

Natural Sciences 360

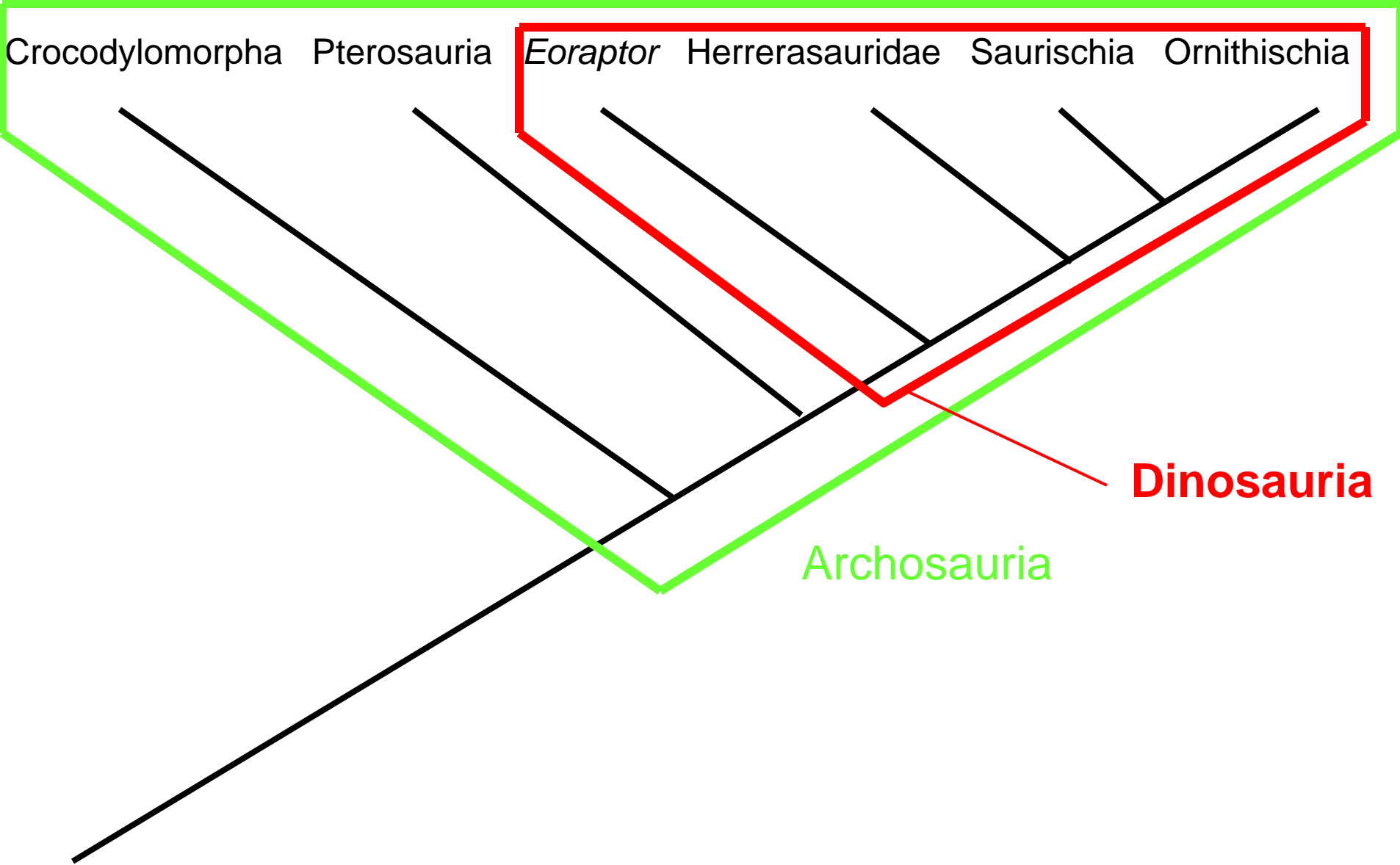
Legacy of Life

Lecture 16

Dr. Stuart S. Sumida

Theropoda (Including Birds)

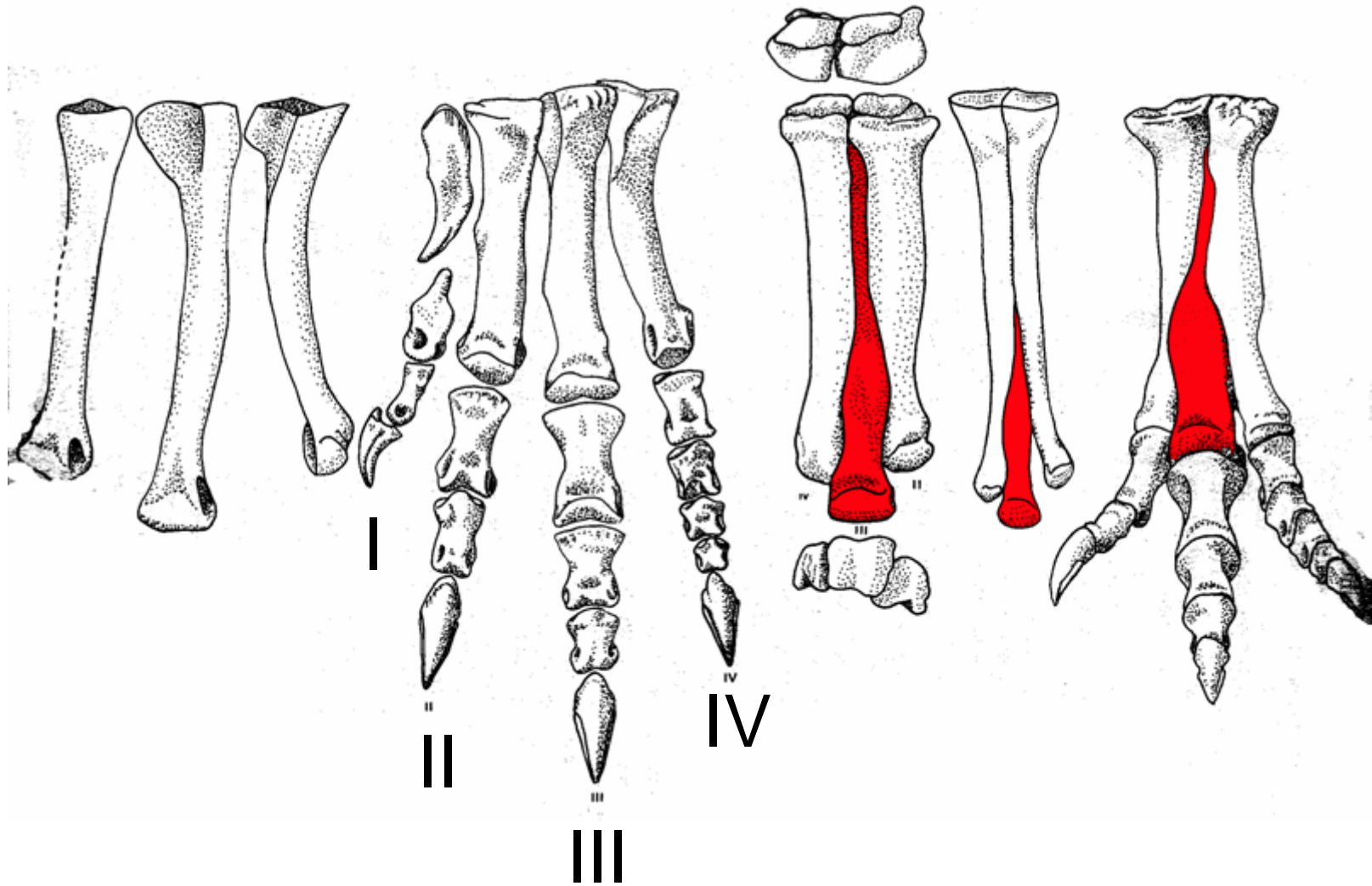
Recall:



THEROPODA

- Pronograde bipeds.
- Pneumatic (hollow) bones.
- Enlarged hand.
- Vestigial digits IV and V on hand.
- Highly extendable digits I-III on hand.
- Compact, elongate, narrow foot – usually missing digit V.

Theropod Feet: Note missing V.



CERATOSAURIA: COELOPHYSOIDEA

Difficult to diagnose, as they retain many primitive features:

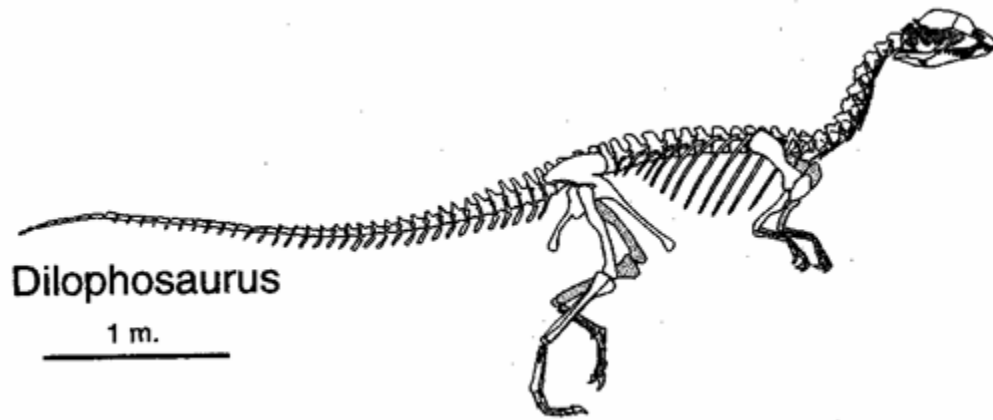
- Pronograde bipeds.
- Relatively small.
- Skulls are narrow, not boxy in shape.
- Many undifferentiated teeth.

Best known taxa:

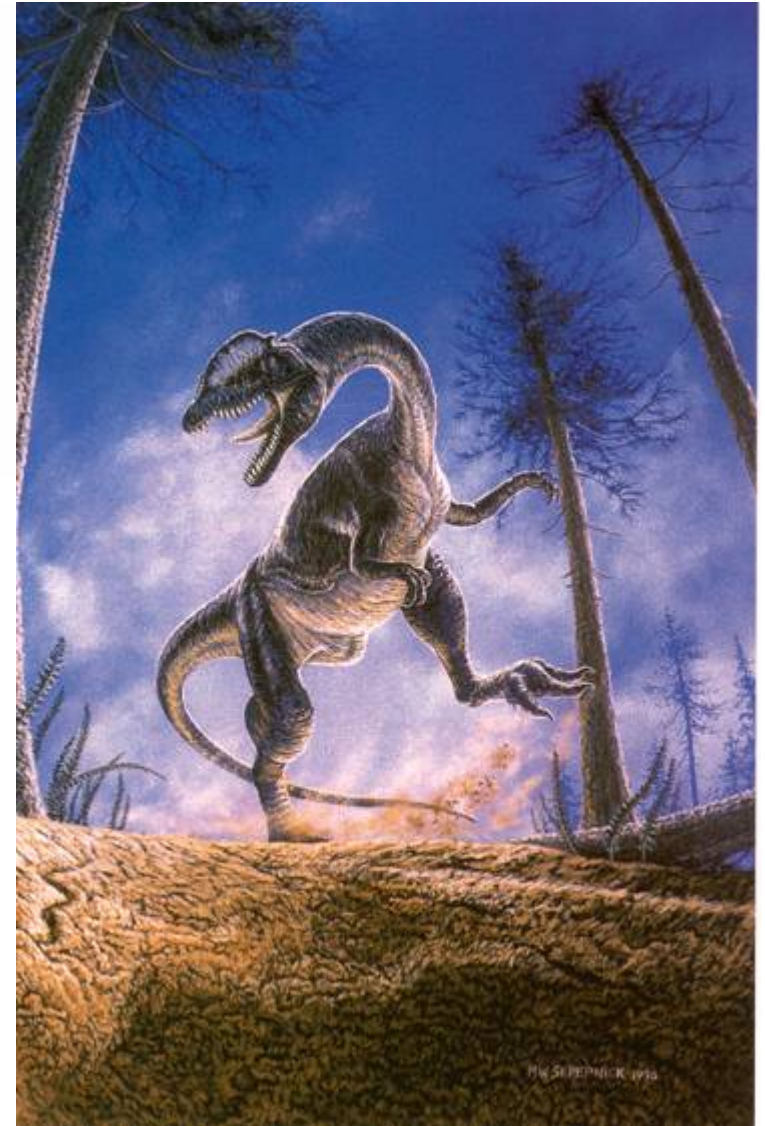
Coelophysis

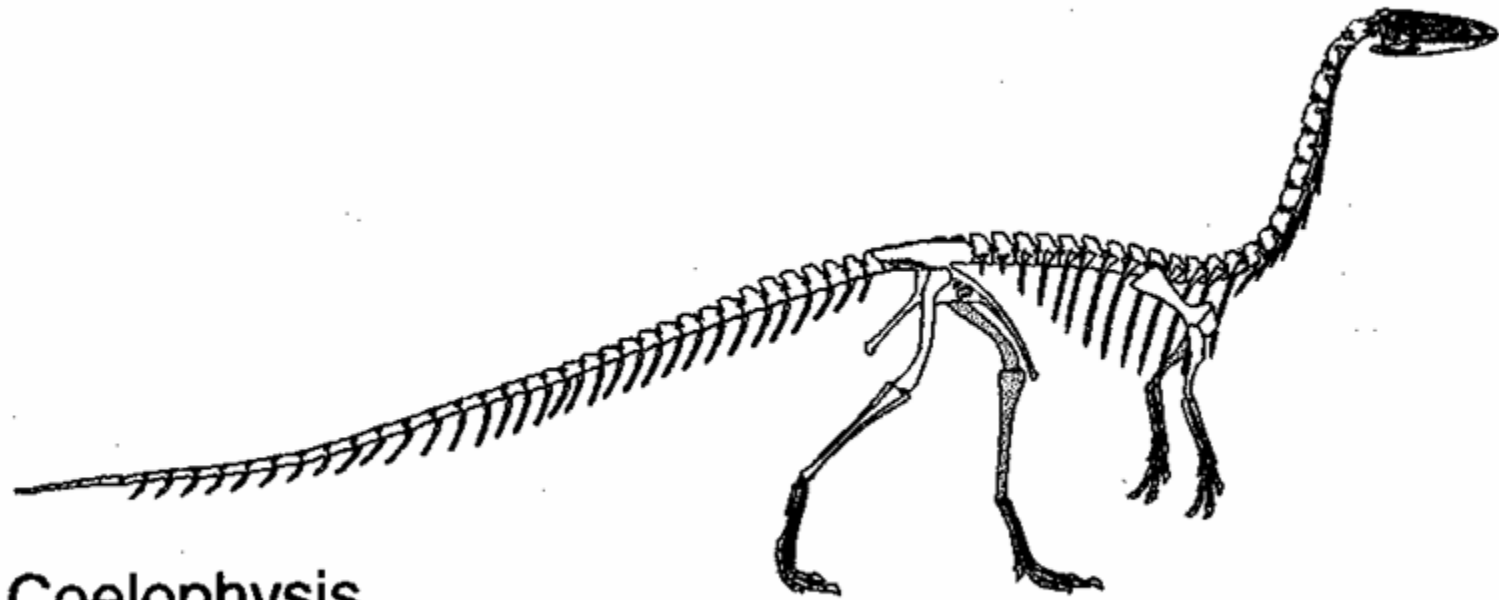
Dilophosaurus

“Syntarsus”



Dilophosaurus: a
crested ceratosaur
(No, they didn't
spit.)





