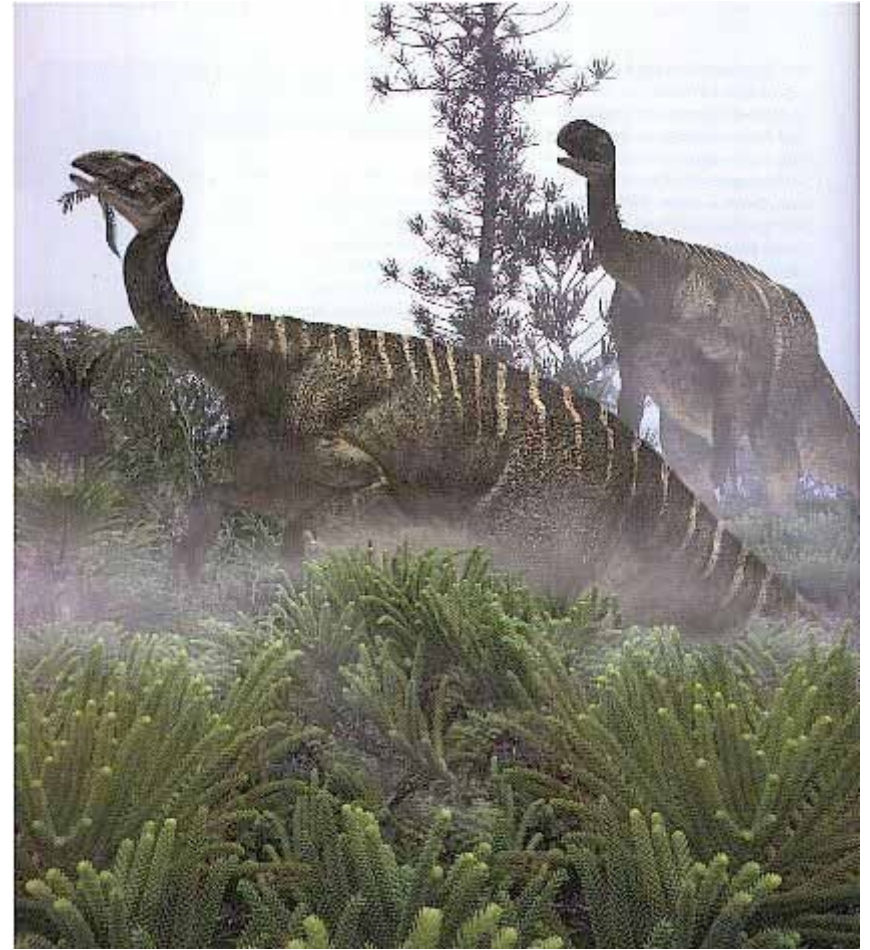
Anchisaurus



©ZoomDinosaurs.com

6.5 to 8 feet (2 to 2.5 m) long

Prosauropoda (Plateosaurus)



Plateosaurus (small head)



Plateosaurus was the most common early dinosaur that we know. Dozens of skeletons of this large 26-foot-long (8m) animal have been collected all over central Europe. Some of these are beautifully preserved. Plateosaurus had a fairly long and light skull with small, leafshaped teeth spaced out along its jaws. It had quite a long neck and strong limbs. Plateosaurus had broad hands with a thumb claw that was large and curved. Plateosaurus could have moved on all fours, and reared up on its hind legs to feed in trees

Sauropoda

Sauropoda

Období jejich hlavního rozkvětu byla jura, v křídě ustupují do pozadí. V severní Americe např. ke konci jury vymírají a nová kolonizace sem pronikla z jižní Ameriky v podobě titanosauridů.

Tato skupina patří mezi největší zvířata, která na zemi žila - nejdelší byli delší než 50m (Seismosaurus) a nejtěžší vážili okolo 130 tun (Ultrasaurus). Tvar jejich těla byl podobný jako u prosauropodů. Na malé hlavě byly většinou vysoko položené nozdry, podobně jako u dnešního slona nebo tapíra. Někteří paleontologové předpokládají, že i tito sauropodi mohli mít orgán podobný chobotu. Zuby kolíčkovitého nebo lžícovitého tvaru bez kousacích nebo rozměňovacích ploch sloužili podobně jako u prosauropodů ke strhávání a rozlámání potravy, zatímco hlavní zpracování probíhalo ve svalnatých útrobach pomocí gastrolitů. Některé z nich se neustálým třením o sebe vybrousili do vysokého lesku. Mozek byl ve srovnání s velikostí těla neuvěřitelně malý. Je však třeba si uvědomit, že přes tuto gigantickou velikost počet svalů, kloubů atd. a tím pádem i pohybových funkcí podstatě byl stený jako u menších živočichů. Obecně tedy u gigantických forem není potřeba nějakého velkého nárůstu objemu mozku. Podrobná studia v posledních letech výrazně pozměnili představu o přihlouplých pomalých tvorech - složité vzory chování sauropodů ukazují, že jejich mozek byl mnohem výkonnější než se dříve předpokládalo.

Rozšíření míchy v oblasti křížové páteře souviselo s pohybem zadních končetin a nemělo funkci řídicího centra.

Podobně jako u prosauropodů se i sauropodi vyznačovali dlouhým krkem, který byl však většinou ještě delší než u jejich předchůdců. V některých případech byl podstatně delší než trup. Délka krku určovala i velikost hlavy, která musela být malá aby ji sauropod unesl. Podobně i ocas dosahoval značných rozměrů. U některých forem dlouhý bičovitý ocas sloužil jako zbraň. Některé formy měly domonce na jeho lonci kostěné palice. Končetiny byly podsunuty kolmo přímo pod tělem aby unesly obrovskou váhu živočicha. Přední končetiny byly většinou kratší než zadní (až na čeled' Brachiosauridae). Pohybovali se po 4, pouze při spásání potravy v korunách velmi vysokých stromů mohl ocas sloužit jako opora při postavení se na zadní nohy.

Na rozdíl od dřívějších představ se ukazuje že sauropodi obývali spíše sušší oblasti, rozbahněné území v okolí vodních ploch při jejich velké hmotnosti znesnadňovalo jejich pohyb a hrozilo i že zde mohou uvíznout.

Who were the Sauropods?

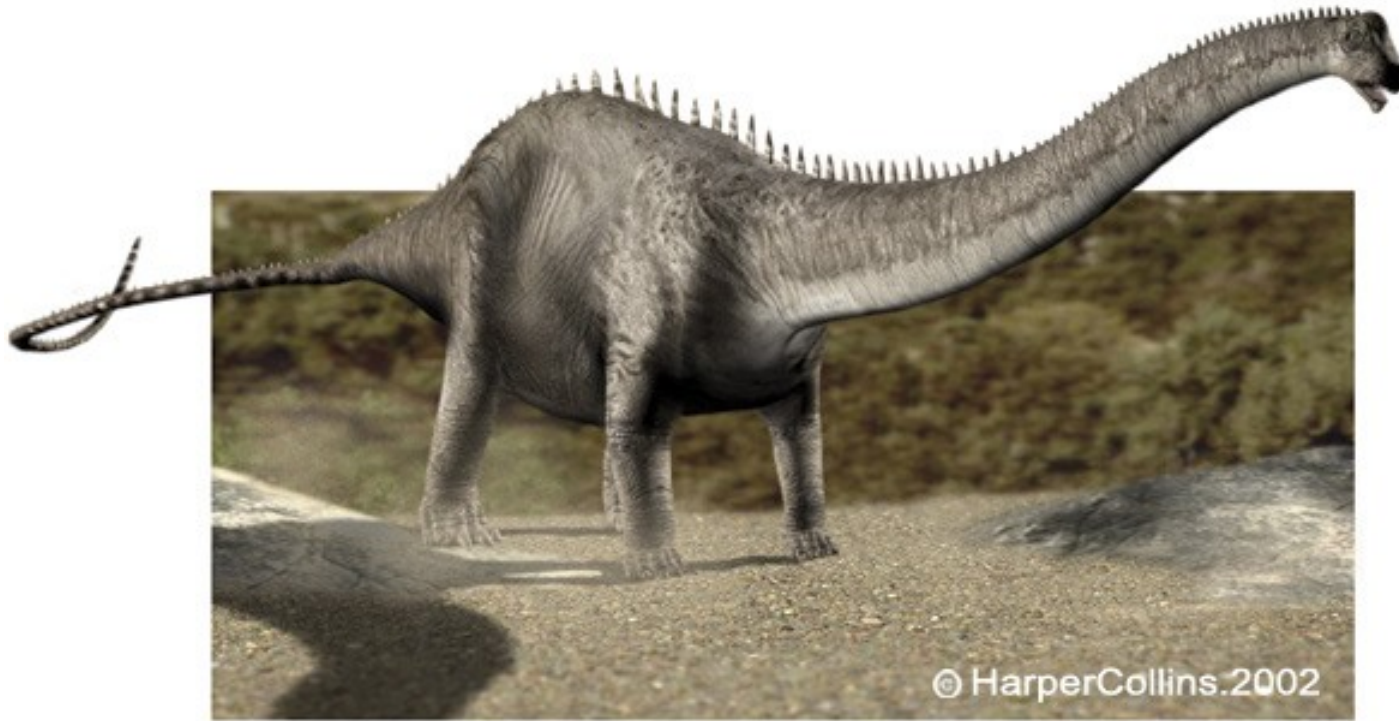


Brontosaurus

Who were the Sauropods



Apatosaurus



Diplodocus



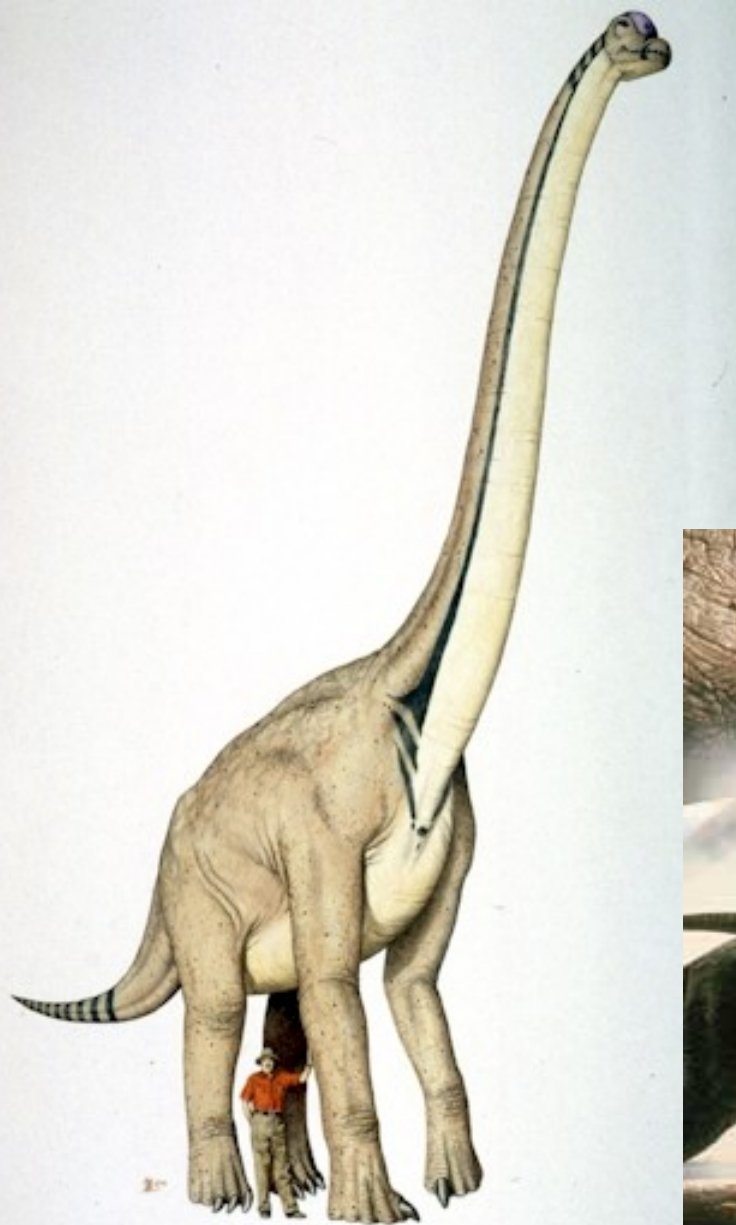
Seismosaurus was an enormous, long-necked, whip-tailed, small-headed dinosaur. It measured about 130-170 feet (39-52 m) long and was roughly 18 feet (5.5 m) tall (measured from the ground to the top of the shoulder). This giant may have weighed about 30 tons (roughly 60,000 pounds). It was among the longest land animals that ever lived. Seismosaurus lived during the late [Jurassic Period](#), from 156-145 million years ago.

Who were the Sauropods?



Brachiosaurus was one of the biggest land animals ever. Its weight has been estimated at about 80 tonnes, twenty times as heavy as a large elephant. Unlike other dinosaurs it had front legs longer than the hind ones, so that its back sloped upwards towards the head. In the Natural History Museum in Berlin there is a mounted skeleton of *Brachiosaurus*; the head is 13 metres above the ground, its upper arm bone is over 2 metres long, and it dwarfs the *Diplodocus* standing next to it.





Two Allosaurus individuals
cruise the perimeter of a
herd of Ultrasaurus





**Right Front
Foot-
Ultrasaurus**

The Ornithischians (bird-hip structure)



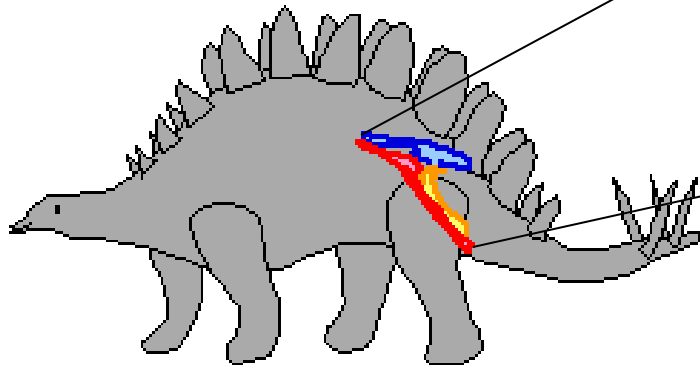
There were five basic kinds of ornithischians

- (1) stegosaurs
- (2) ankylosaurs
- (3) ornithomimids
- (4) pachycephalosaurs
- (5) ceratopsians
- Each group included many different species.

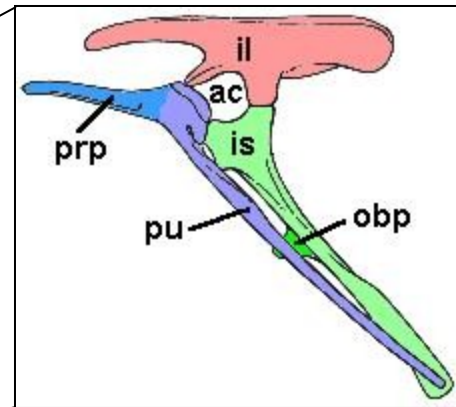
Entirely vegetarians

- Exploited vegetation low to the ground

Pelvis characteristics



Ornithischian hip



(1) stegosaurus

Stegosaurus



Ankylosaurs



Ornitopoda

Iguanodonts

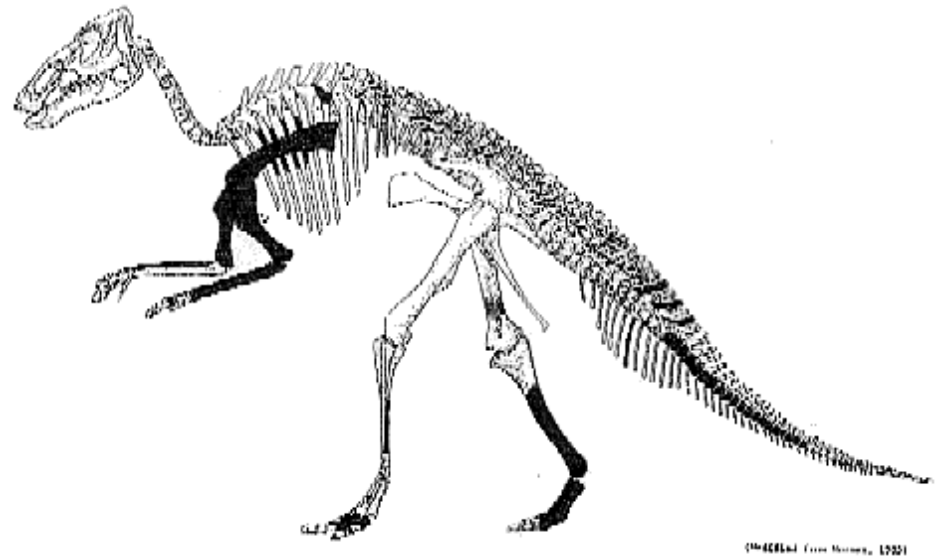
Iguanodon



© DK 2003



Hadrosaurs

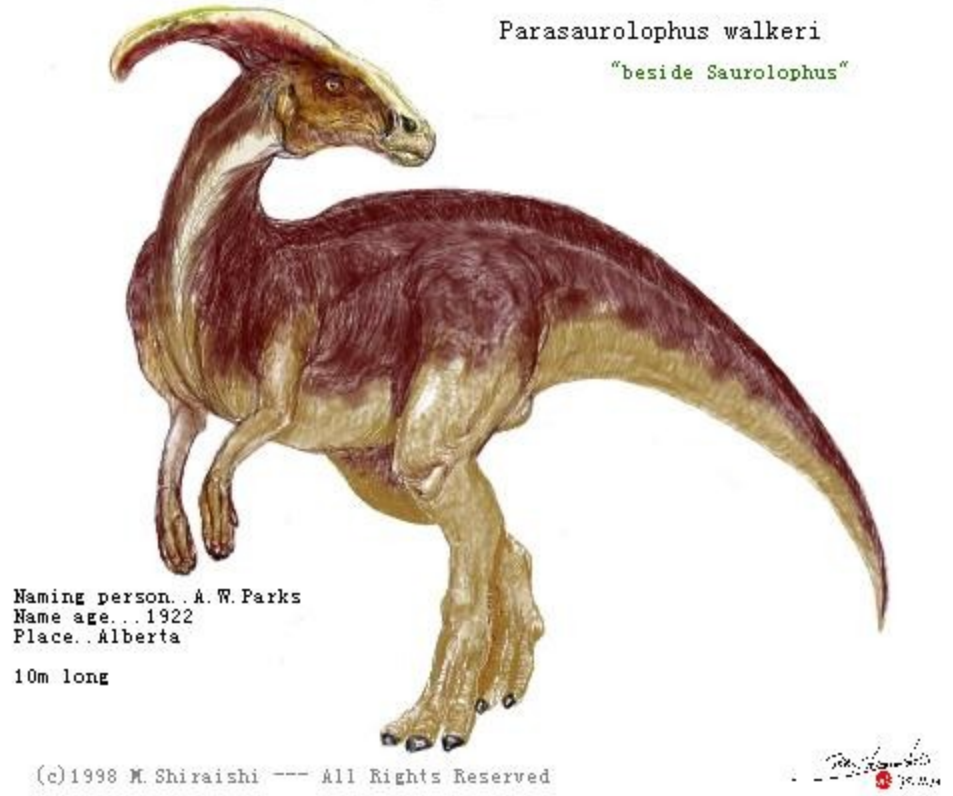


Duck Bill Idea – Sometimes called Duck-billed dinosaur

Types of Hadrosaurs



Anatosaurus



Parasauro

Pachycephalosaurs



Pachycephalosaur

tzv trkaví dinosauři s mimořádně zesíleným temenem lebečním, tvořícím často nápadnou kopuli. Pravděpodobně údery do měkkého těla dravce nebo protivníka. U samců větší.. Měli poměrně krátké nohy a nedokázali dobře běhat. Primitivní listovité zuby, potrava pravděpodobně měkká, bylinná. Nálezy hlavně v Severní Americe a Asii, vzácně Evropa a Afrika. Nejběžnějším rodem byl Stegoceras, asi 2m dlouhý. Hlavní rozvoj proběhl ve svrchní křídě.

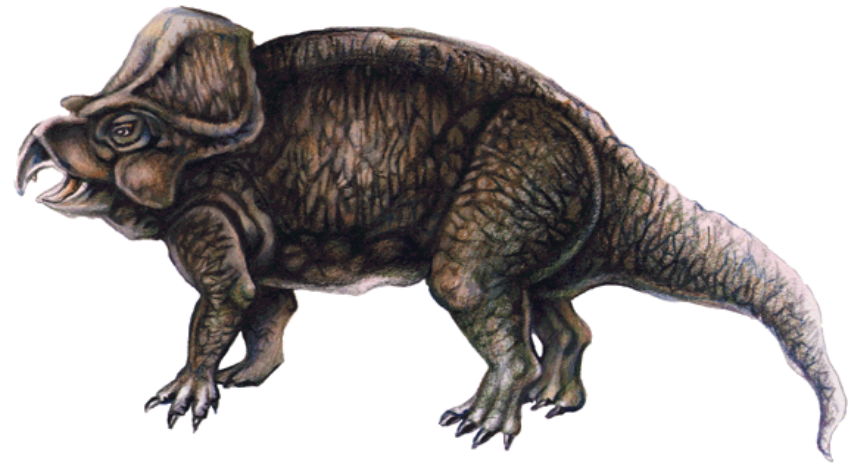
Ceratopsia



*M. Shiraiishi
original 1999*

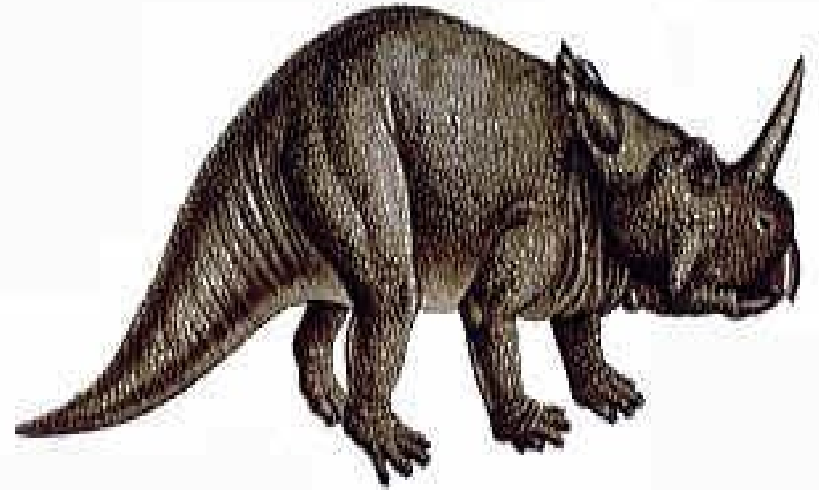
(c)1999 M. Shiraiishi---All Rights Reserved