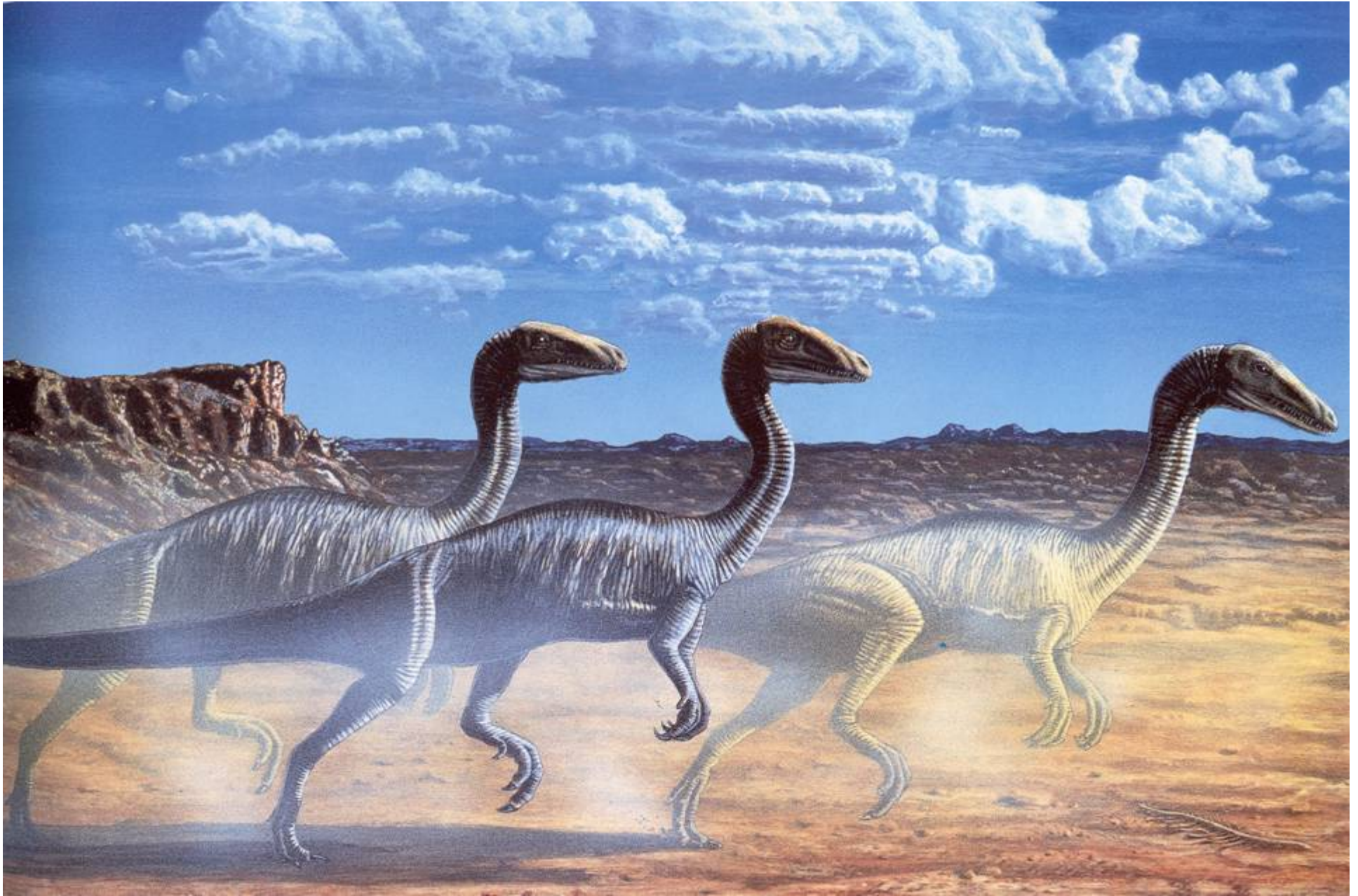
Coelophysis

1 m.



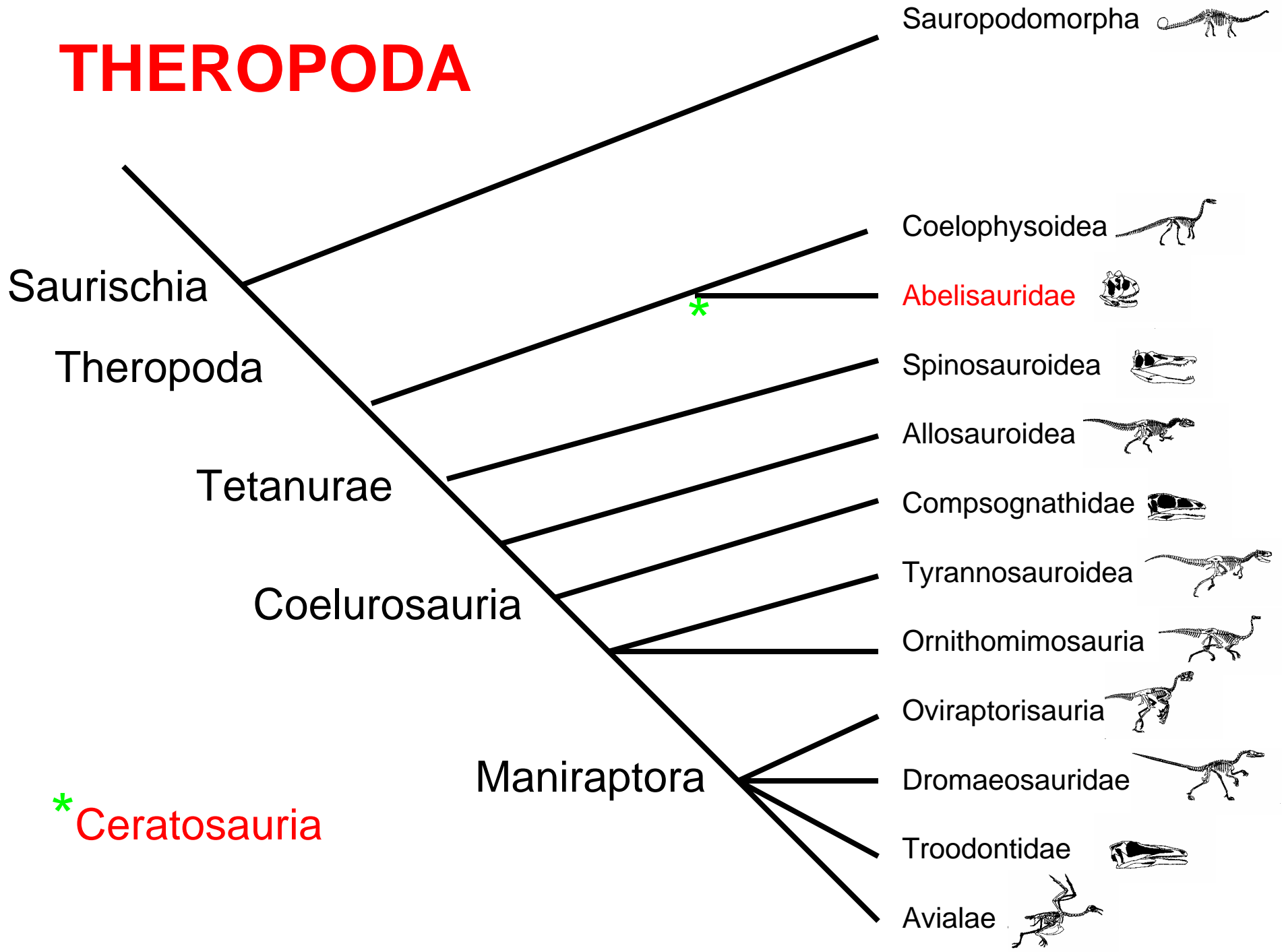



Coelophysis, skull




Coelophysis: reconstructed in northern New Mexico

THEROPODA




Sauropodomorpha 

Coelophysoidea 


Abelisauridae 

Spinosauroidae 

Allosauroidae 

Compsognathidae 

Tyrannosauroidae 

Ornithomimosauria 

Oviraptorosauria 

Dromaeosauridae 

Troodontidae 

Avialae 

Saurischia

Theropoda

Tetanurae

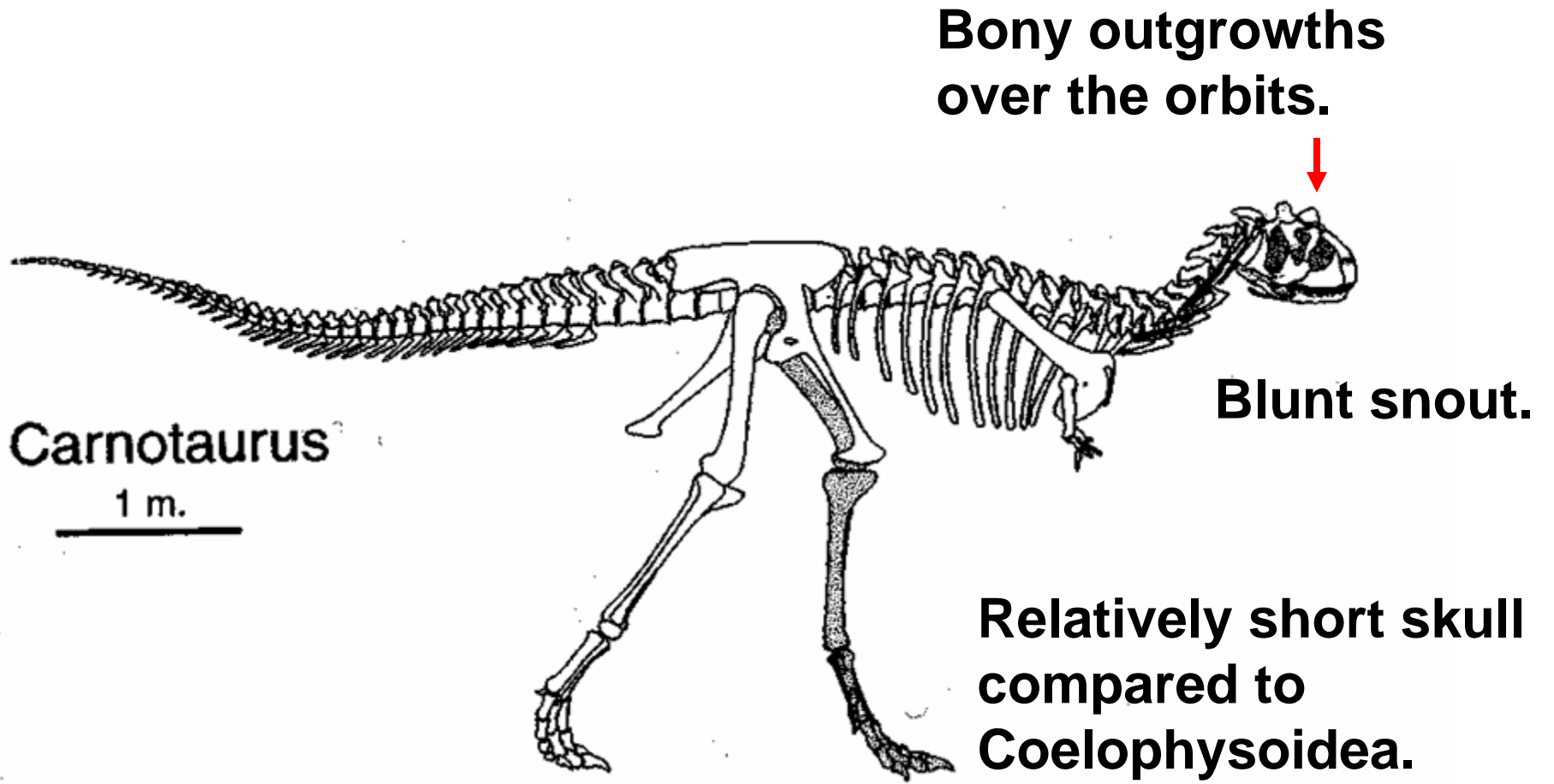
Coelurosauria

Maniraptora

* Ceratosauria

CERATOSAURIA: ABELISAURIDAE

- Bony outgrowths over the orbits.
- Relatively short skull compared to Coelophysoidea.
- Blunt snout.
- Ornamentation on skull
- Reduced forelimbs (like *T. rex*), but retain a well-developed pectoral girdle.



**Bony outgrowths
over the orbits.**



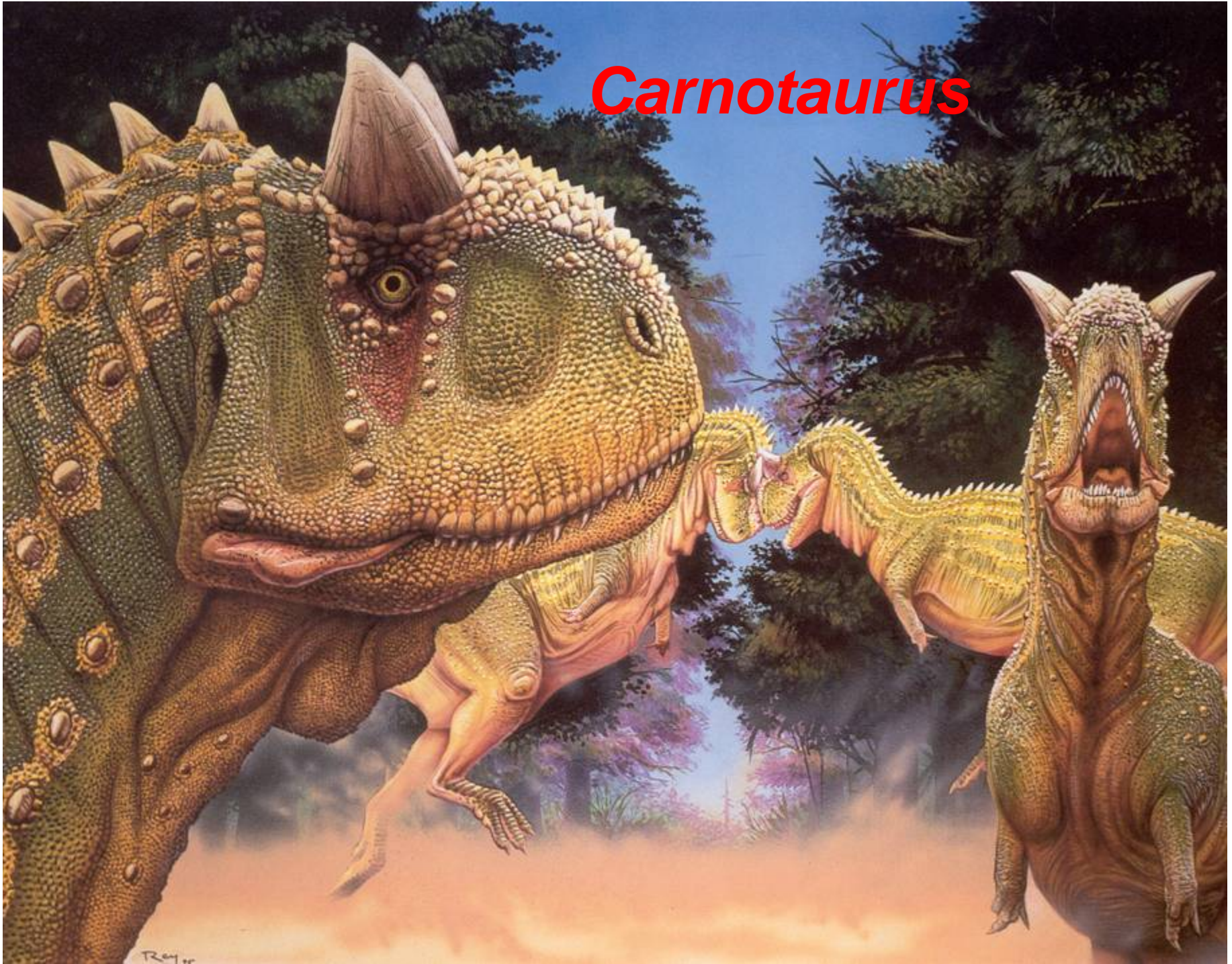
Blunt snout.

Carnotaurus

1 m.