Types of Ceratopsia



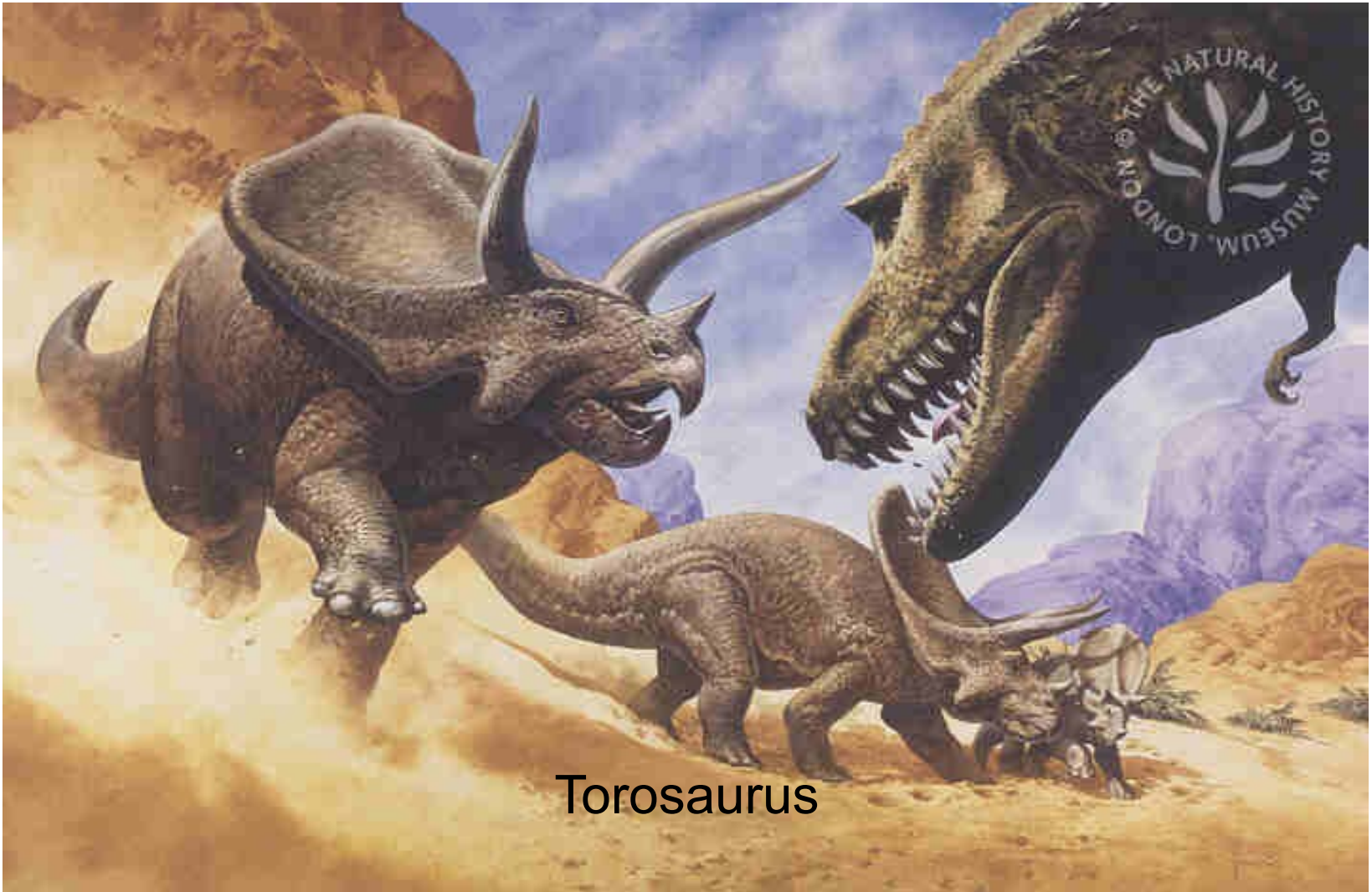
Protoceratops

Types of Ceratopsia



Monoclonius

Types of Ceratopsia



Torosaurus

Triceratops



Styracosaurus



Geographic Distribution



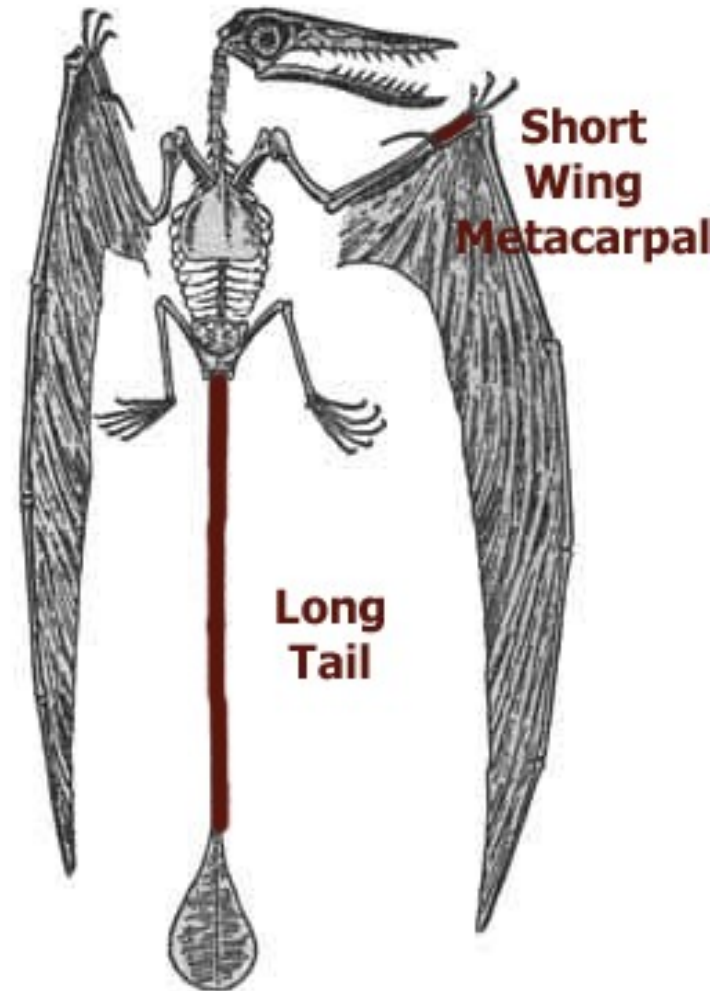
Pterosauria

Pterosaurs are divided into two sub-orders. The first one is;

Rhamphorhynchoidea

(Ram-for-rink-oid-eah)

Early pterosaurs with **long** tails and **short** wing metacarpals.

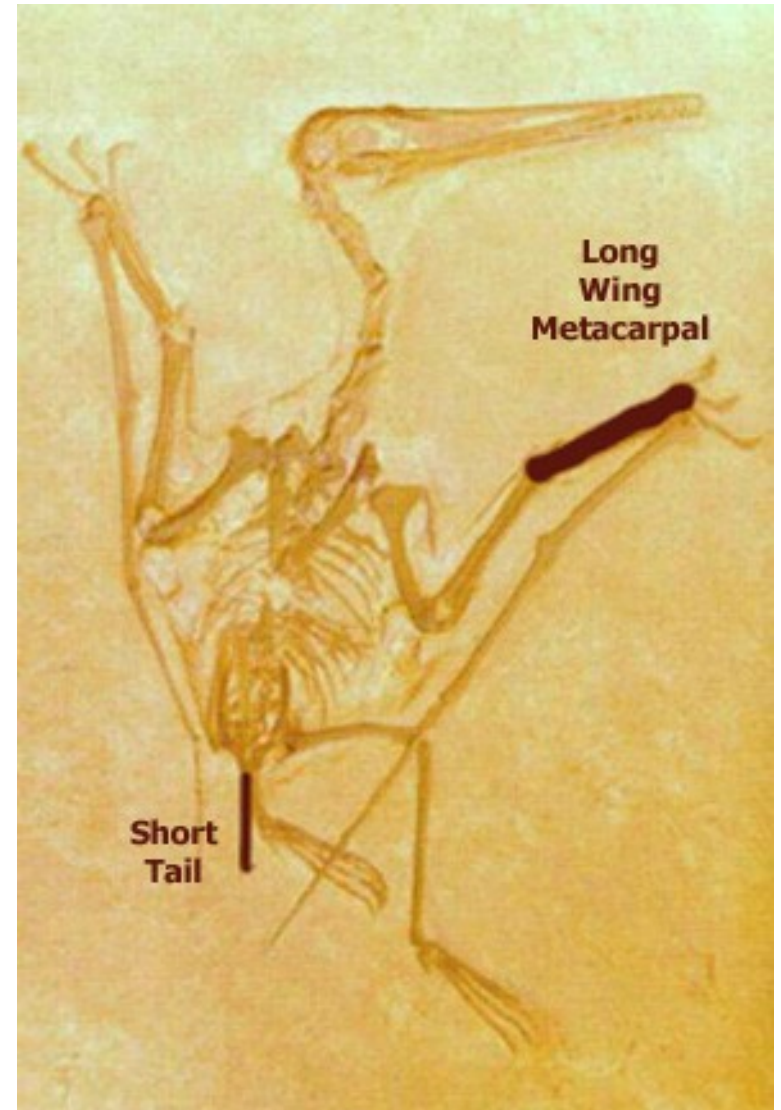


Pterosaurs are divided into two sub-orders. The second one is;

Pterodactyloidea

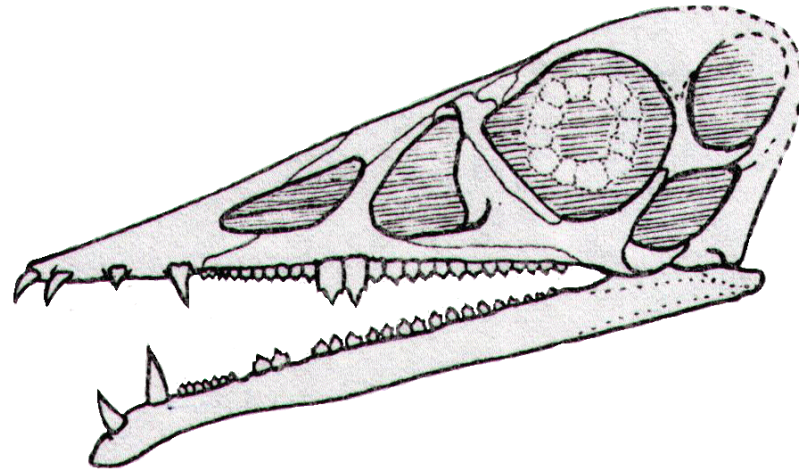
(terro-dactyle-oid-eah)

Later pterosaurs with **short** tails and **long** wing metacarpals.



Triassic Pterosaurs

Eudimorphodon Ranzii
(*Zorzino Limestone, Italy*)



Eudimorphodon is a typical Triassic pterosaur, with different size teeth and some teeth with three cusps.

The earliest known pterosaurs were fully formed flying animals with long tails and well developed wings. They all appear to have been carnivores.

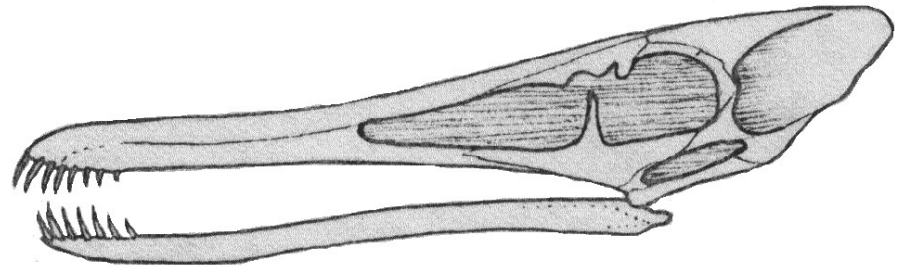
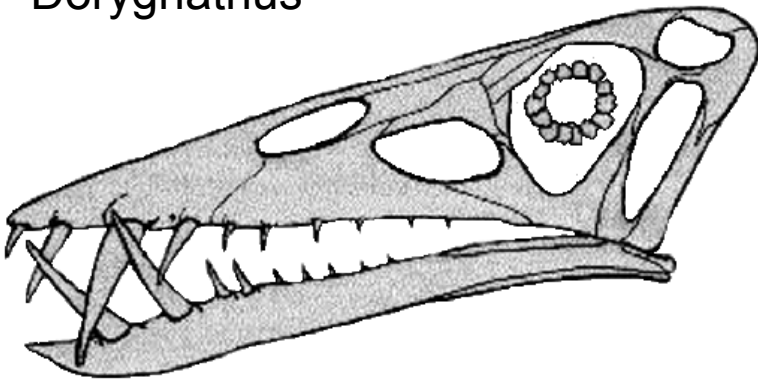
Most of the larger Triassic pterosaurs were about the size of large crows or buzzards.

Jurassic Pterosaurs

During the Jurassic Period there were a large number of different types of pterosaurs. Some were as big as small birds and others were larger than eagles. Many forms had very large teeth.

Rhamphorhynchus and Pterodactylus lived side by side in the late Jurassic era. This was when the large dinosaurs roamed the land.

Dorygnathus

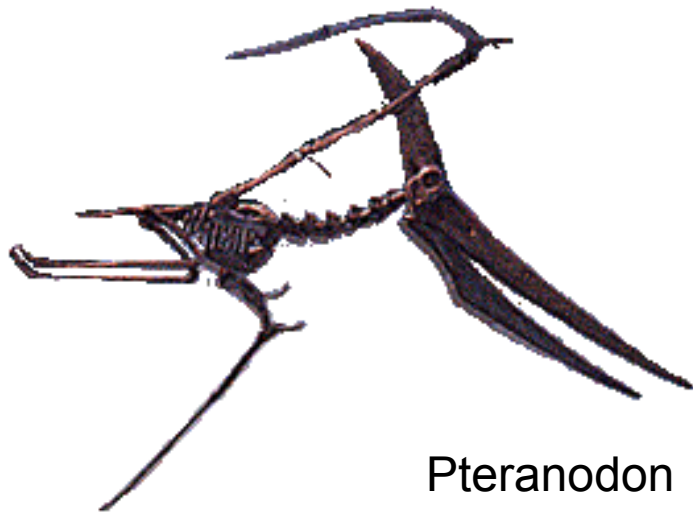


Gallodactylus

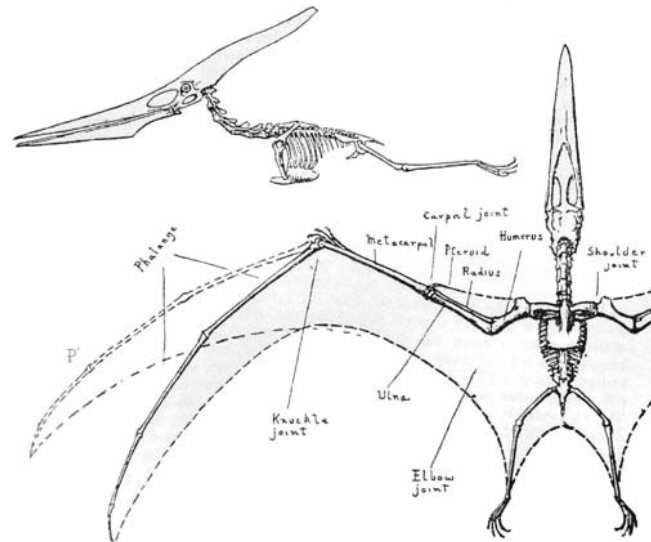
Cretaceous Pterosaurs

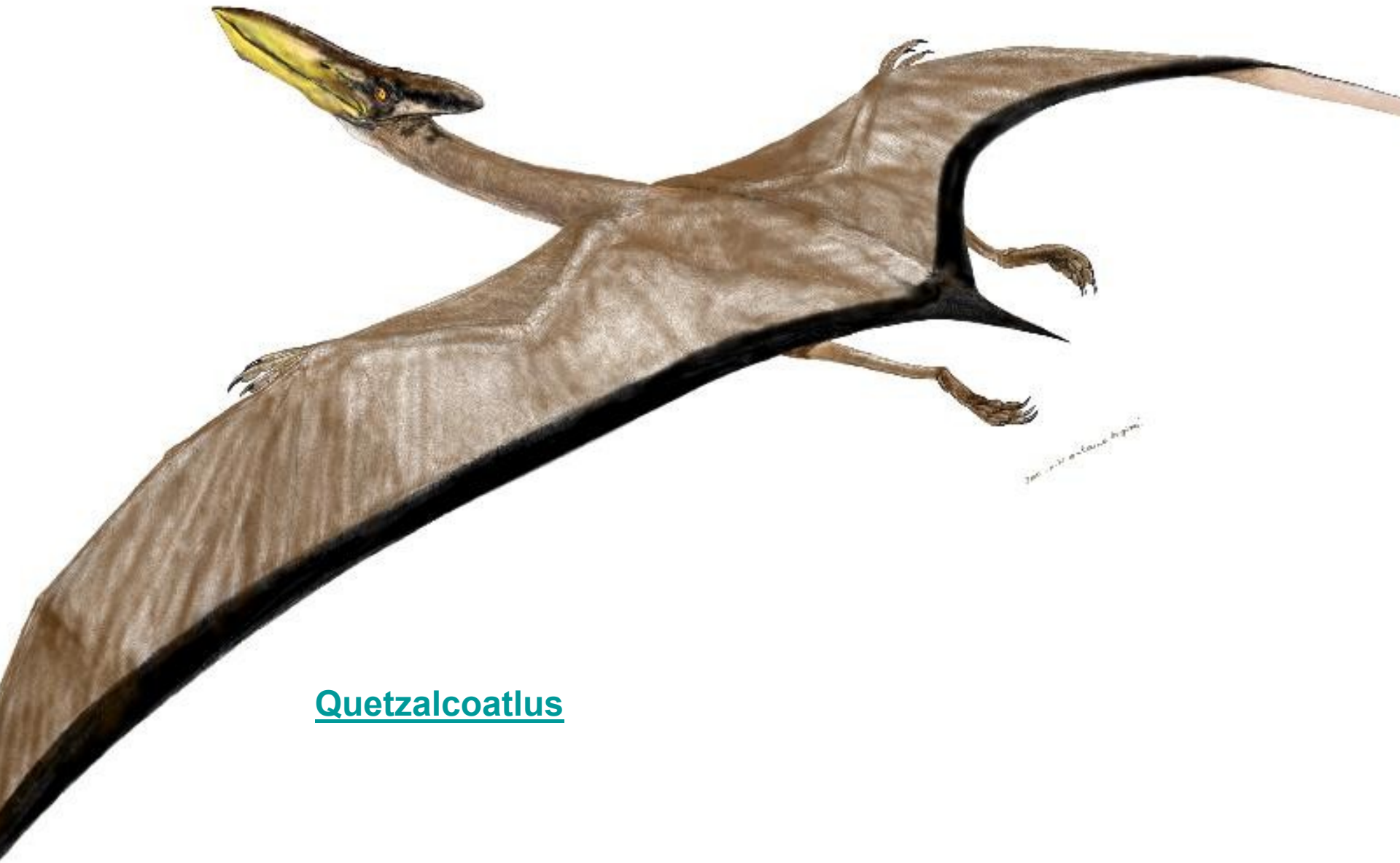
During the Cretaceous Era the pterosaurs became larger than ever. Some species had wingspans equal to those of a small aeroplane.

Small pterosaurs had almost disappeared, they were probably unable to compete with the newly evolved birds.



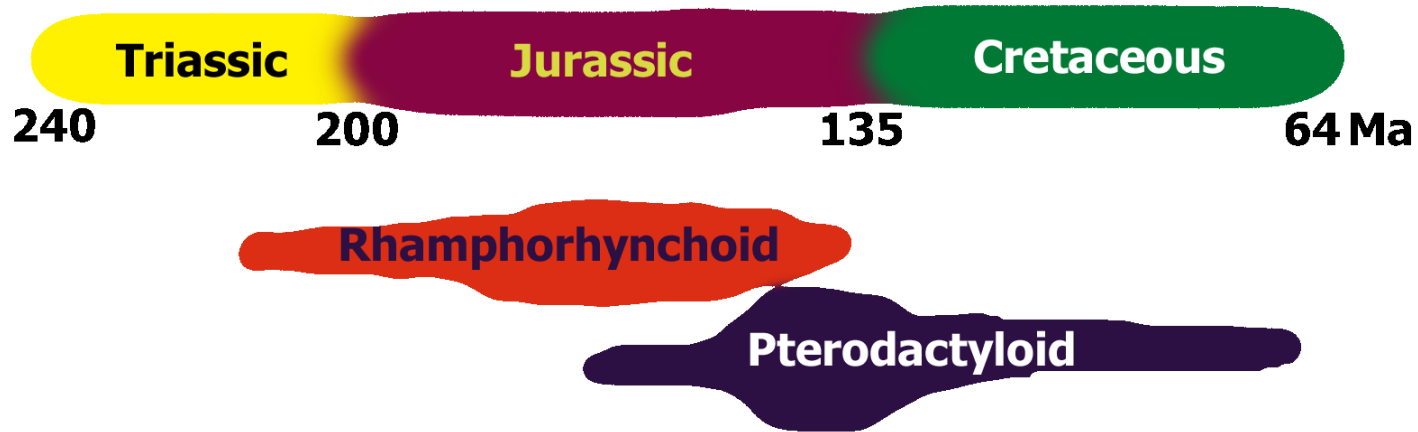
Pteranodon





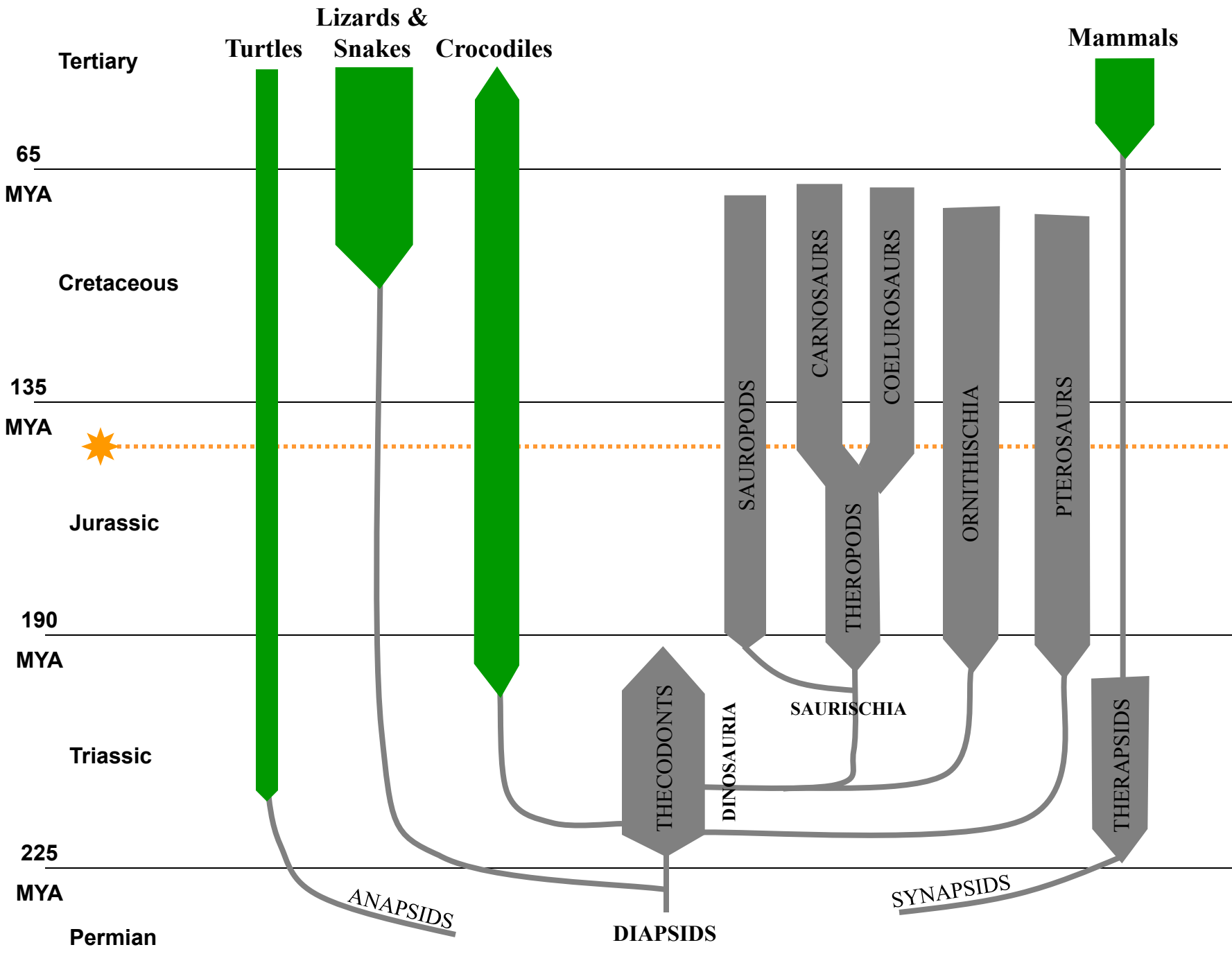
Quetzalcoatlus

Pterosaur Timeline



Pterosaurs were at their height in the Late Jurassic Era.

Only the large pterosaurs remained until the end of the Cretaceous Era.