**Relatively short skull
compared to
Coelophysoidea.**

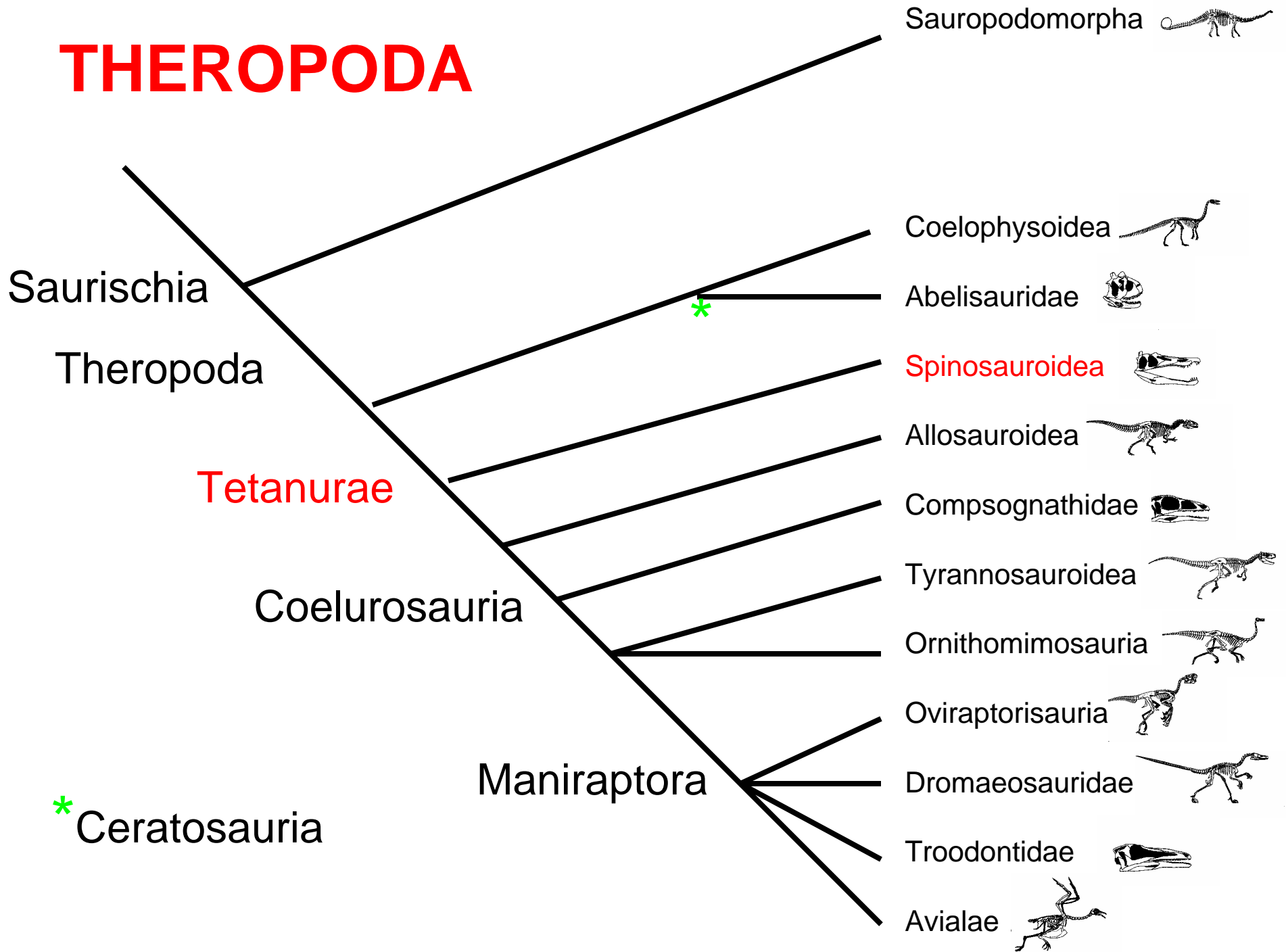
Carnotaurus





Majungatholus

THEROPODA

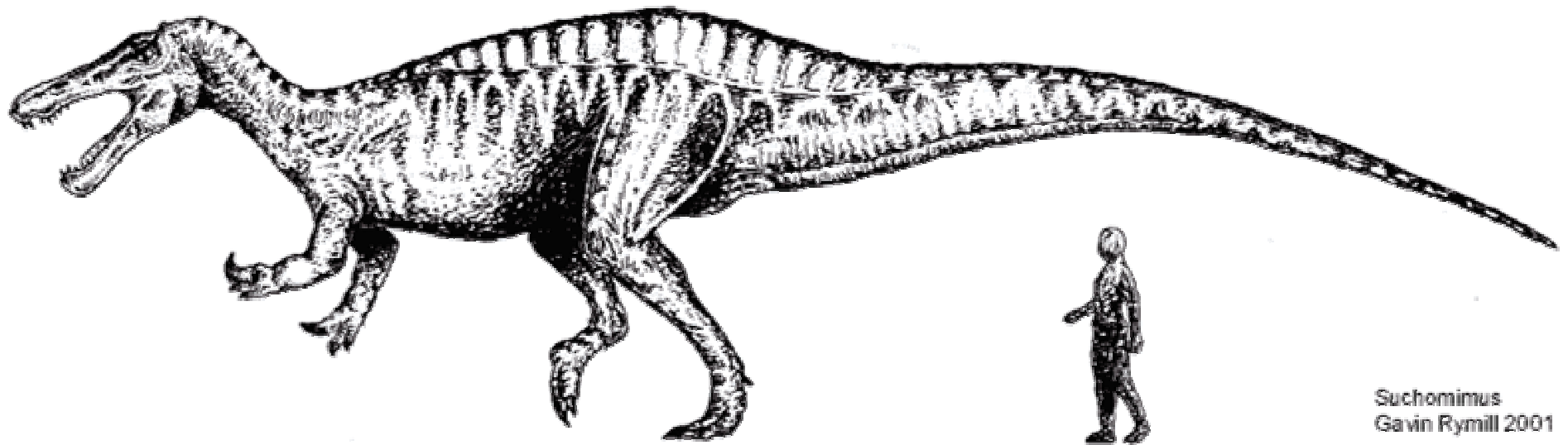


TETANURAE: SPINOSAUROIDEA

Include all of the tetanuran features plus extremely elongate neural spines of vertebrae – creates a sail-like structure on the back.

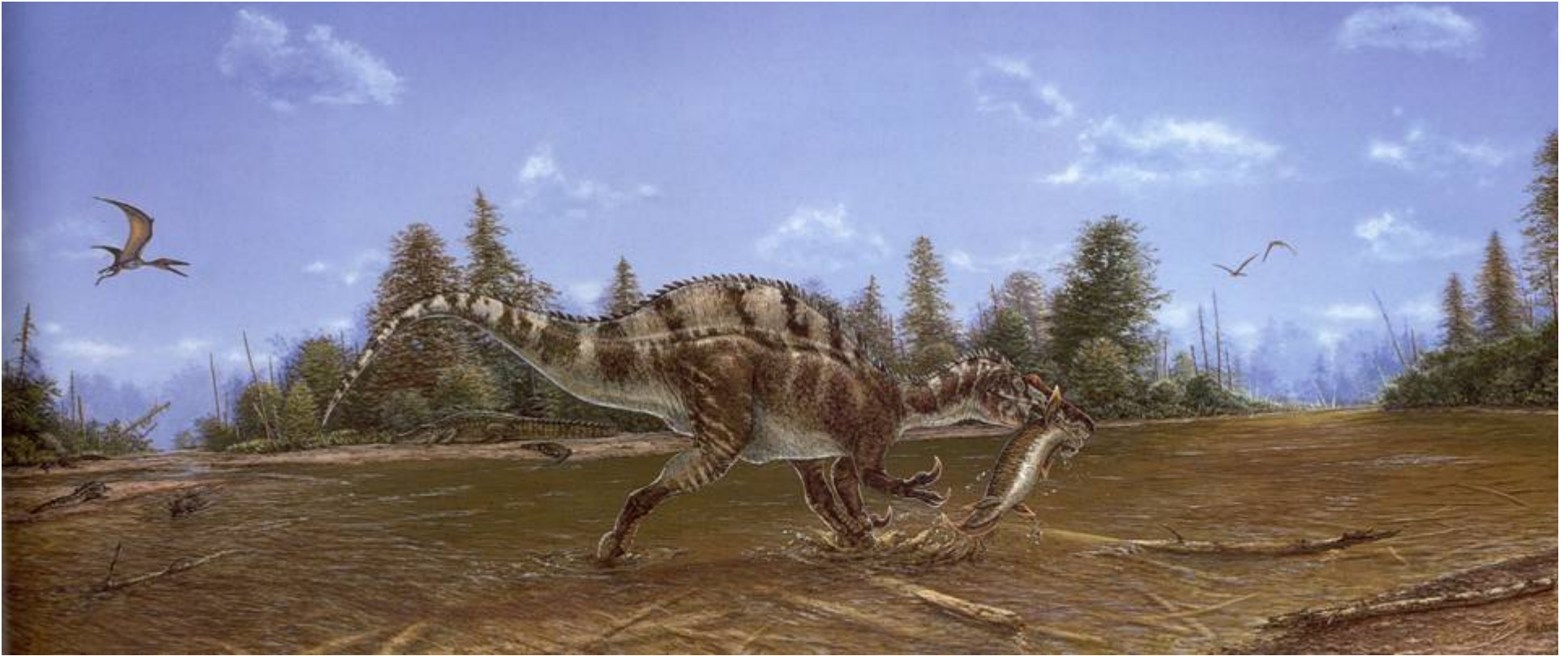
Group named for ***Spinosaurus*** – which is actually not very well known.

(The animal in Jurassic Park III was called a “***Spinosaurus***” but it was actually based on an animal called ***Suchomimus***.)

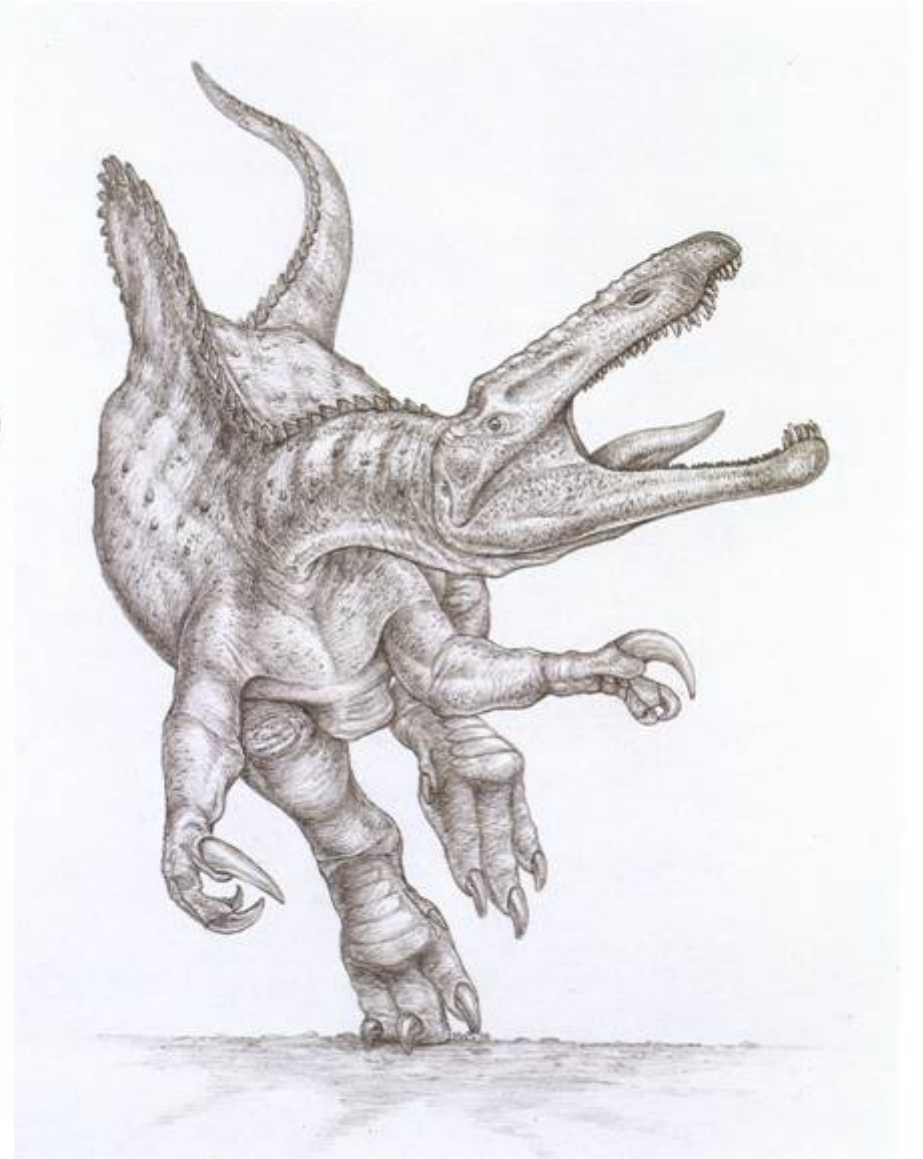


Suchomimus
Gavin Rymill 2001

Suchomimus

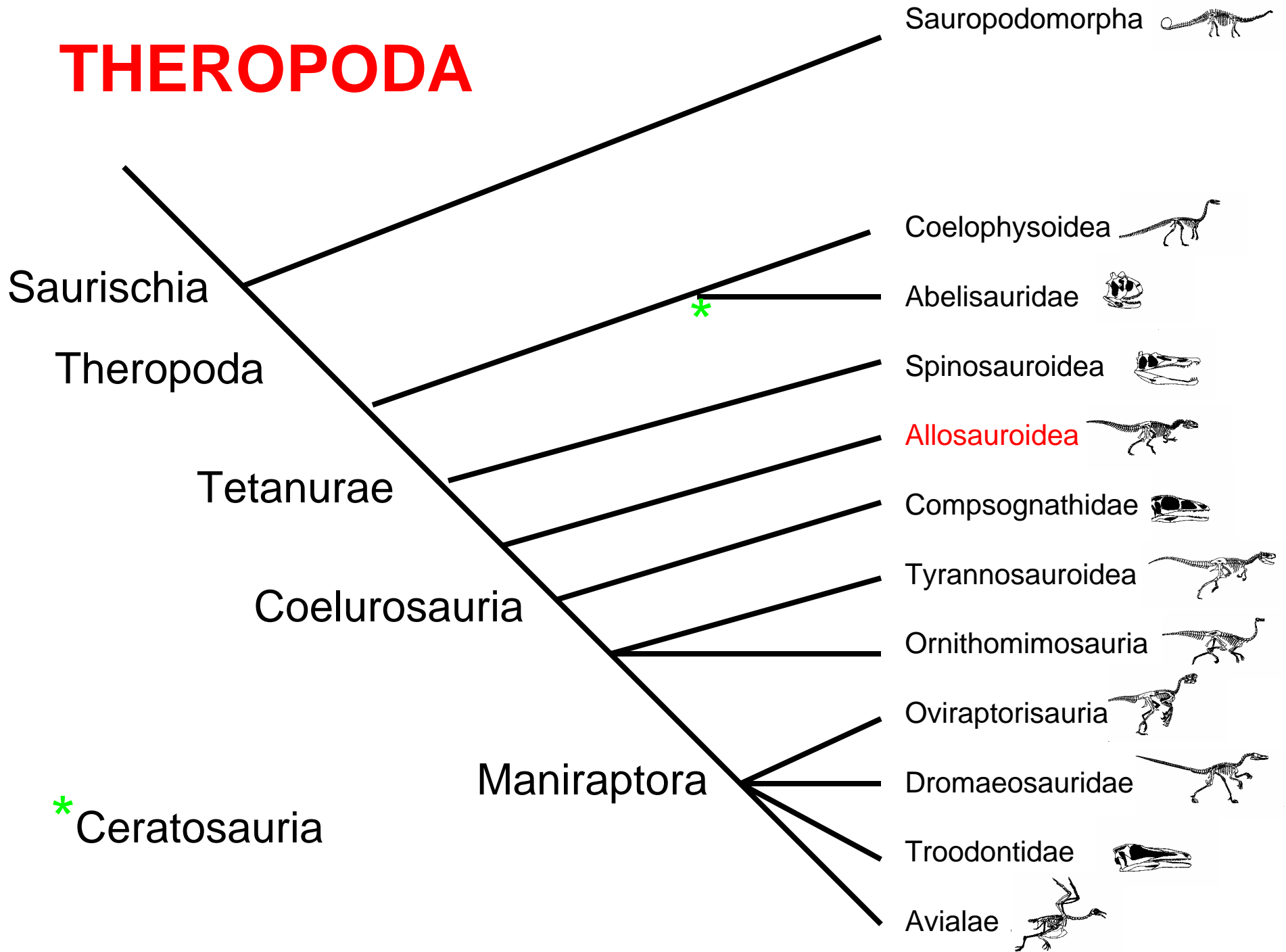


Suchomimus had an elongate skull, probably indicative of being a fish eater (piscivore). (Not a big nasty mammal eater as portrayed in Jurassic Park III.)