Tertiary

Turtles

Lizards & Snakes

Crocodiles

Mammals

65

MYA

Cretaceous

135

MYA



Jurassic

190

MYA

Triassic

225

MYA

Permian

DIAPSIDS

SYNAPSIDS

ANAPSIDS

THECODONTS

DINOSAURIA

SAURISCHIA

THERAPSIDS

SAUROPODS

CARNOSAURS

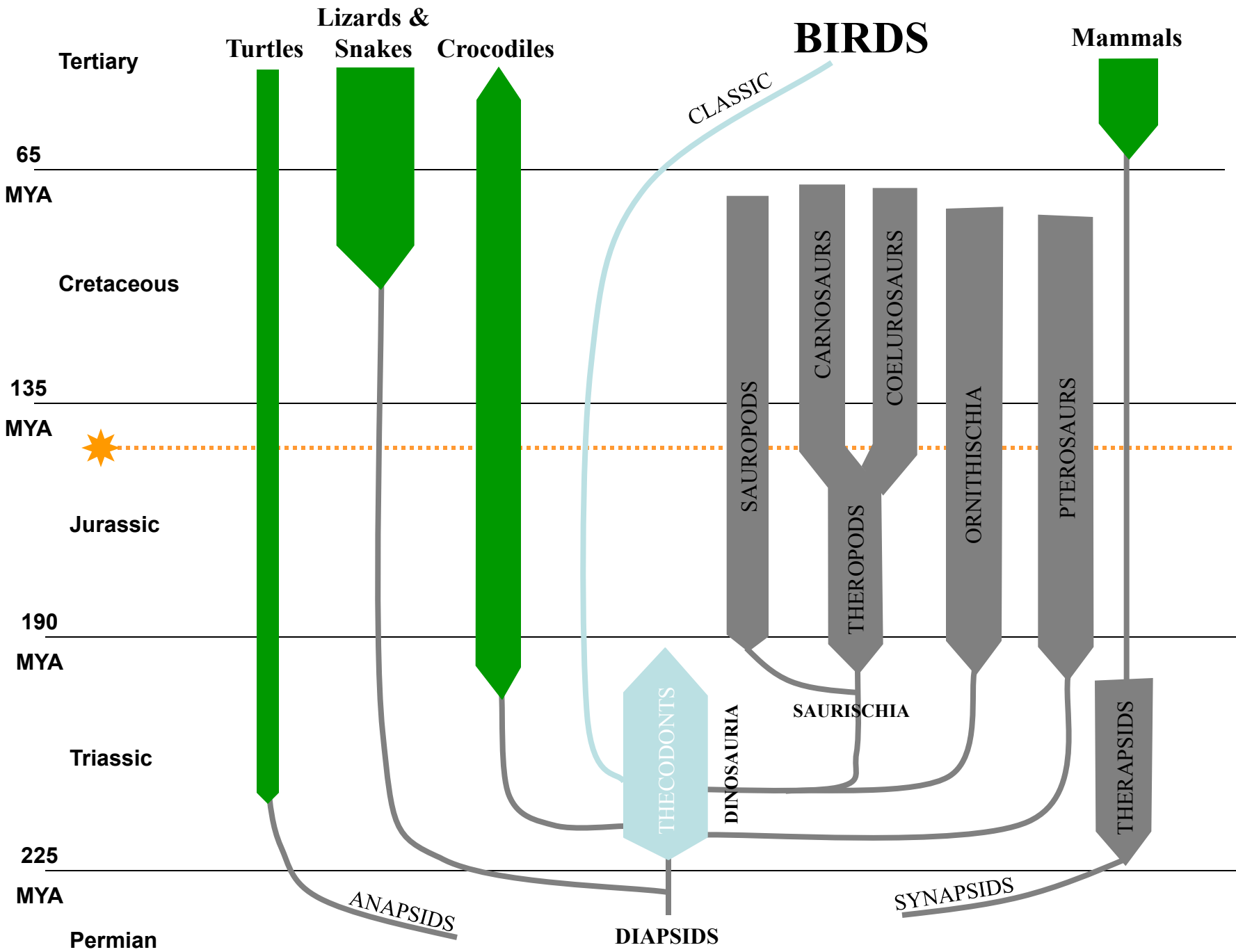
COELUROSAURS

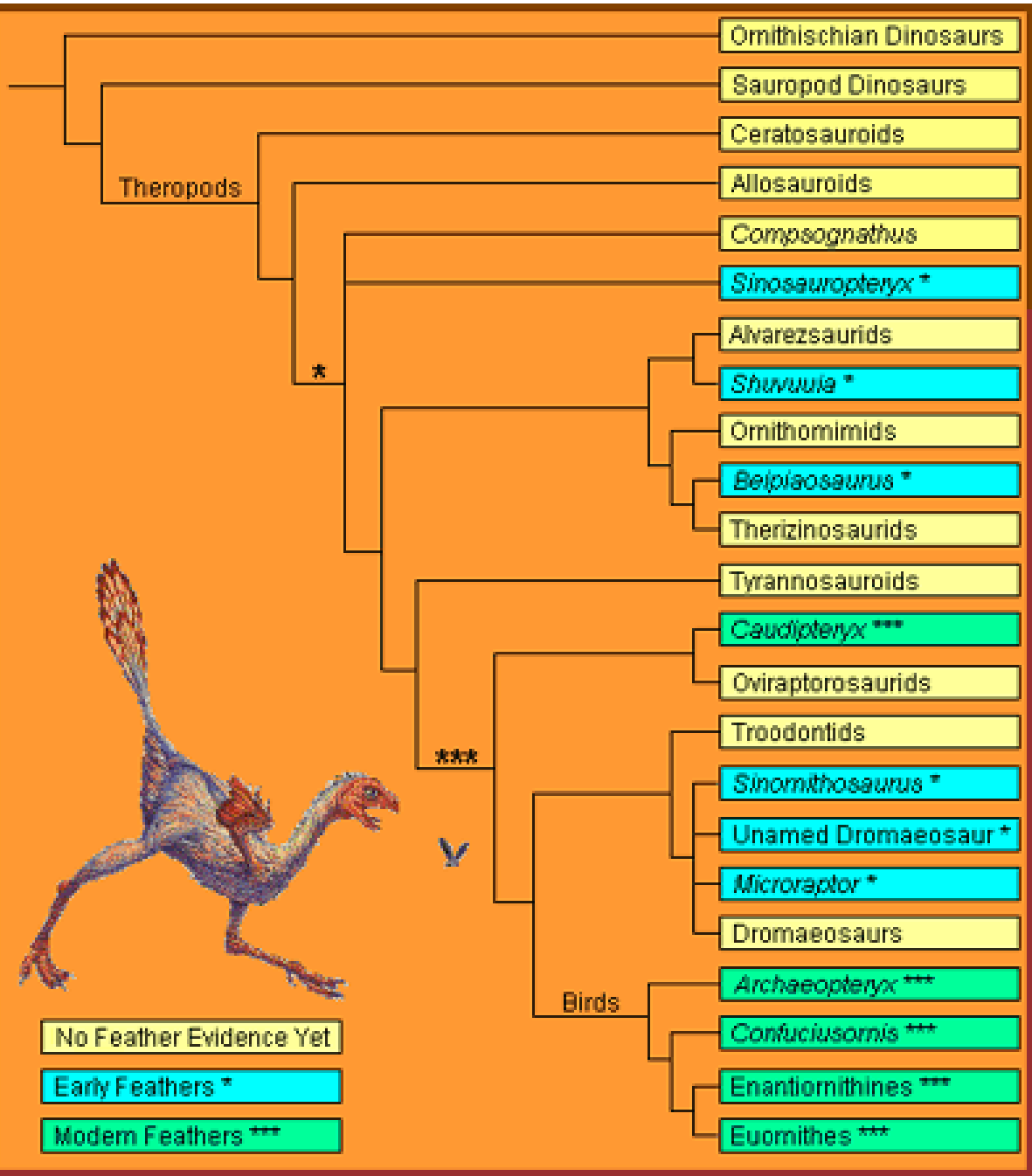
ORNITHISCHIA

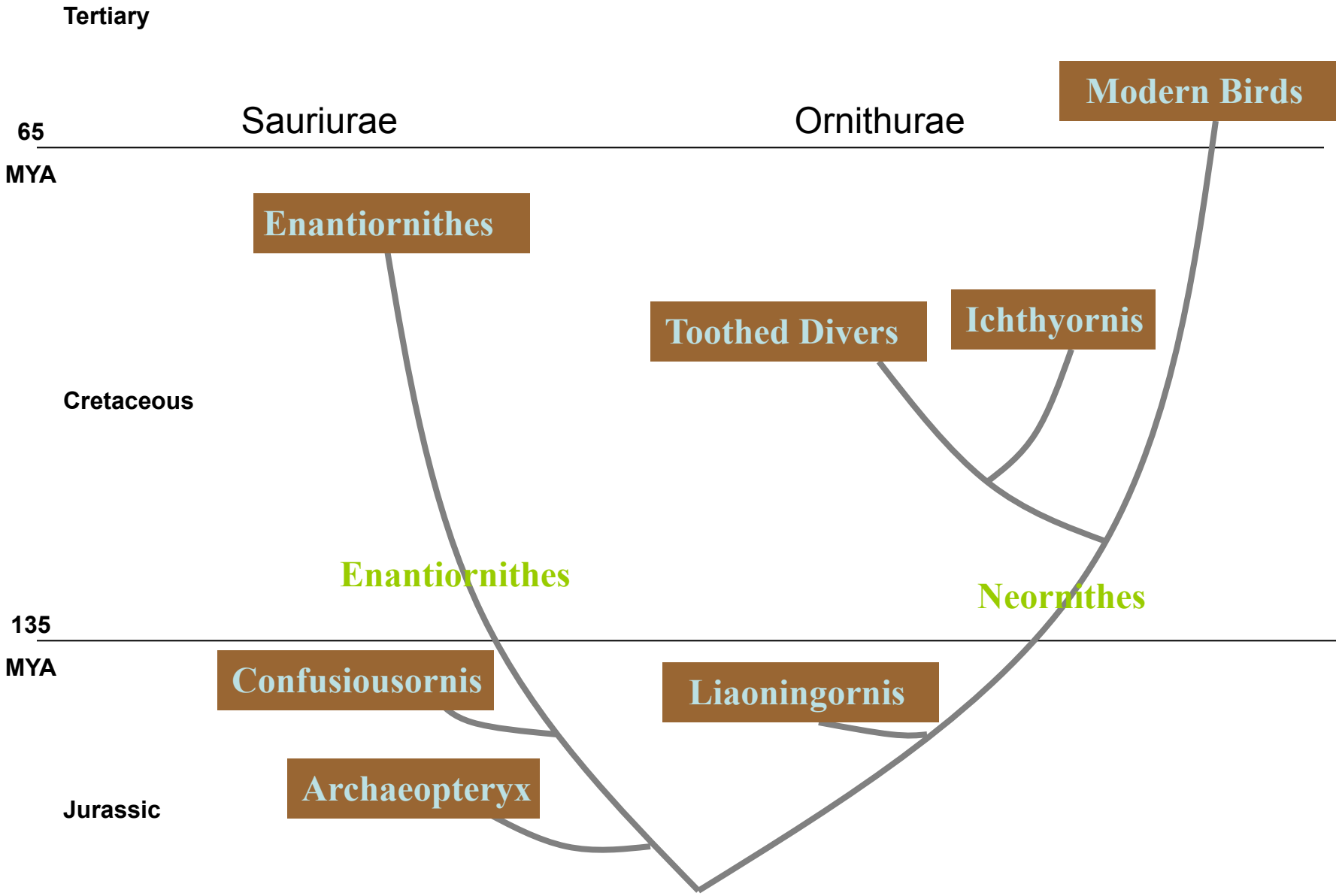
PTEROSAURS

Aves

Historie ptáků (Aves) začíná během **jury** (všechny starší údaje se ukázaly jako neopodstatněné). Úsvit této skupiny je ještě zahalen řadou nejasností vyplývajících z obtížné fosilizace i z nejisté datace nejstarších nálezů. Zmíněný *Archaeopteryx* je v této souvislosti považován buď za zástupce jedné skupiny dinosaurů (viz výše) nebo za sesterskou skupinu některých tzv. **opozitních ptáků** (tři kůstky jejich chodidla srůstají odshora dolů, tj. opačně než u moderních ptáků). Ptačí předek se tedy mohl odštěpit od nelétavých dinosaurů už před archeopteryxem. Každopádně při hranici jura/křída dochází k radiaci různých skupin ptáků, z nichž dnes již dobře doložený *Confuciusornis* zastupuje opozitní ptáky (nebo také Sauriurae) a *Chaoyangia*, *Liaoningornis*, *Hesperornis* a *Ichthyornis* již sesterskou skupinu Ornithurae zahrnující i **moderní ptáky**.







Two Major Bird Lineades

- Enantiornithes
 - Fusion of tarsometatarsus in opposite c
 - Most Diverse avian group in Cretaceous
- Neornithes



Two Major Bird Lineages

- Enantiornithes
- Neornithes
 - Predecessors to modern birds
 - Toothed Divers – Hesperornis
 - Tern-like – Ichthyornis

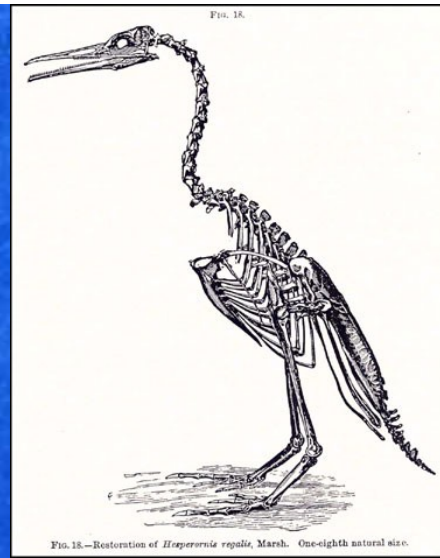
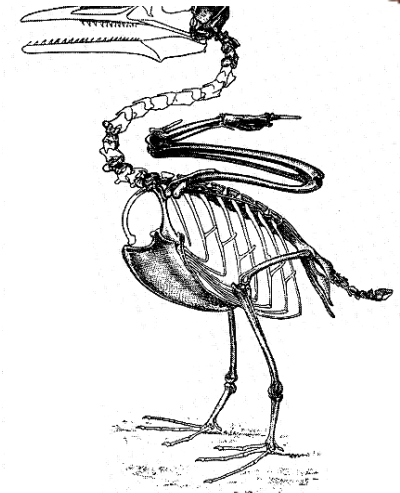


FIG. 18.—Restoration of *Hesperornis regalis*, Marsh. One-eighth natural size.



True Birds (Aves)



- Archaeopteryx long thought to be a bird ancestor
- Still hotly debated
- Ground-Up vs. Trees-Down models of flight
- This one is Trees-Down

Archaeopteryx



This one is a Ground-Up representation - they could have started flight with long leaps

Archaeopteryx is somewhat advanced, and could have made some longish flights, but likely not really well or all day.

Archaeopteryx with no artist's interpretation - (note the feathers!)