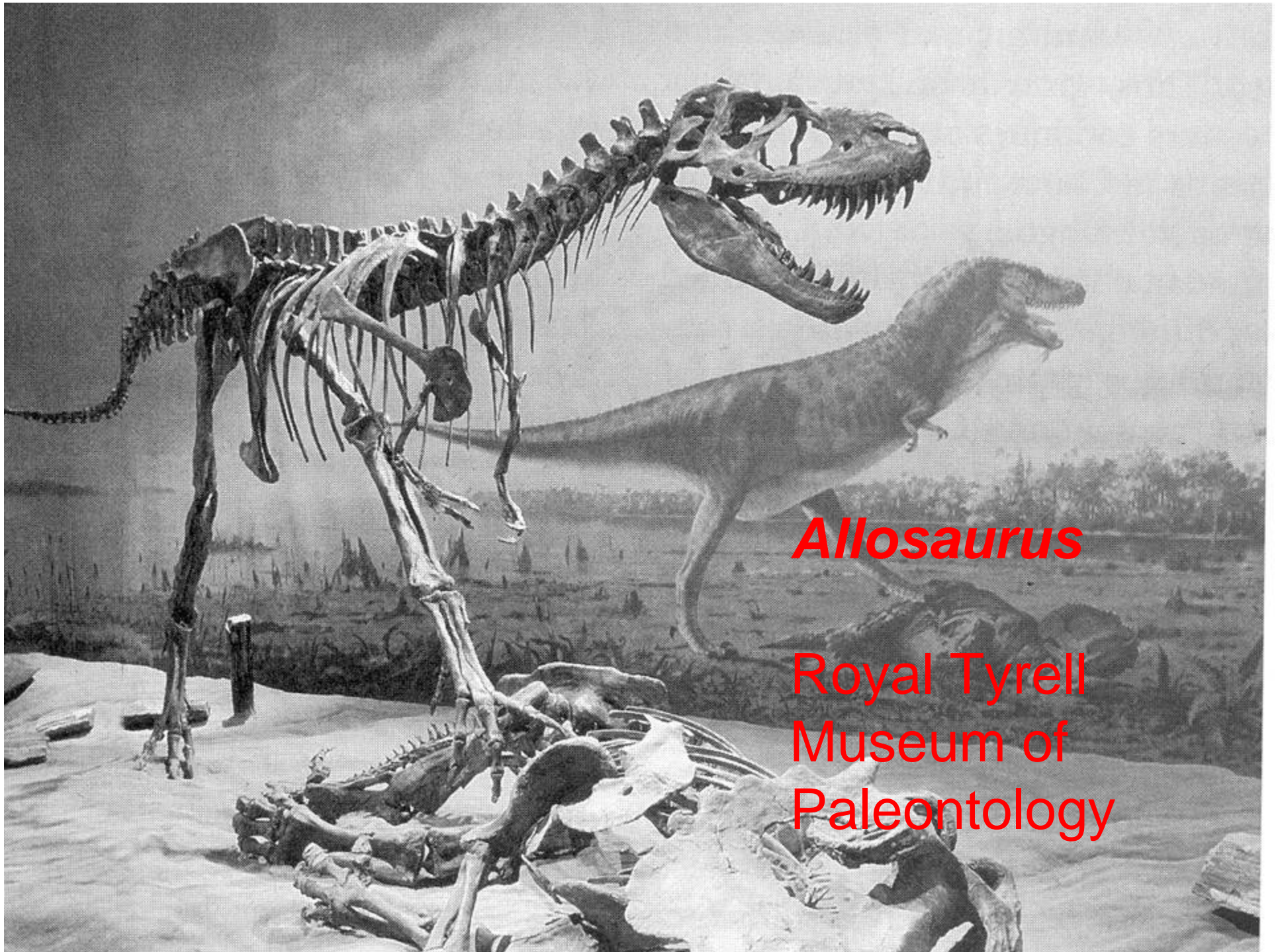
Suchomimus

THEROPODA



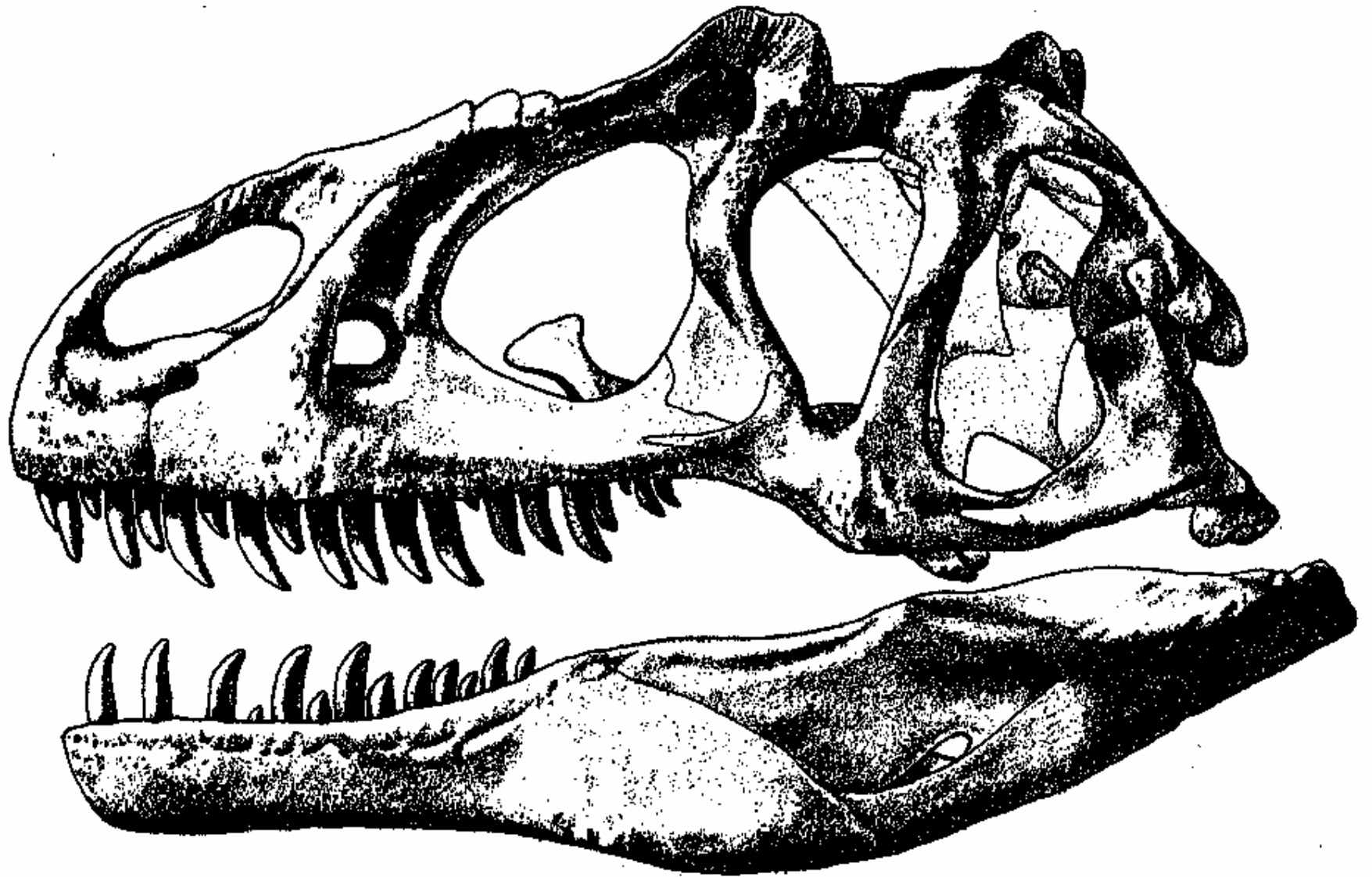
TETANURAE: ALLOSAUROIDEA

- Nasal bone makes up part of the antorbital fenestra.
- Small diameter external mandibular fenestra.
- The quadrate bone reaching up to the middle level of the orbit.

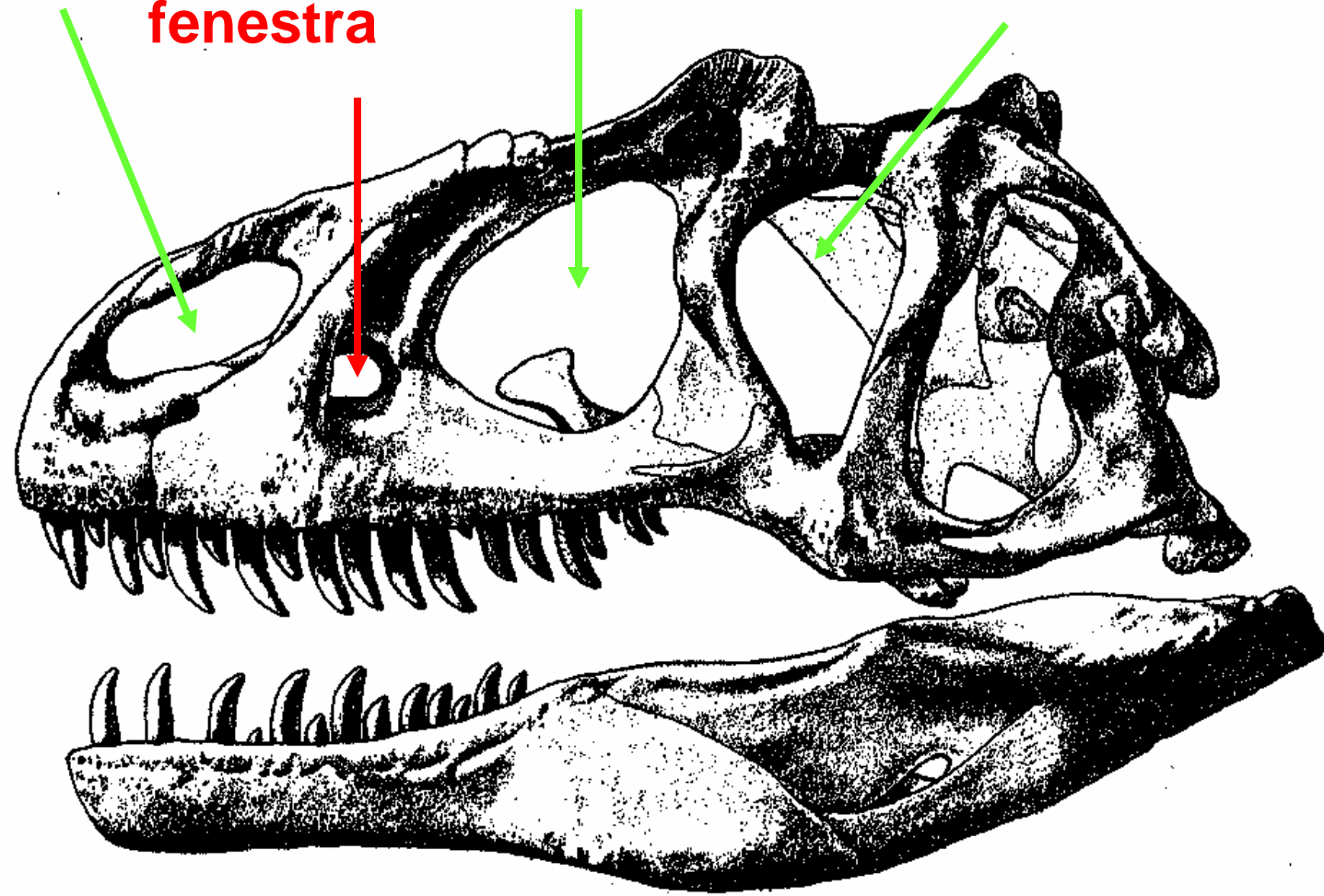


Allosaurus

**Royal Tyrell
Museum of
Paleontology**



Naris **Additional fenestra** Antorbital fenestra Orbit



Allosaurus

ALLOSAUROIDEA:

Includes three major groups:

Family	Major Representative
Allosauridae	<i>Allosaurus</i> <i>Afrovenator</i>
Sinraptoridae	<i>Sinraptor</i>
Carcarodontosauridae	<i>Carcarodontosaurus</i> <i>Giganotosaurus</i>

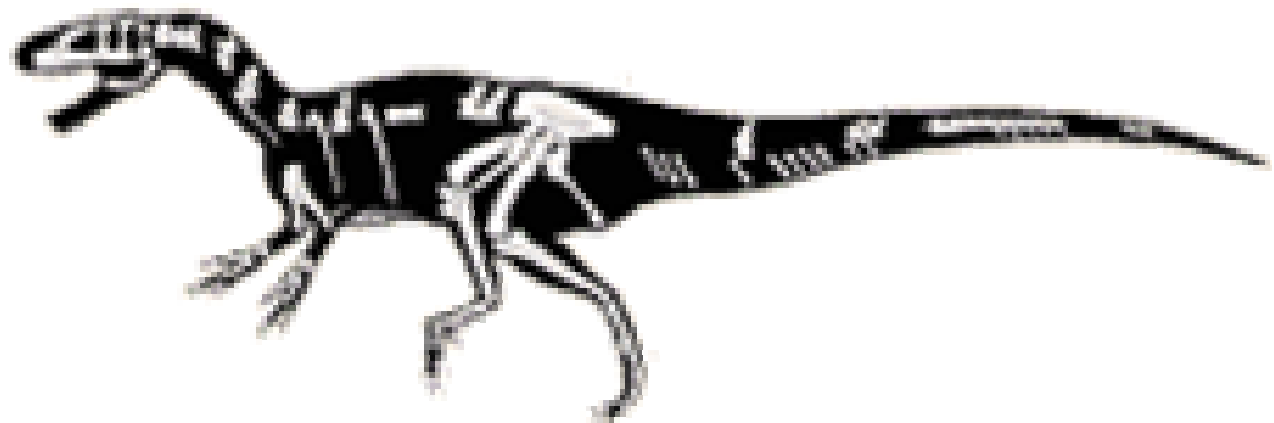
Allosaurus





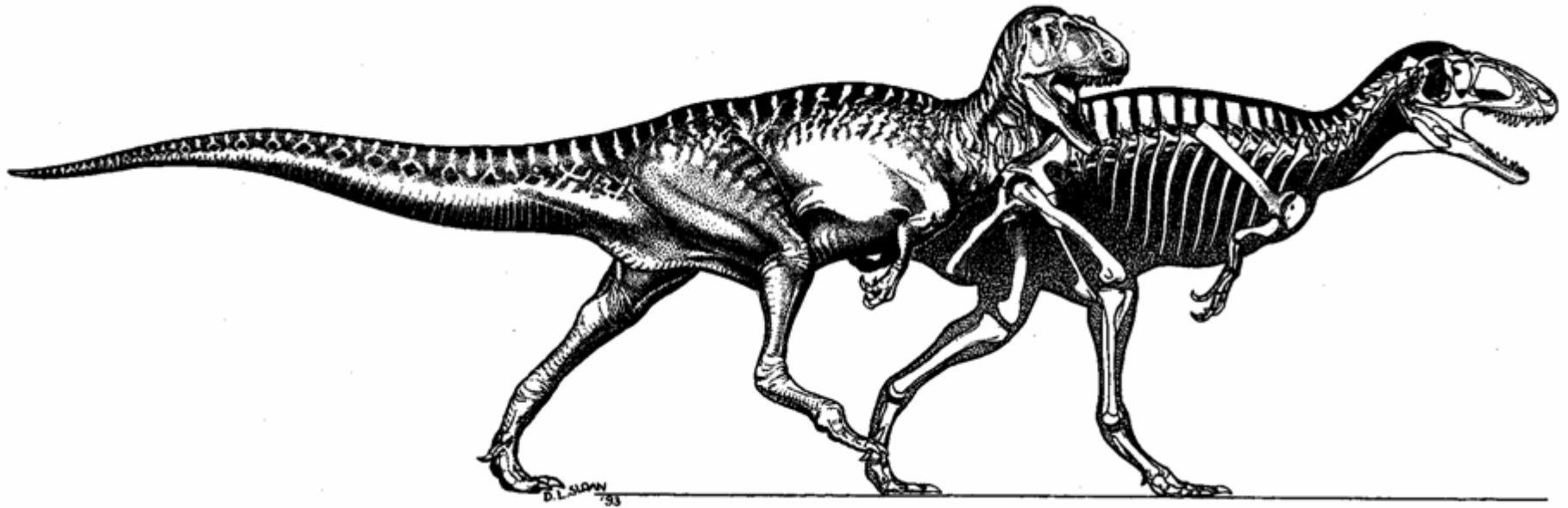
Afrovenator

is actually known from only a very partial skeleton.

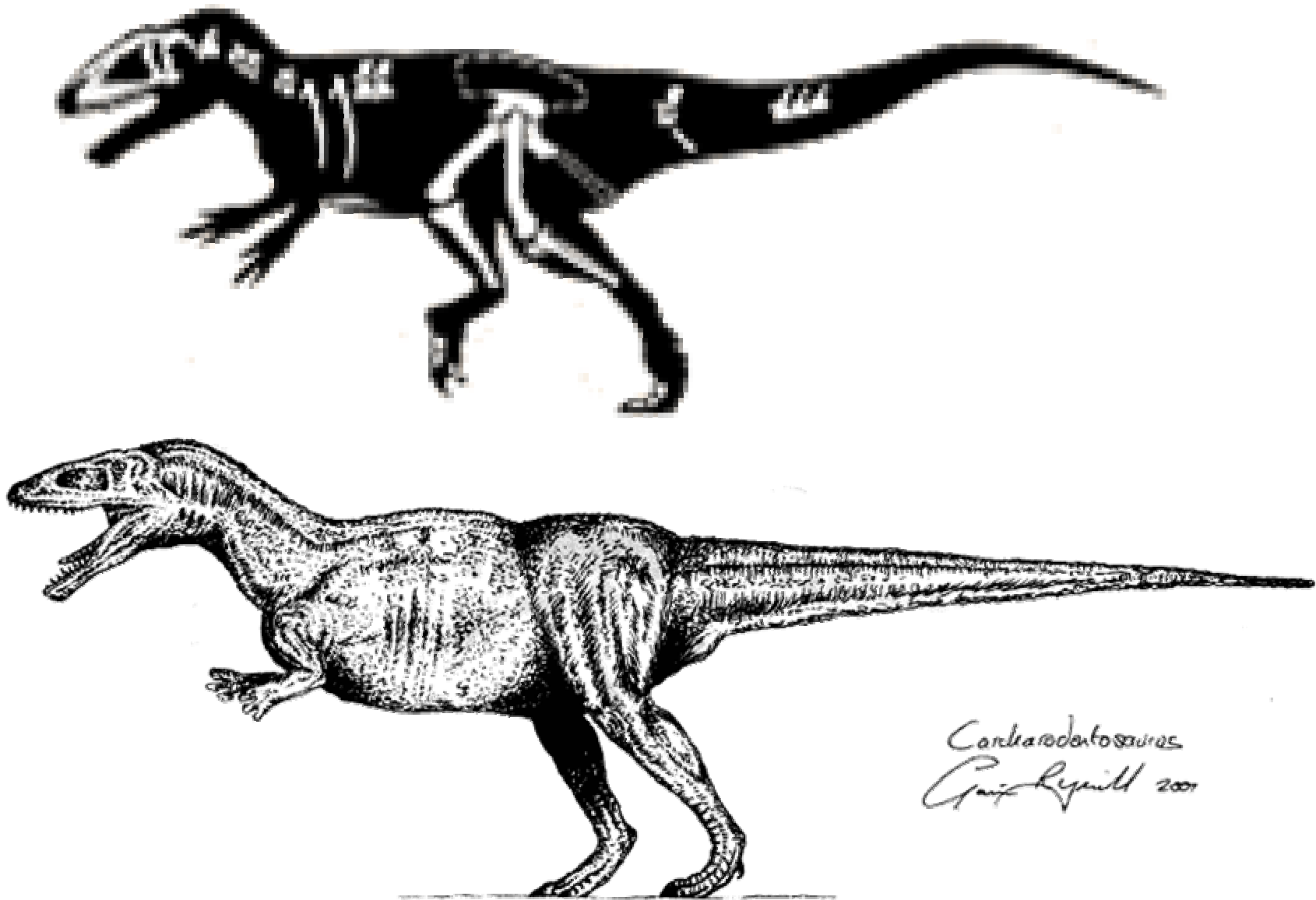




Afrovenator: African allosaur from subsaharan Africa.



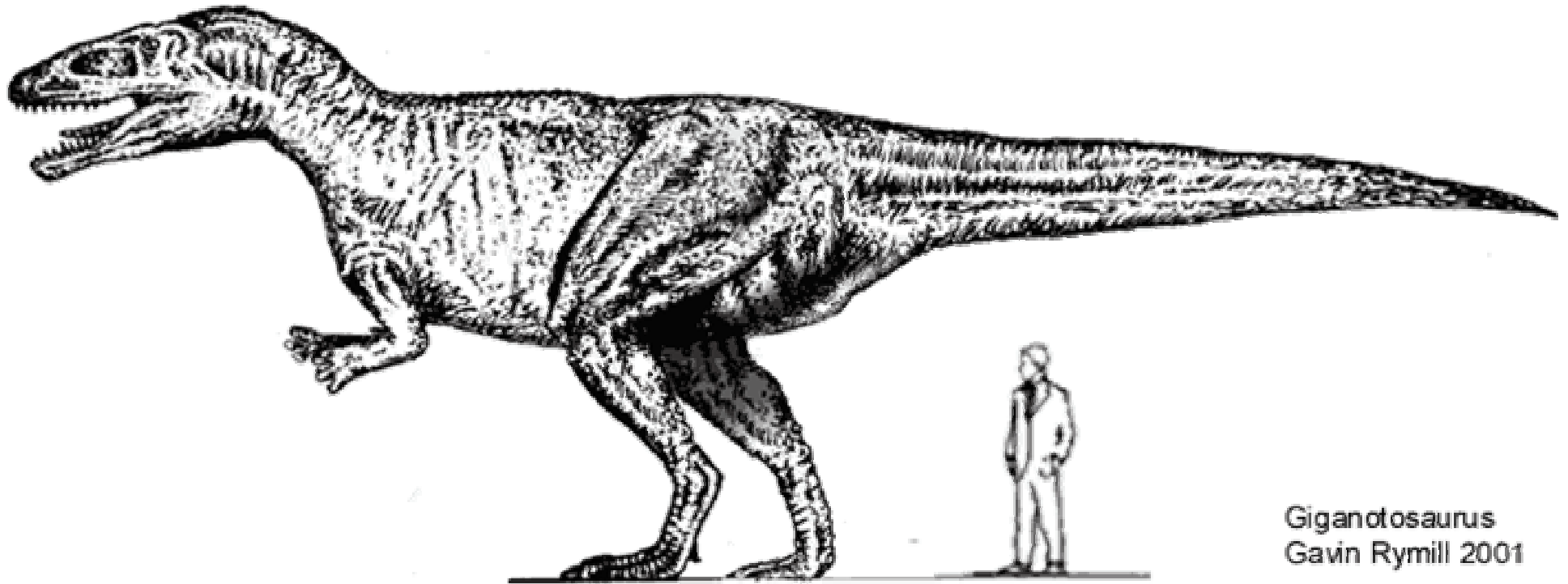
Sinraptor. Chinese allosaurid



Charcarodontosauridae: **Charcarodontosaurus**
Also known from incomplete material.



Charcarodontosauridae: ***Charcarodontosaurus***
Larger (longer) than *T. rex*, but more lightly built.



Charcarodontosauridae: ***Giganotosaurus***



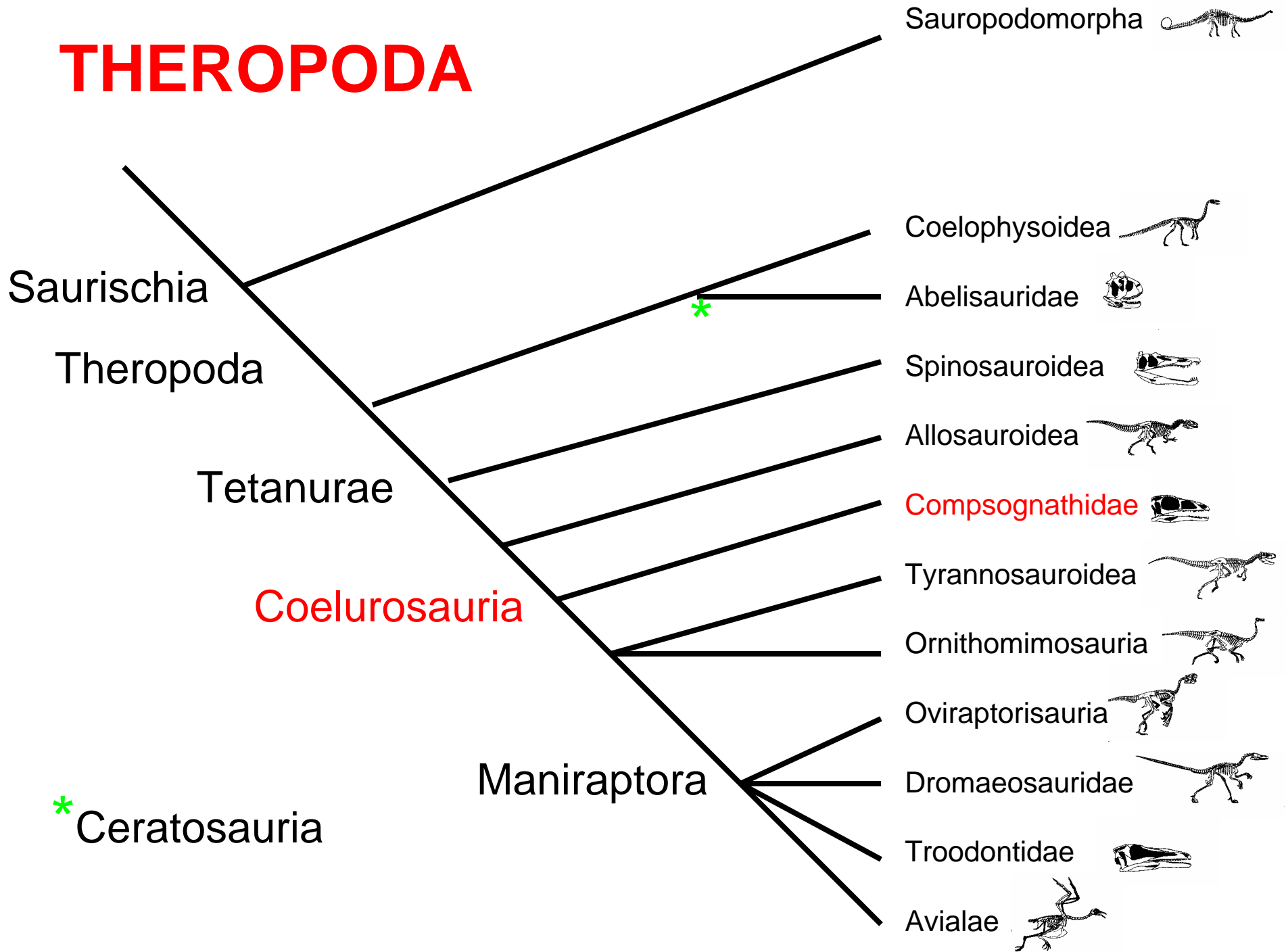
Charcarodontosauridae: ***Gigantotyrannus***

Also larger but less robust than *T. rex*.



Charcarodontosauridae: ***Giganotosaurus***

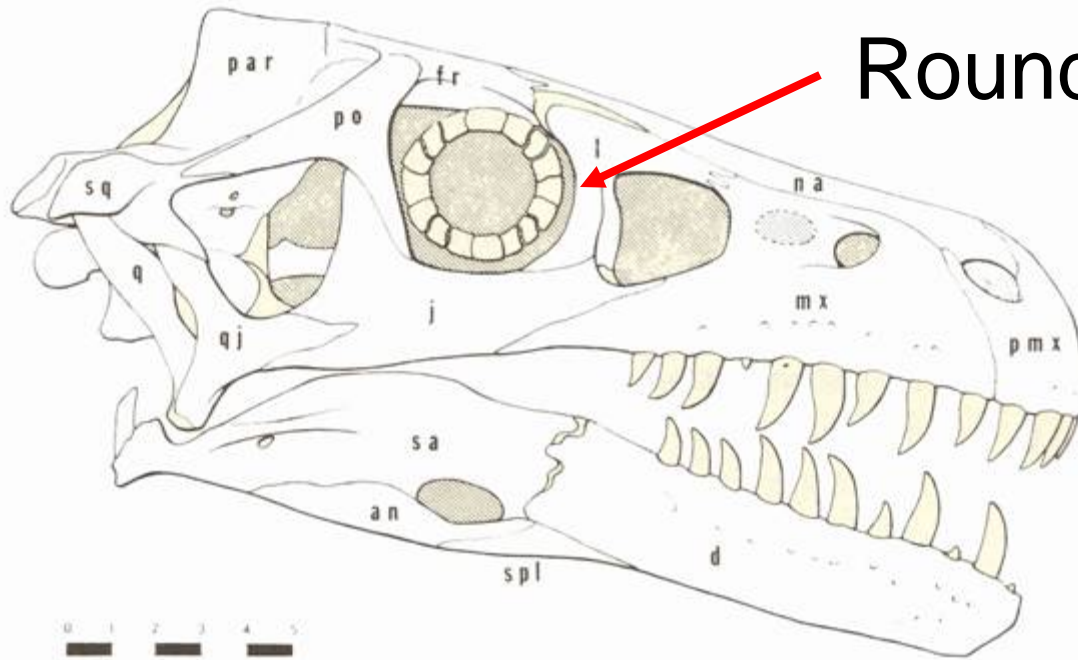
THEROPODA



COELOSAURIA

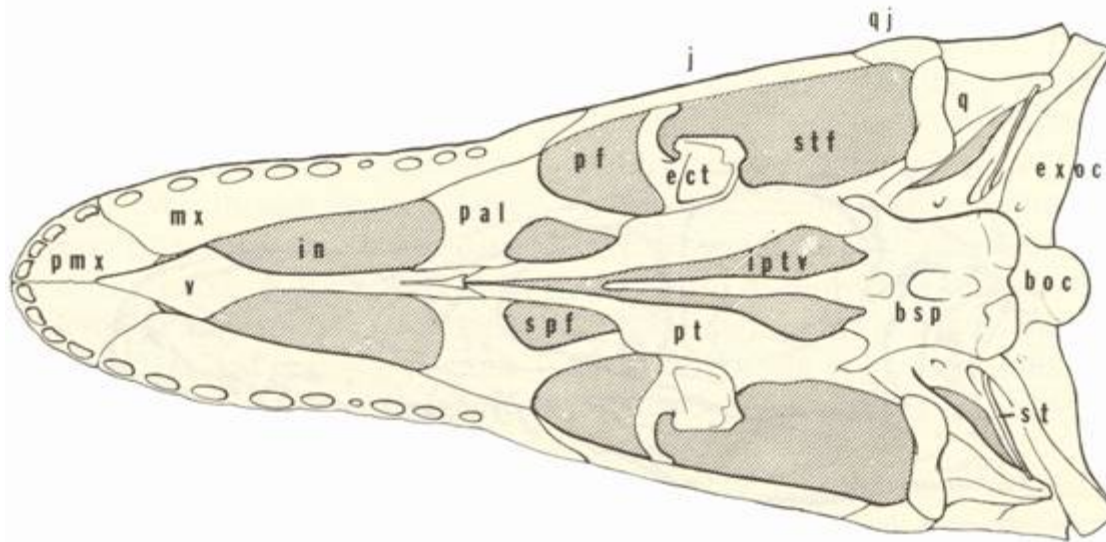
- Includes a number of feathered forms/groups.
- Group was far more bird-like than more basal theropods.

- A large, circular orbit.
- Semilunate carpal – a distinctive, half-moon shaped bone in the wrist. This was key in the potential movements of the hands.