Feathers

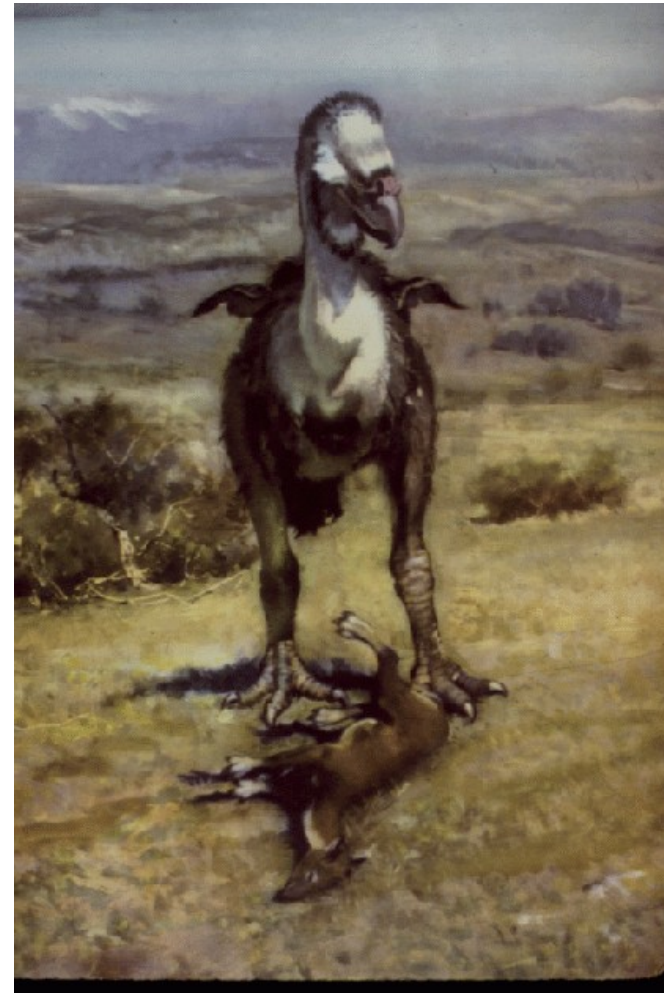
- Feathers are obviously good for flight
- Feathers are also good insulators
- It's not clear which property was the impetus for their evolution - Archaeopteryx might well have just been trying to keep warm.

Timing of Birds

- Birds don't fossilize well - they have weak, light bones that are often hollow.
- From 1990-1995, the number of known bird fossils doubled.
- When did they start?
- Archaeopteryx is from Late Jurassic
- There were lots of birds, flying and flightless, by the end of the Cretaceous, including members of modern groups

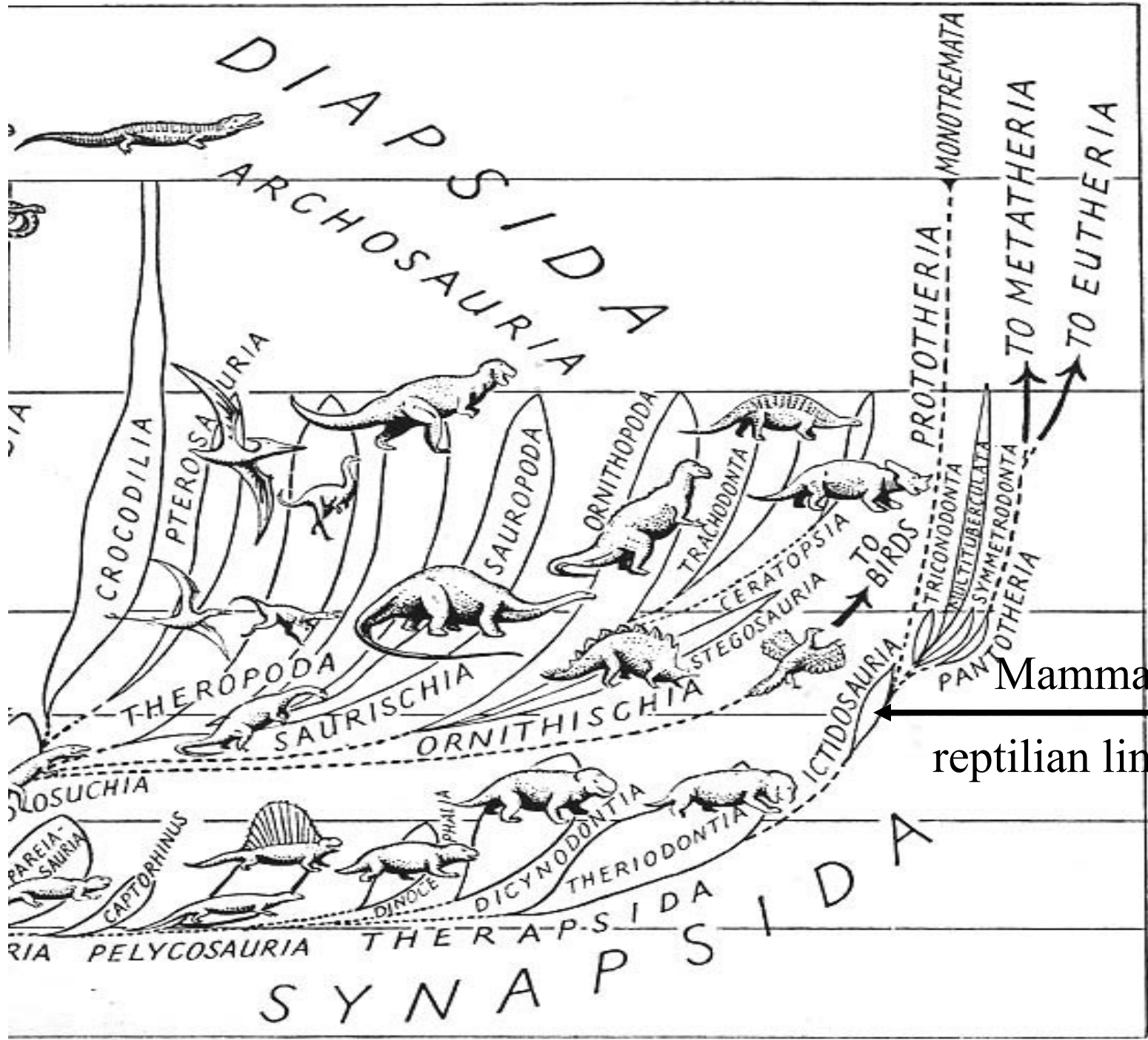
Timing of Birds

- Lots of bird diversification in the Cenozoic, although most fossils are incomplete.
- By the Early Oligocene (35 Ma), most modern bird groups had arrived.
- There were unusual forms, e.g. phororhachids from South America - present for much of Cenozoic



Timing of Birds

- Controversy -*Protoavis* from Late Triassic
- This would move back bird evolution about 80 million years to the earlier parts of the Mesozoic
- Not everybody thinks this is a real bird, although its discoverer (Chatterjee) claims it is closer to modern birds than *Archaeopteryx* is
- Birds have lots of fans - creates interest



Mammalian-reptilian line

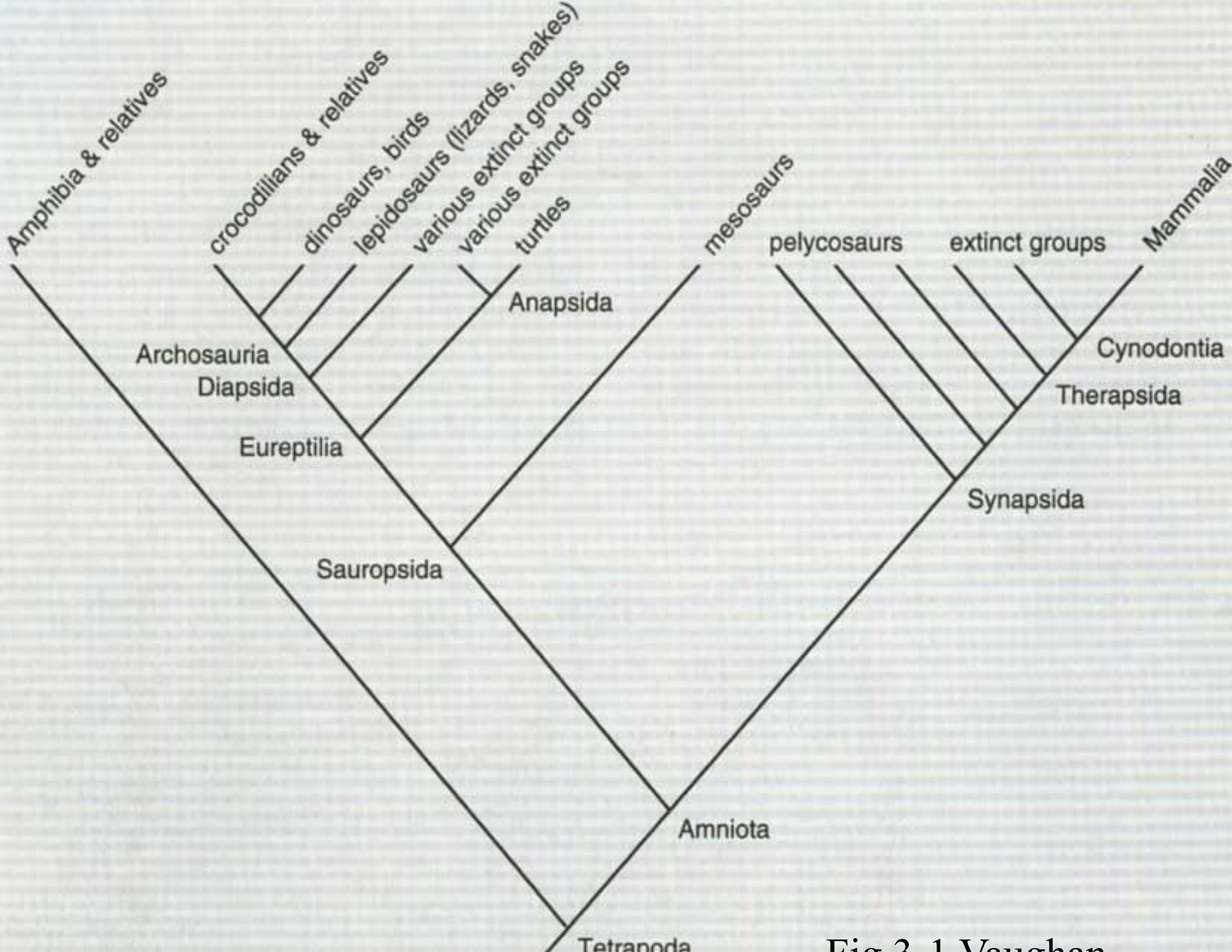
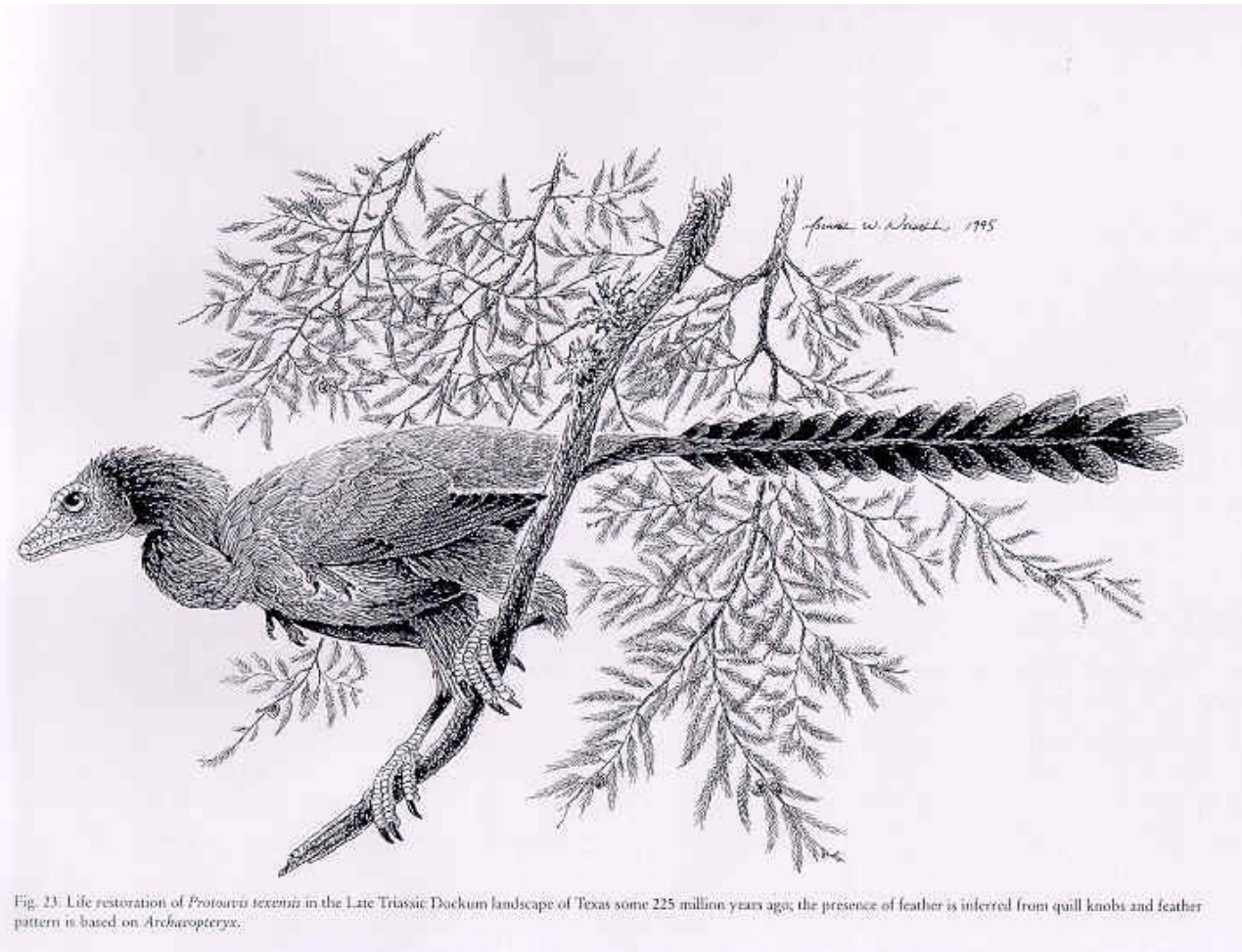
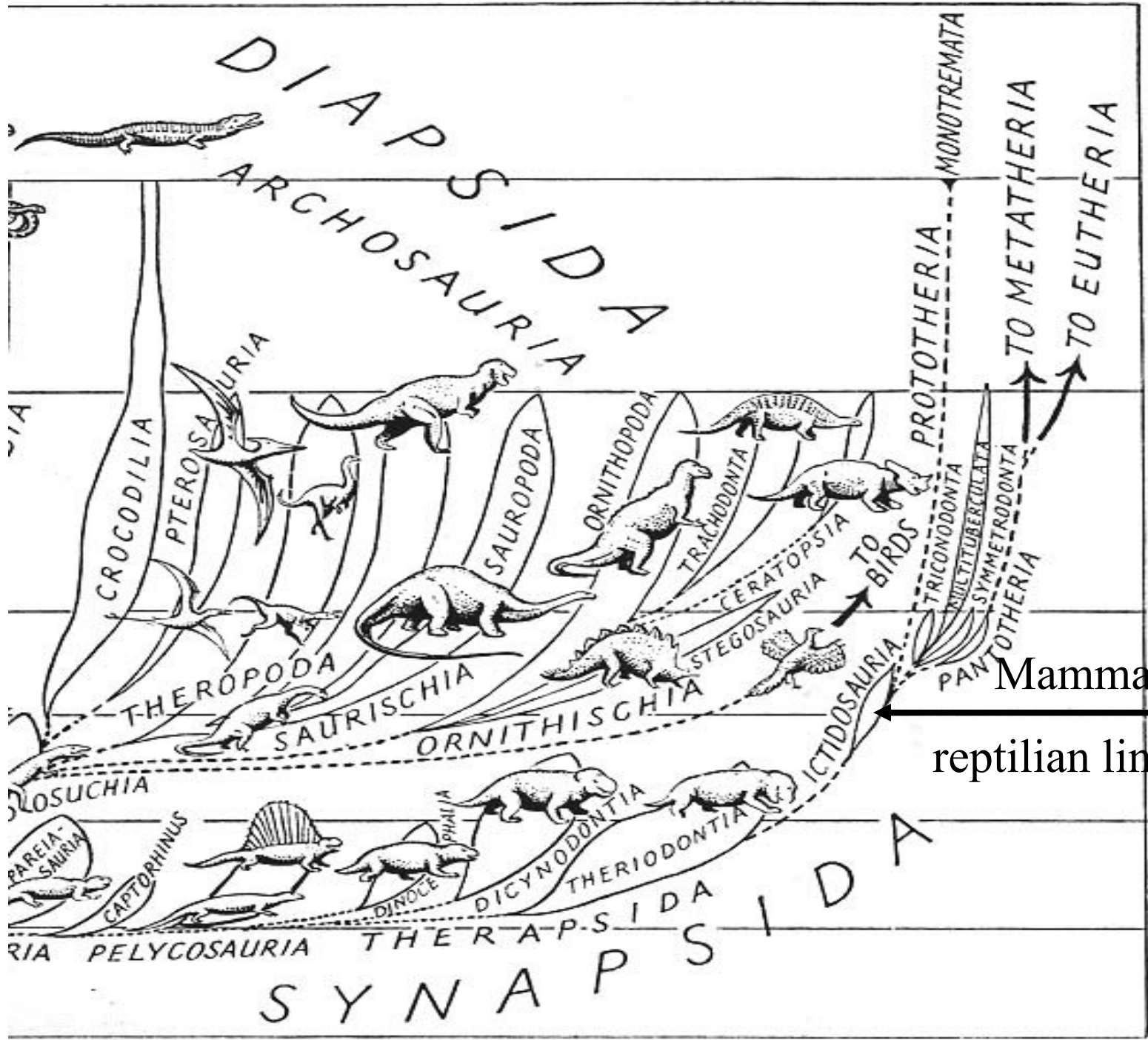