Rounded orbit

Dromaeosaurus
– an advanced
coelurosaur



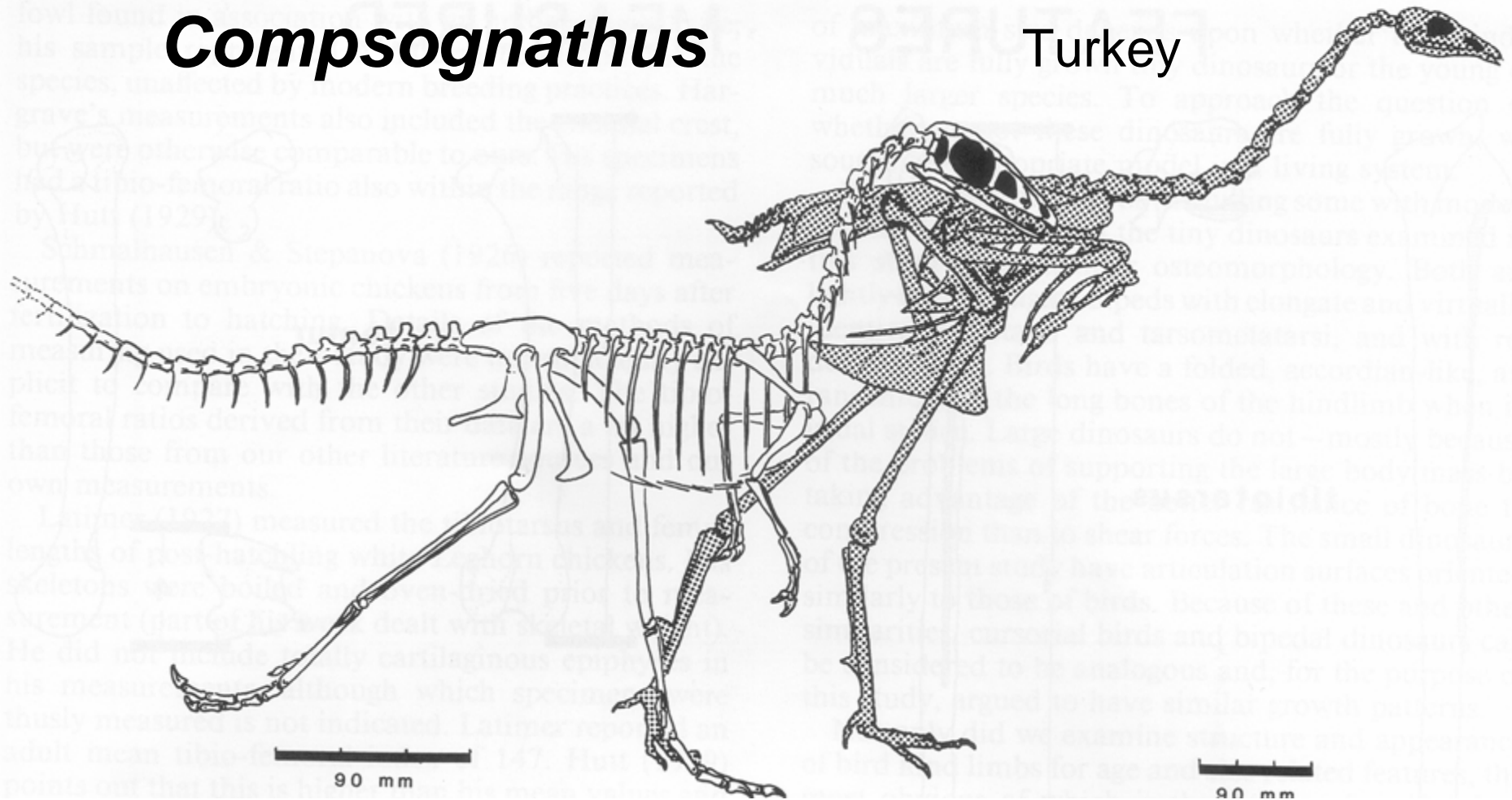
COELOSAURIA: COMPSOGNATHIDAE

- The most primitive members of the Coelurosauria.
- Small, pronograde, bipedal, omnivorous (possibly insectivorous) forms.

Best known examples: ***Compsognathus***,
Ornitholestes, ***Sinosauroptryx***.

Compsognathus

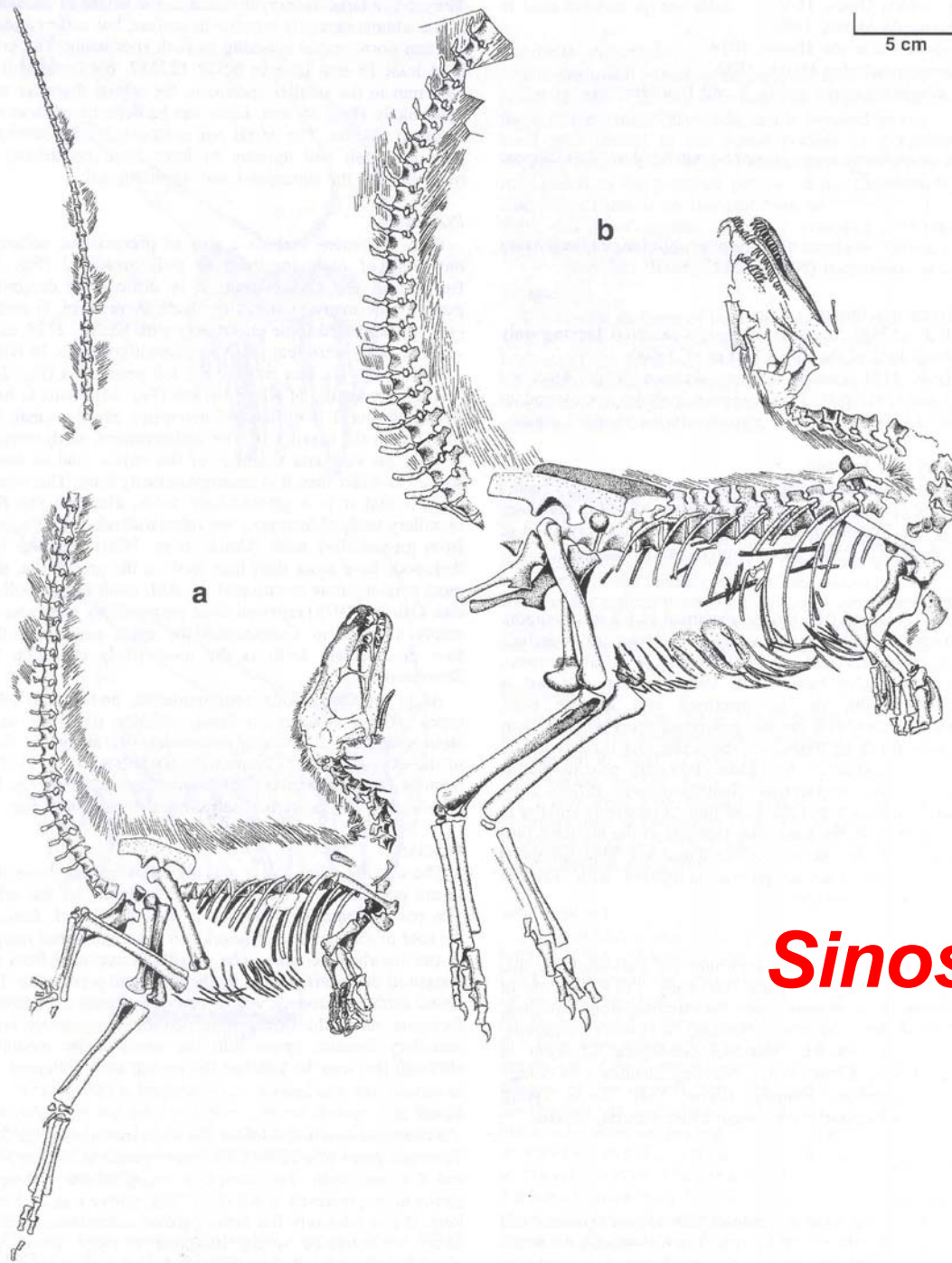
Turkey



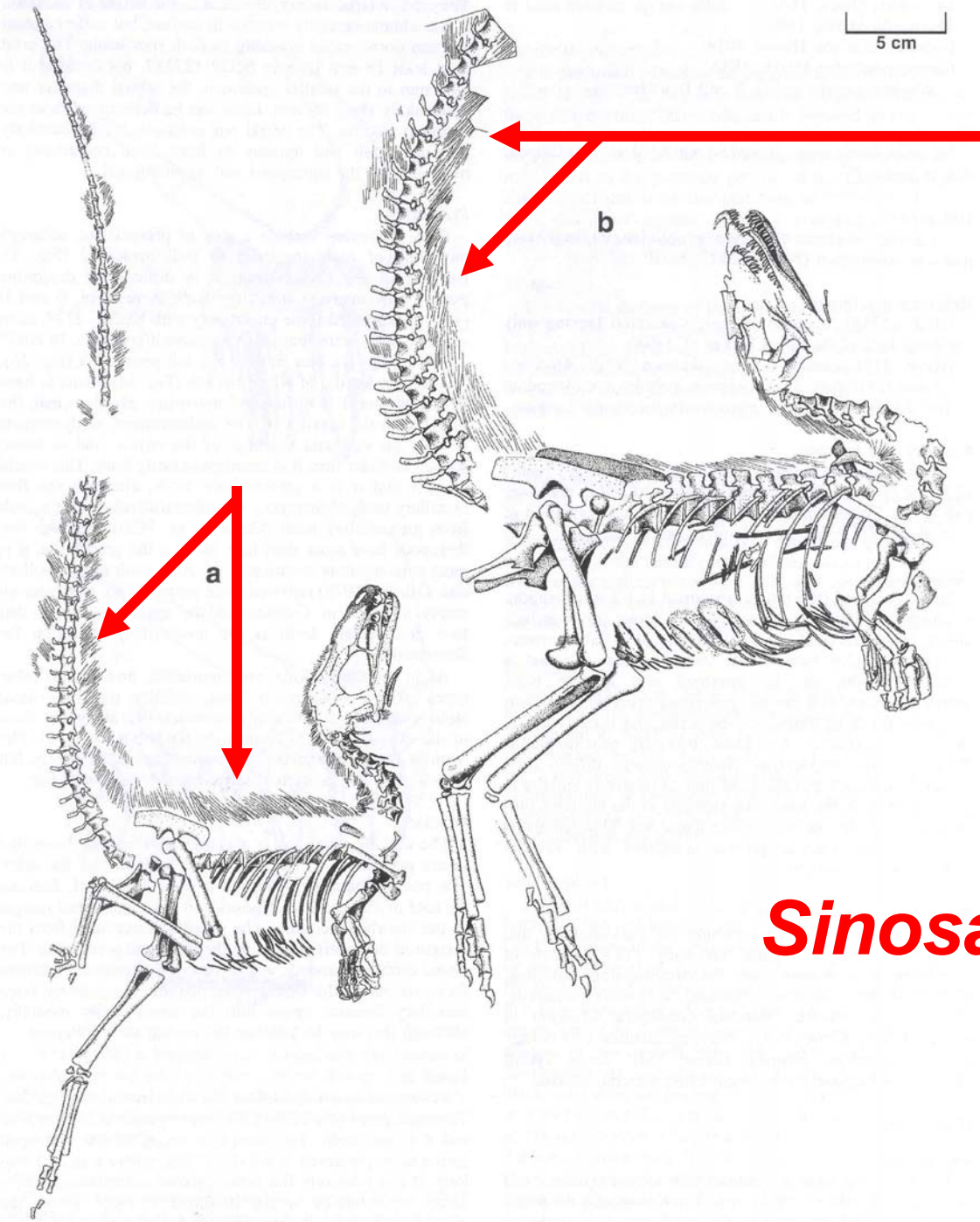
Small, pronograde, bipedal, omnivorous (possibly insectivorous) forms.



Compsognathus



Sinosauropteryx



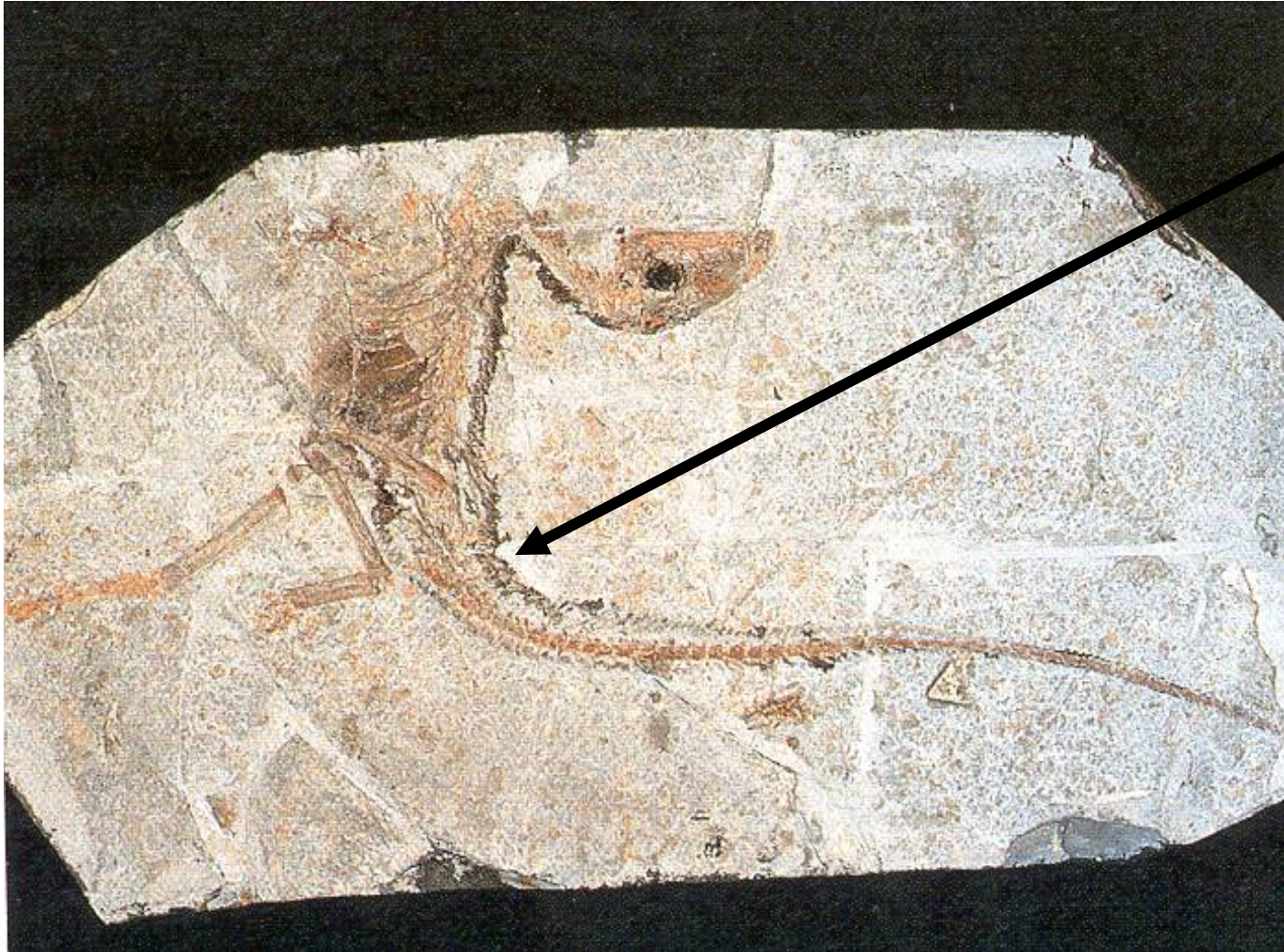
Impressions of
feathers

Sinosauropteryx

Sinosauropteryx



Sinosauropteryx



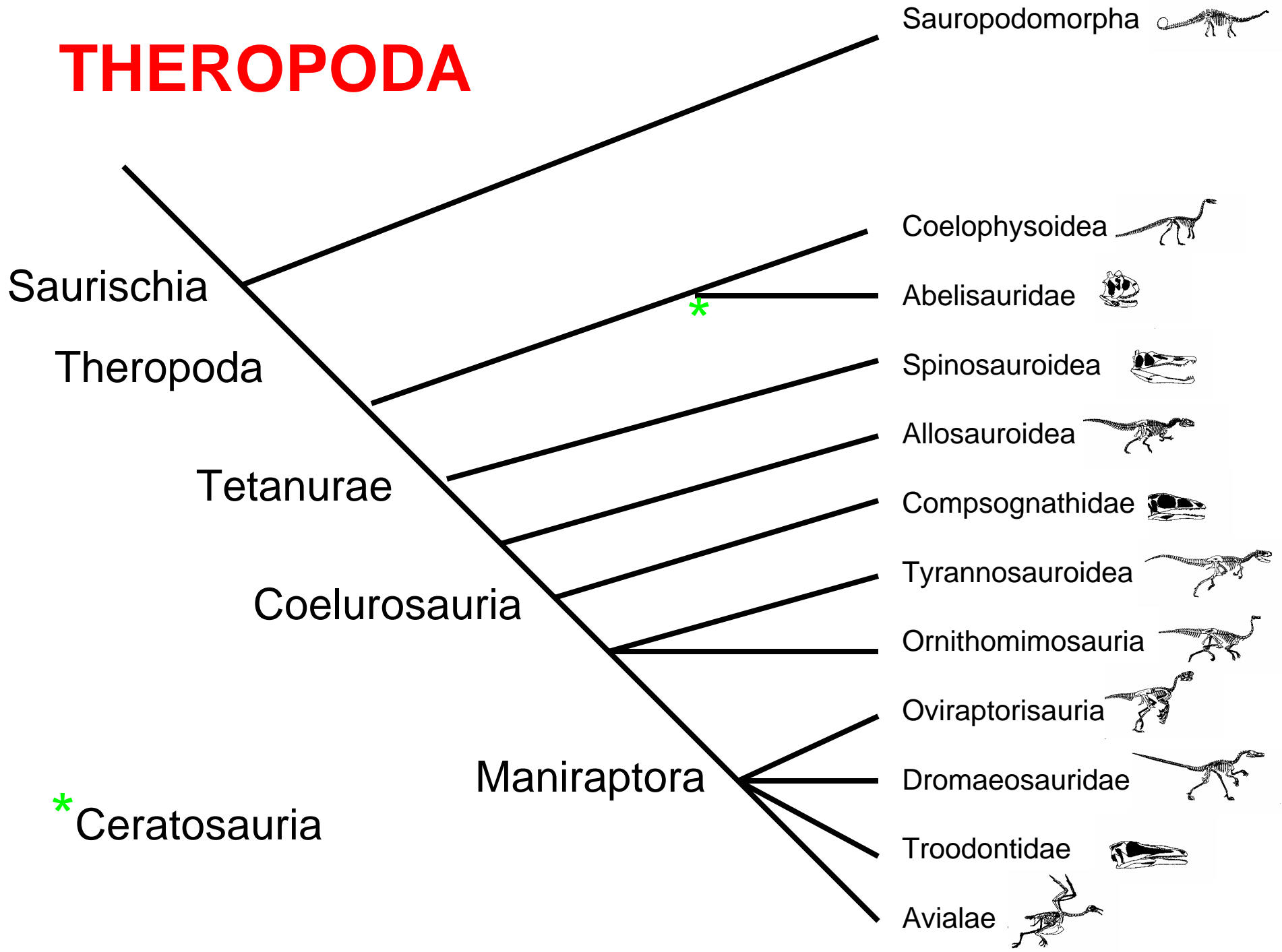
Detail - “Downey” Filaments of *Sinosauropteryx*





Sinosauropteryx prima – a small feathered coelurosaur from Liaoning, northeastern China

THEROPODA

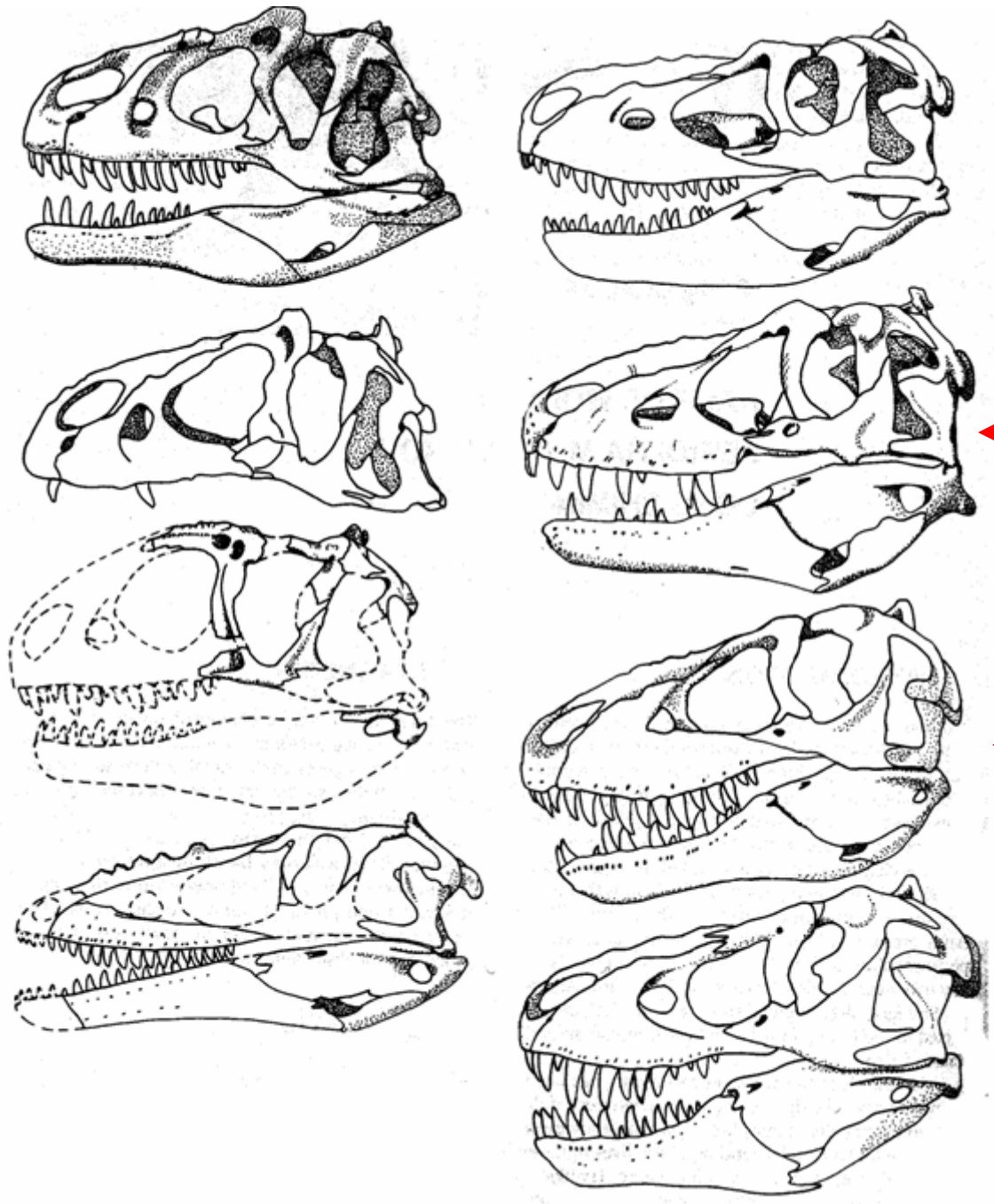


COELOSAURIA: TYRANNOSAUROIDEA

- Extremely large
- Large teeth – “D-shaped” in section.
- Only two fingers; highly reduced forelimb (including pectoral girdle).
- Well developed pubic boot.
- With Ornithomimids, shares: Middle metatarsal narrow and wedge-shaped proximally

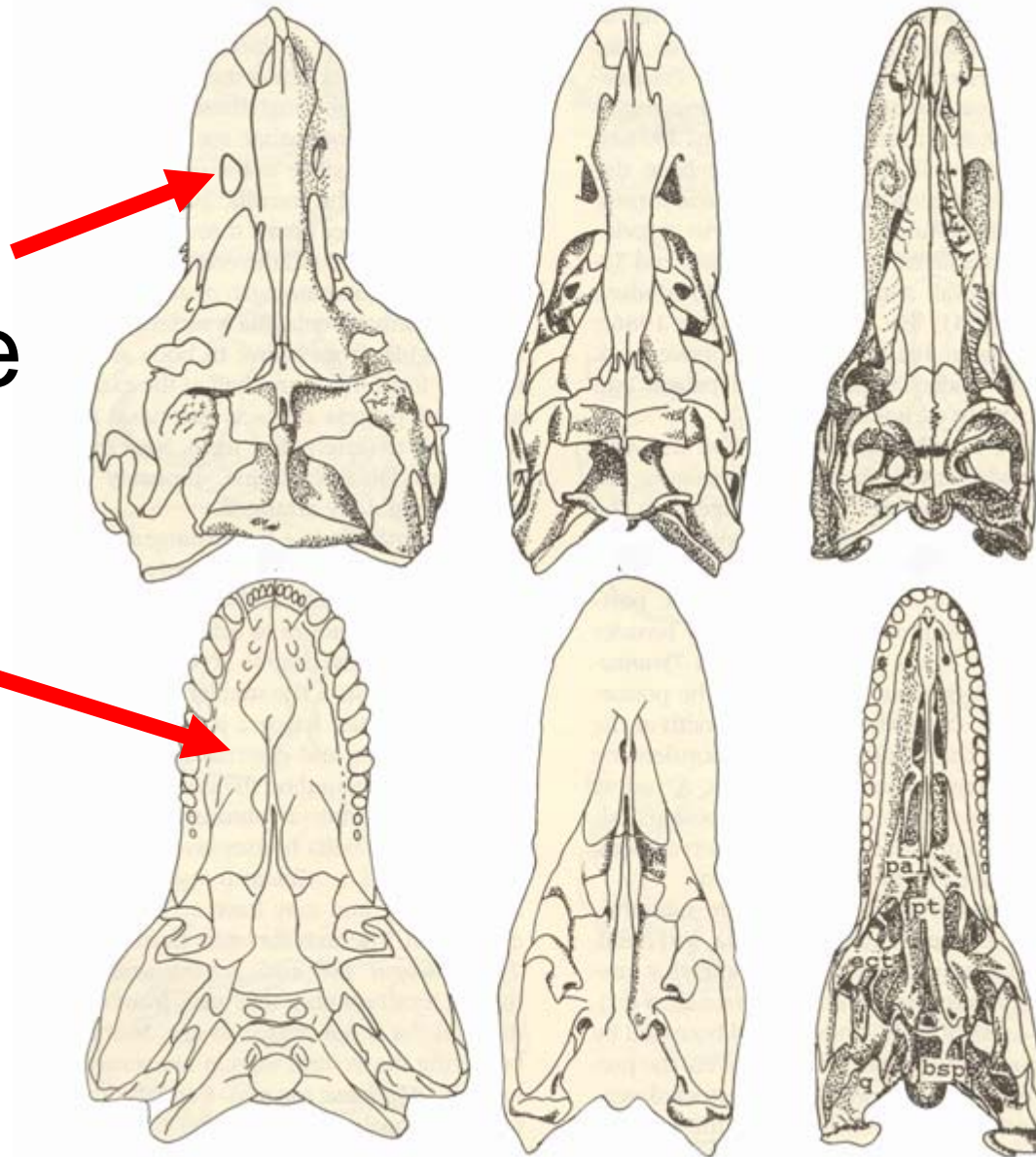
THE FAMOUS TYRANNOSAURS

<i>Tyrannosaurus</i>	=	<i>Tyrannosaurus</i>
<i>Nanotyrannus</i>	=	<i>Tyrannosaurus</i> (juvenile)
<i>Tarbosaurus</i>	=	<i>Tyrannosaurus</i> ?
<i>Albertosaurus</i>	=	<i>Albertosaurus</i>
<i>Gorgosaurus</i>	=	<i>Albertosaurus</i> ?
<i>Daspletosaurus</i>	=	<i>Daspletosaurus</i>
<i>Alioramus</i>	=	<i>Alioramus</i>
<i>Aublysodon</i>	=	<i>Aublysodon</i>
<i>Alectrosaurus</i>	=	<i>Alectrosaurus</i>



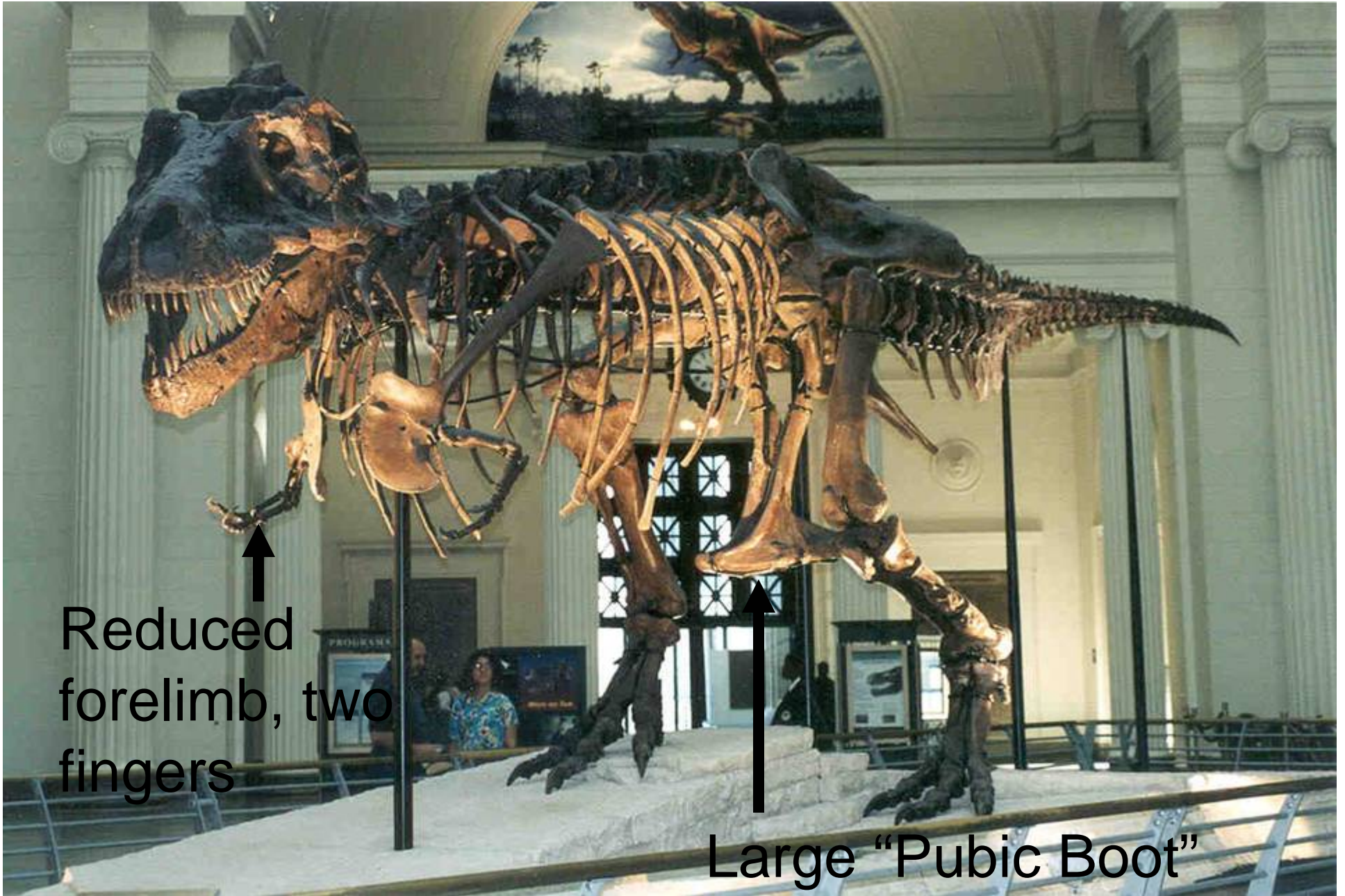
Tyrannosaur skulls are extremely robust compared to other theropods.

Note how wide across the palate the tyrannosaur skull is.