Fig 3.1 Vaughan

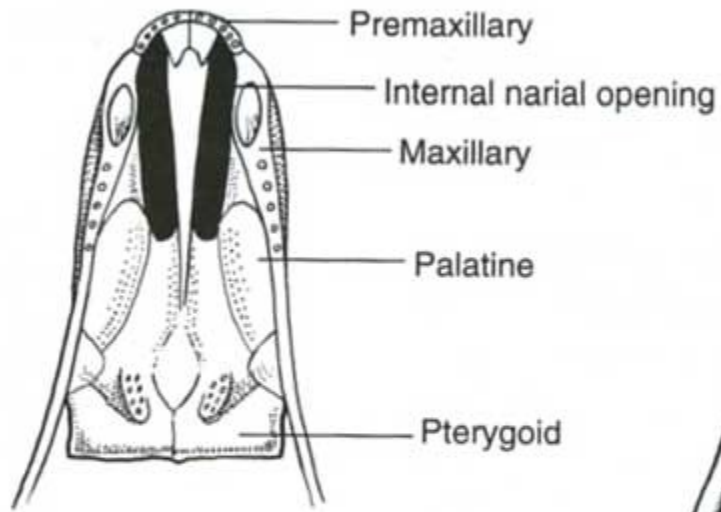
ProtoAvis





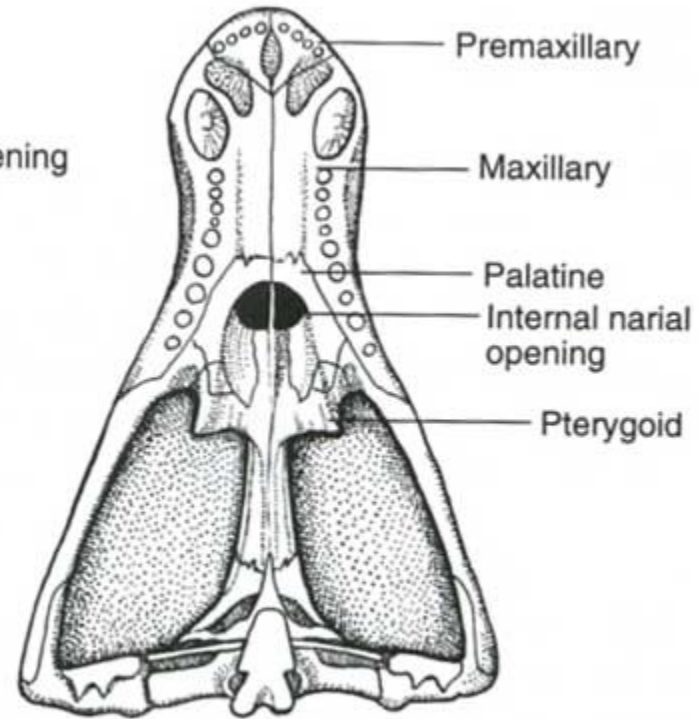
Mammalian-reptilian line

Primitive Therapsid Reptile

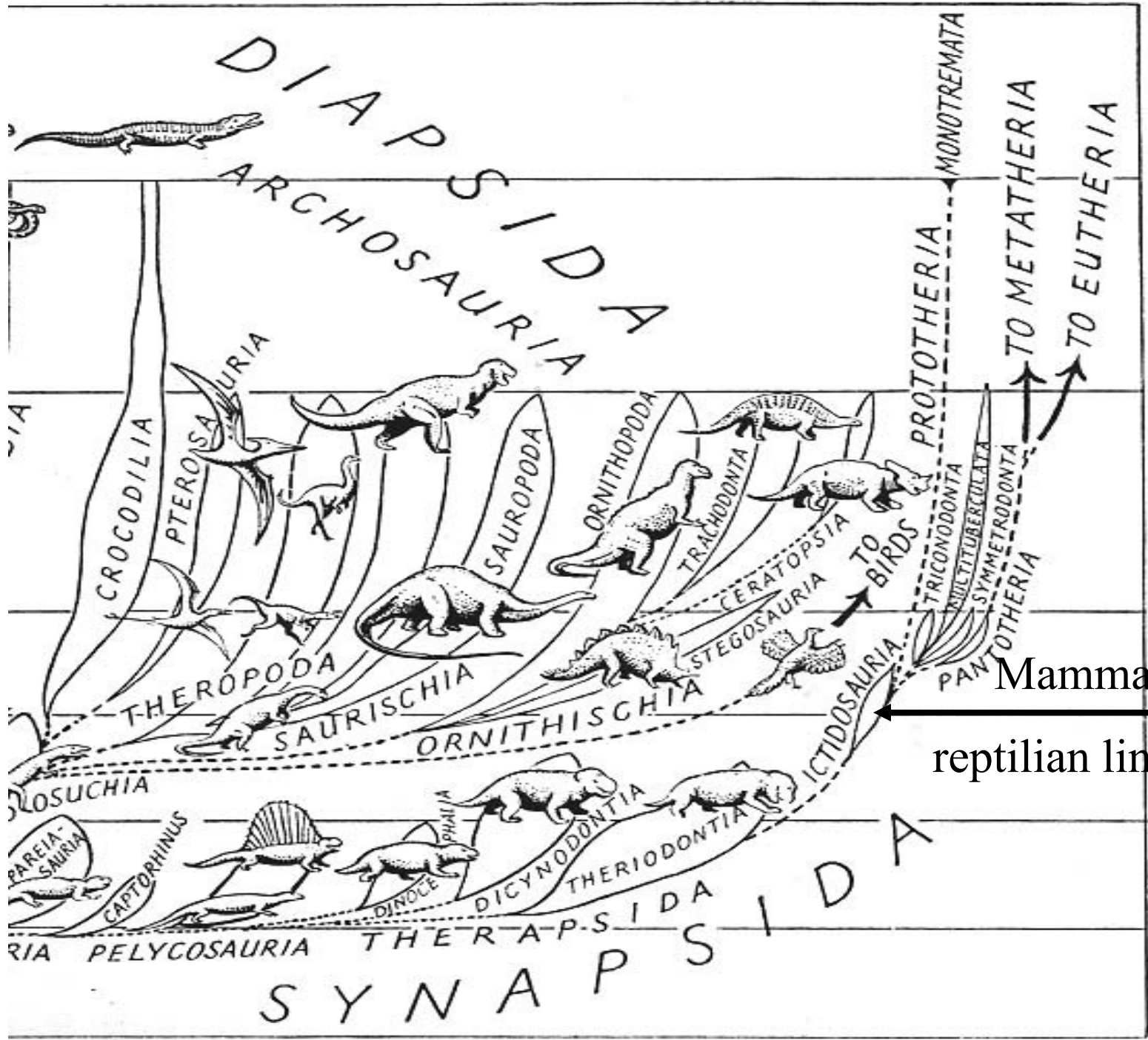


Scymnognathus

Cynodont Mammal

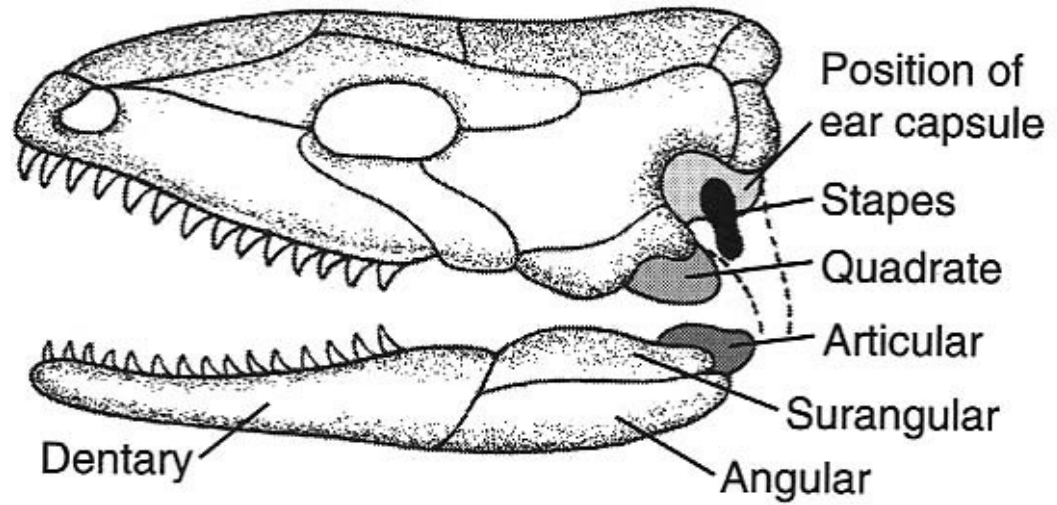


Cynognathus



Mammalian-reptilian line

Early reptiles



A

Mammals

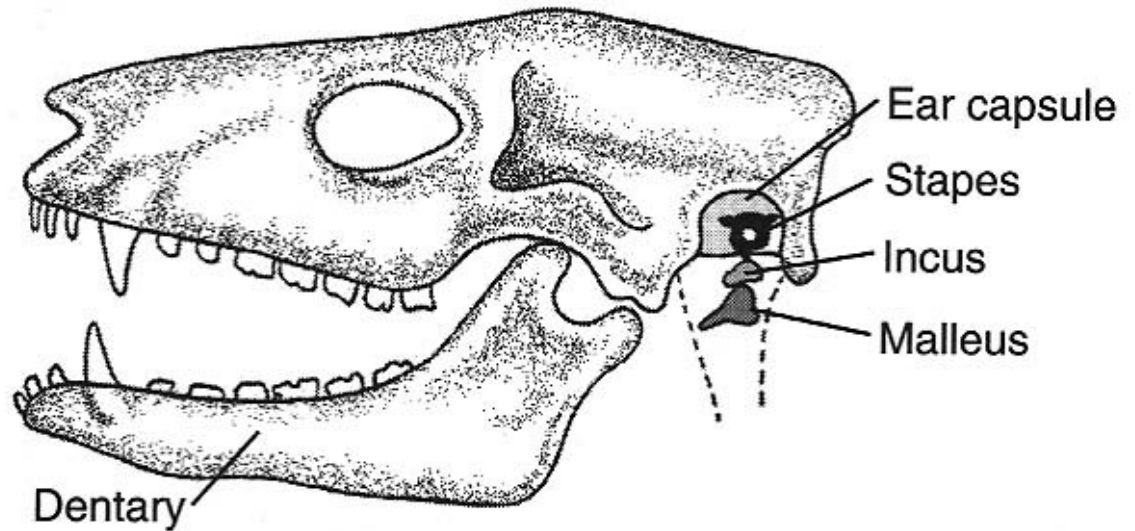


Fig 4.5 Feldhamer

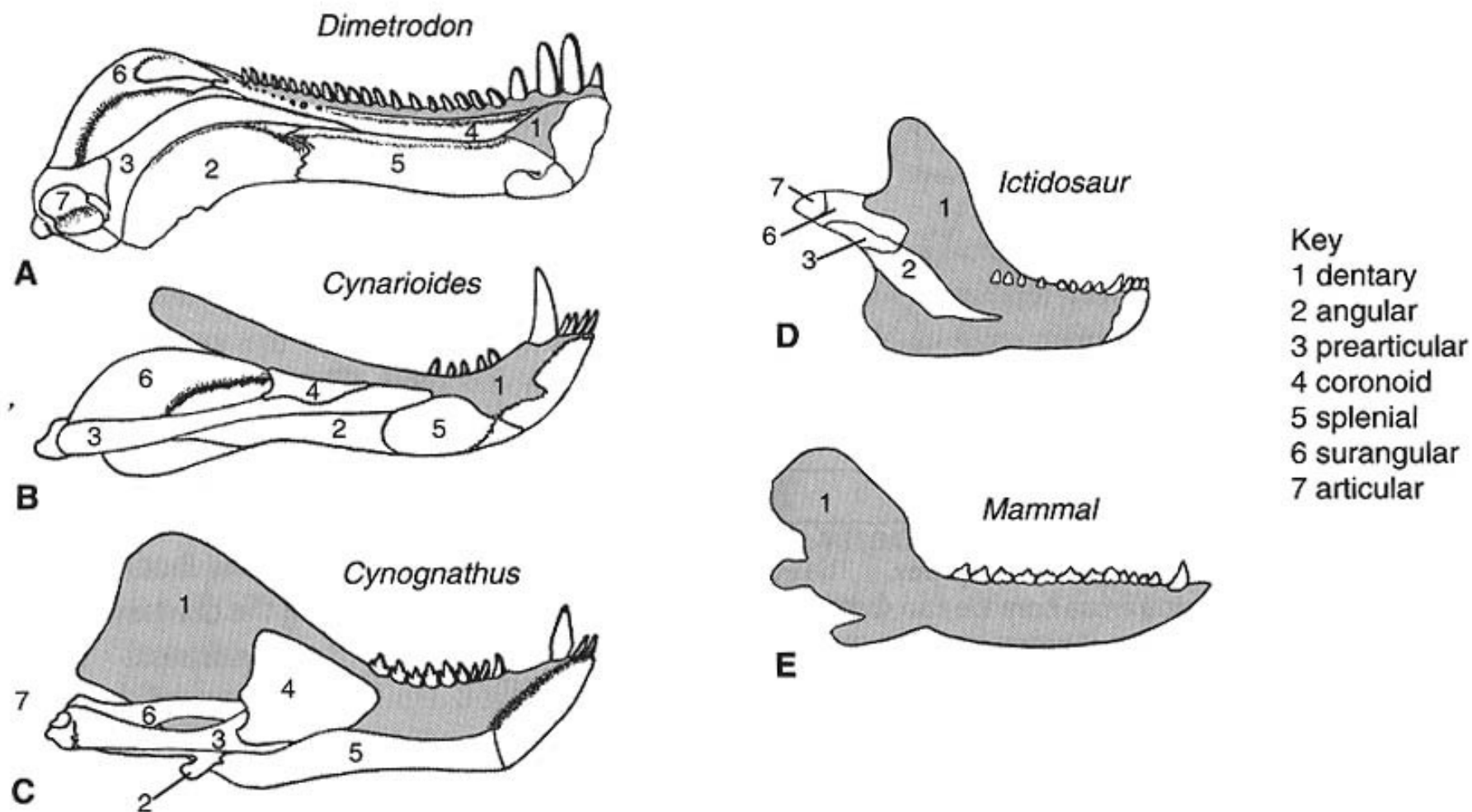
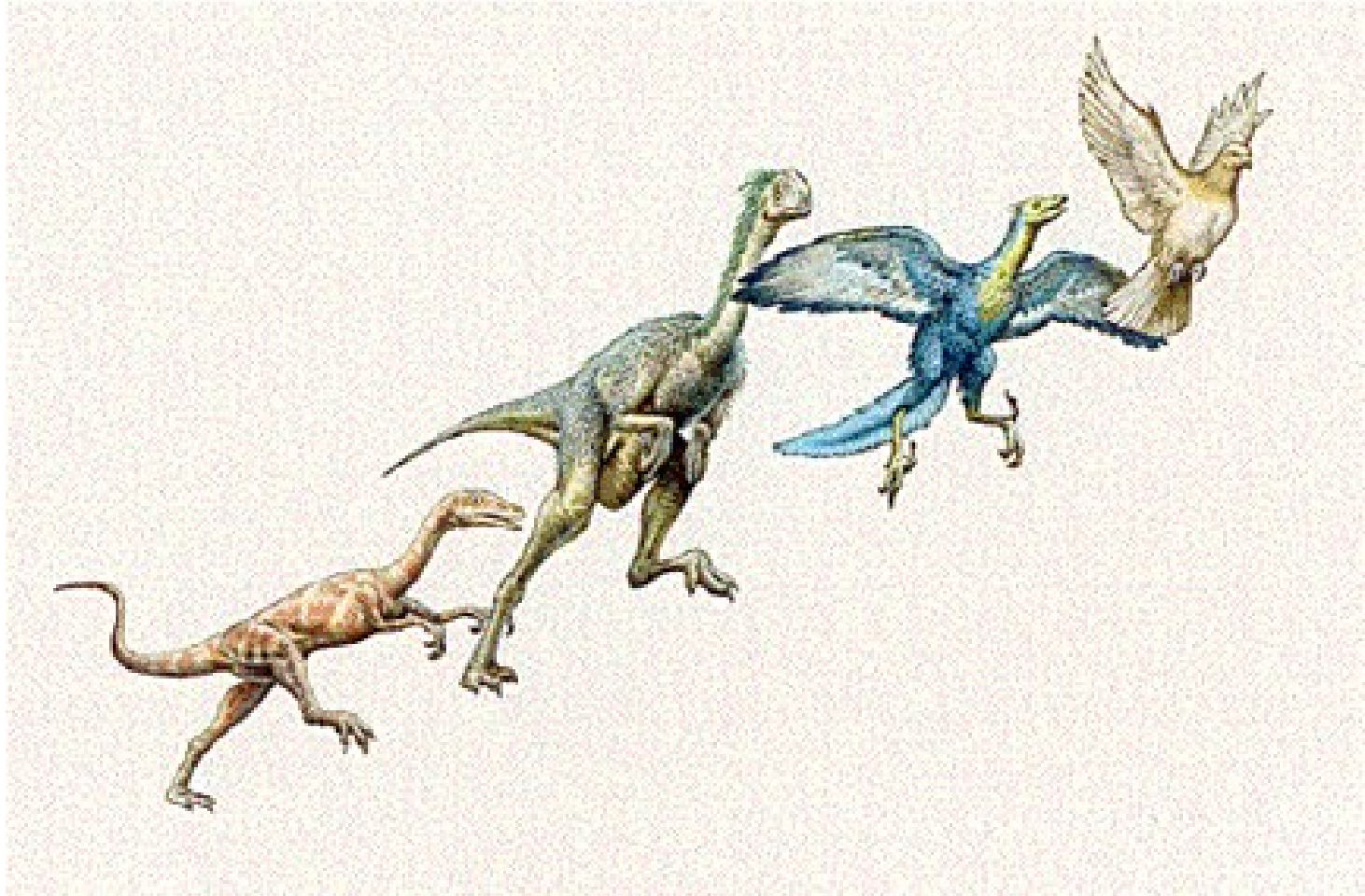


Figure 4.4 Enlargement of the dentary bone. The progressive enlargement of the dentary bone (shaded) and reduction in postdentary bones is evident when comparing jaws of primitive mammal-like reptiles: (A) *Dimetrodon*, an early Permian pelycosaur; (B) *Cynarioides*, a late Permian therapsid; (C) *Cynognathus*, an early Triassic cynodont; and (D) *Ictidosaur*, a late Triassic–early Jurassic cynodont. The dentary is the sole bone in the jaw of mammals (E).

Warm Blooded Dinosaurs, Reptile Biology, Archosaurs vs. Reptiles



The Warm Blooded Dinosaurs



?
||



Bone structure

- Haversian Canals
- Most cold blooded animals lack this bone structure.



Predator-Prey Ratios: ectothermic?

- Require far less food/energy than warm blooded animals



An adult female rubber boa from southeastern Idaho

Dinosaur Communities



Size of dinosaurs



Superiority of predators

- Mammals generally superior to reptiles

Warm blooded vs. Cold blooded Dinosaurs...

Definitions

- Endothermic: creates heat from inside
- Ectothermic: absorbs heat from outside
- Homeothermic: maintains a constant internal temperature
- Poikilothermic: temperature fluctuates depending on outside conditions

Evidence for **endothermic** dinosaurs

- Fast things need to have heat available. Many dinosaurs appear to be fast-moving.
- Today, endotherms normally outcompete ectotherms. Since dinosaurs coexisted with known endotherms, they must also have been endothermic.
- Dinosaurs were upright walkers with legs below their bodies - typical of endotherms

Evidence for **endothermic** dinosaurs

- Dinosaurs had big brains, and endotherms tend to have big brains (but not always, and brain size is correlated with other things, too).
- Ectotherms aren't usually found at high latitudes, and dinosaurs were (but it was warmer)
- Endotherm predator/prey ratio is usually low, and dinosaur ratios match mammals

Evidence for **endothermic** dinosaurs

- Dinosaurs were big and had large, complex hearts. Complex heart matches modern endotherms.
- Dinosaurs were ancestral to birds, and birds are endotherms.
- Endotherms tend to grow fast, and dinosaurs were big (but who knows how long they lived?)
- Dinosaur bone structure matches modern endotherms better than modern ectotherms

Evidence for ectothermic dinosaurs

- Dinosaurs were huge - could have been effectively homeothermic w/o endothermy
- Dinosaurs were huge - couldn't possibly have been endothermic because they'd burn up.
- Mesozoic was warm - dinosaurs didn't need to be endothermic
- Ectotherms tend to be scaly, and dinosaurs were (but so are birds!)

Evidence for ectothermic dinosaurs

- Some dinosaurs show lines of arrested growth (LAGs) in bones. Modern endotherms don't have LAGs (unless stressed), but modern ectotherms do.
- Dinosaurs didn't have respiratory turbinates - bony structures at front of nasal cavity which are covered in mucus, which modern endotherms have.

Five current thermal hypotheses (from UCMP)

- Dinosaurs were complete endotherms, just like birds, their descendants.
- Some or all dinosaurs had some intermediate type of physiology between endothermy and ectothermy.
- We know too little about dinosaurs to hazard a guess at what their physiology was like.
- Dinosaurs were mostly inertial homeotherms; they were ectothermic but maintained a constant body temperature by growing large. Small dinosaurs were typical ectotherms, maybe with a slightly elevated metabolic rate.
- All dinosaurs were simple ectotherms, enjoying the warm Mesozoic climate. But that's okay; many ectotherms are quite active, so dinosaurs could be active, too.