COELOSAURIA: TYRANNOSAUROIDEA

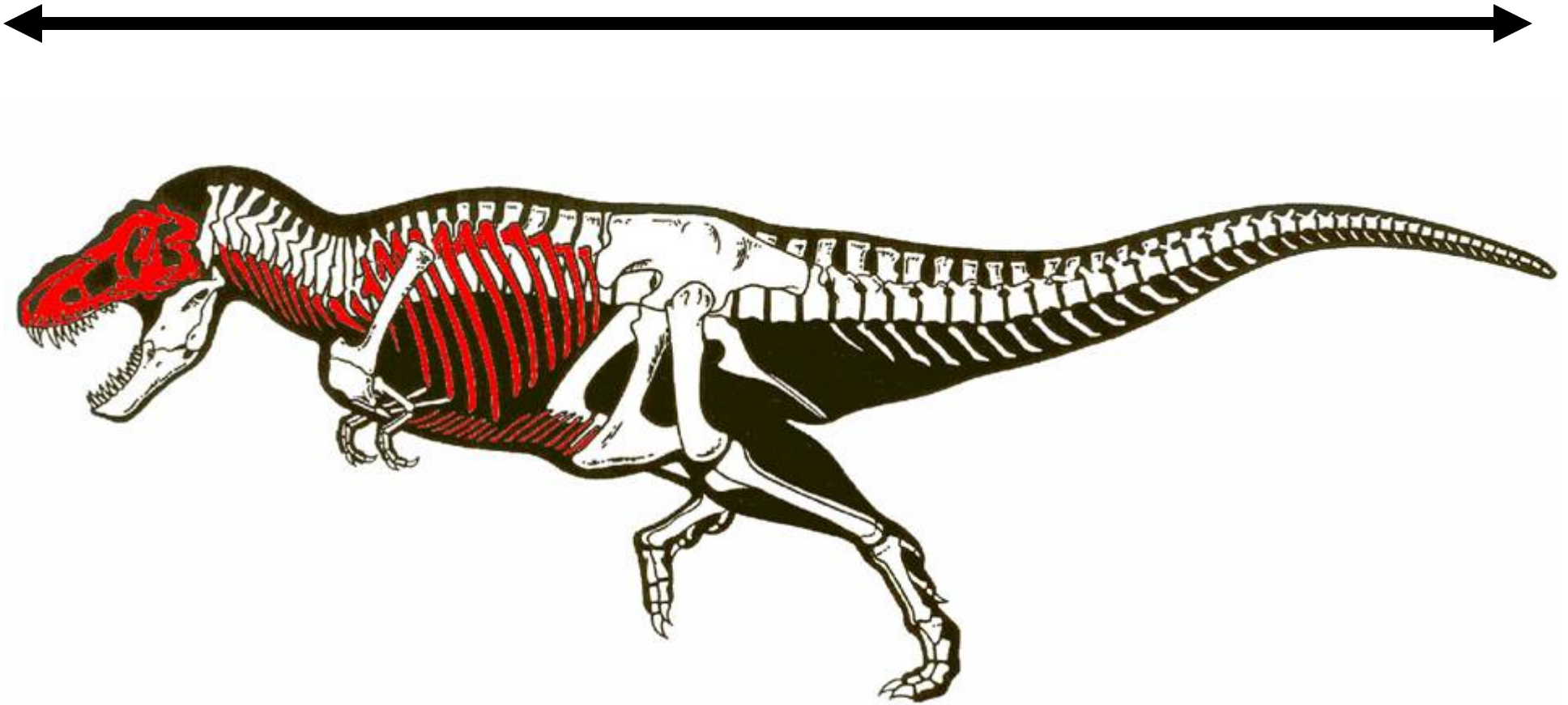
- Extremely large
- Large teeth – “D-shaped” in section.
- Only two fingers; highly reduced forelimb (including pectoral girdle).
- Well developed pubic boot.
- With Ornithomimids, shares: Middle metatarsal narrow and wedge-shaped proximally



↑
Reduced
forelimb, two
fingers

↑
Large "Pubic Boot"

~ 45 feet long



“Sue” – The most complete, most mature, largest *Tyrannosaurus rex* specimen ever found.

Gastralia (“belly ribs”) of Sue (*T. rex*)

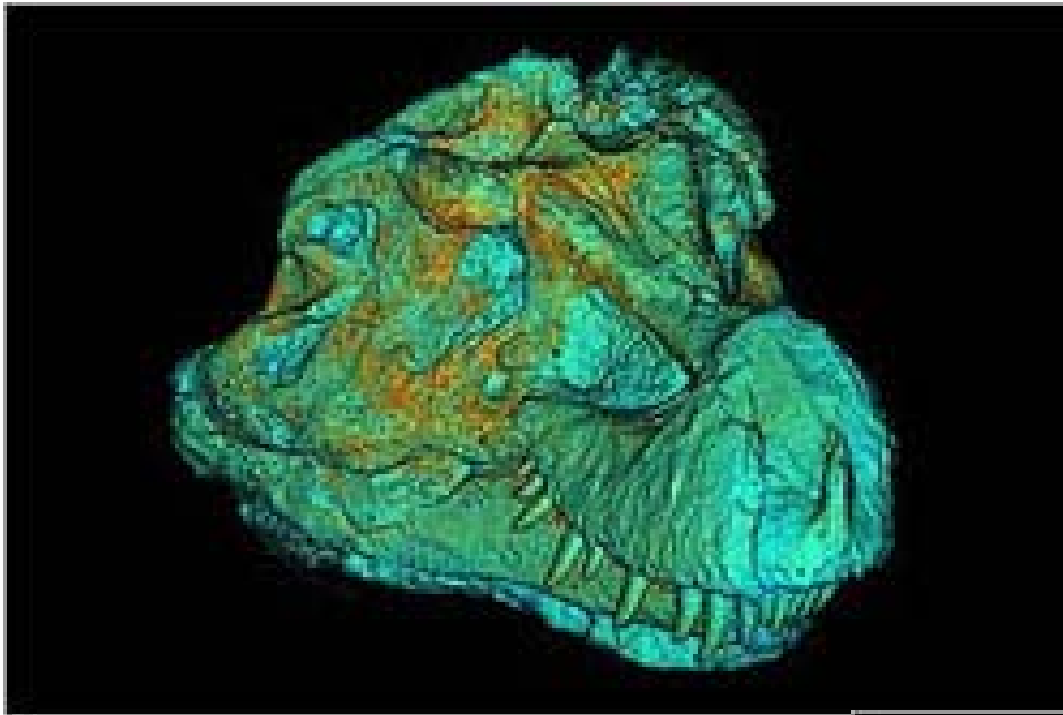




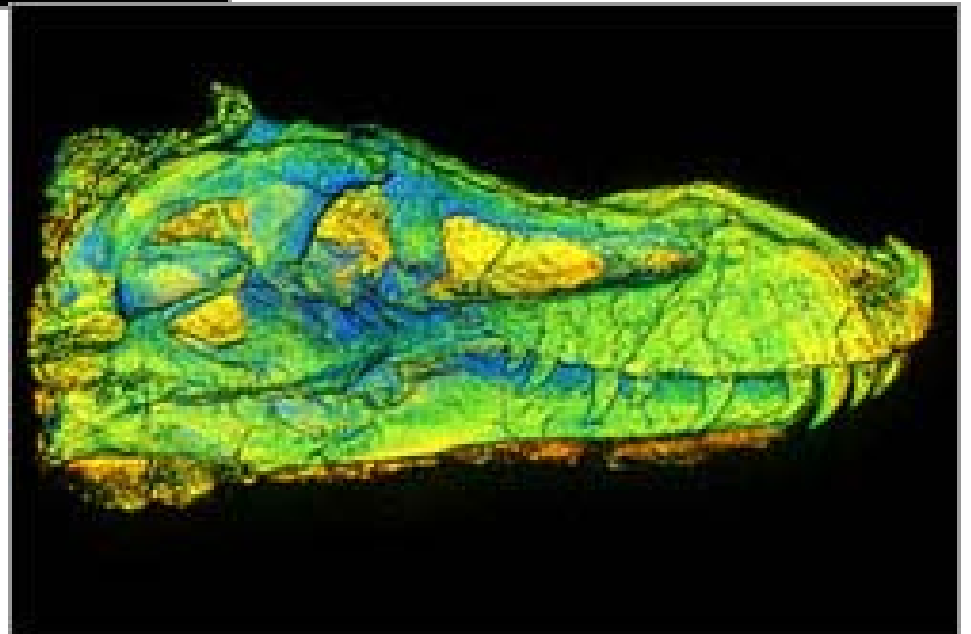








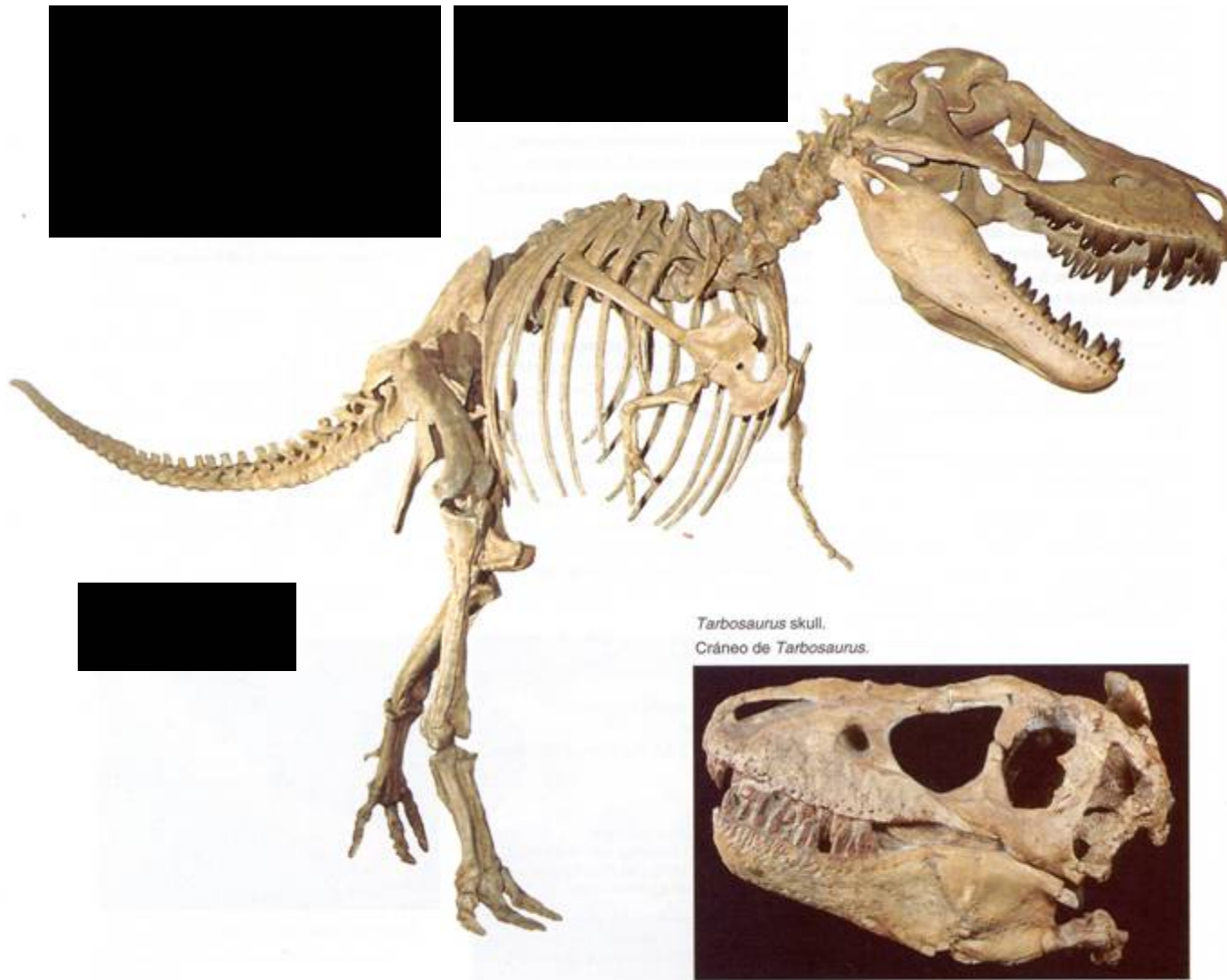
CT-scans of
Sue's skull.





“Nanotyrannus”

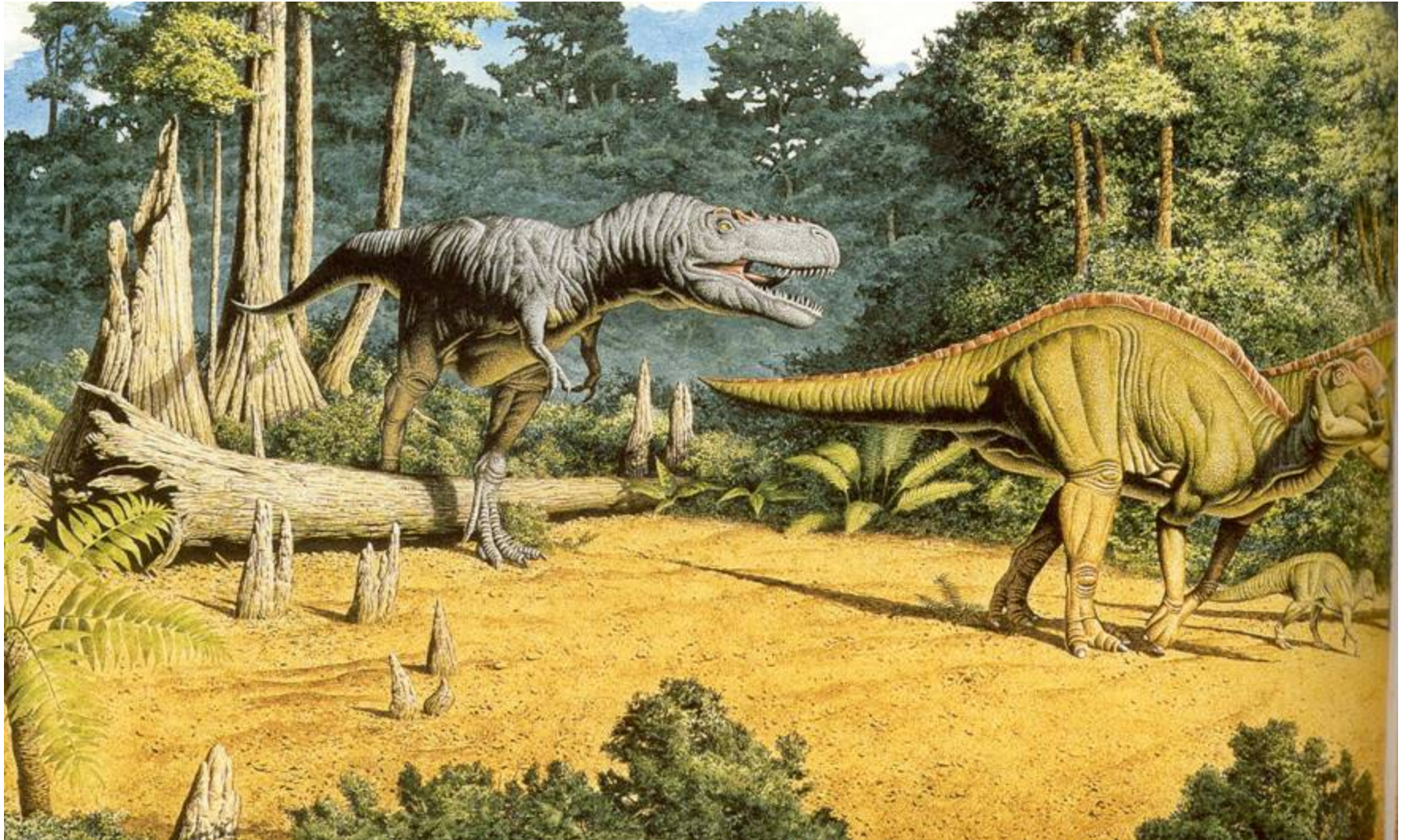
Actually a
juvenile
Tyrannosaurus



Tarbosaurus skull.
Crâneo de Tarbosaurus.

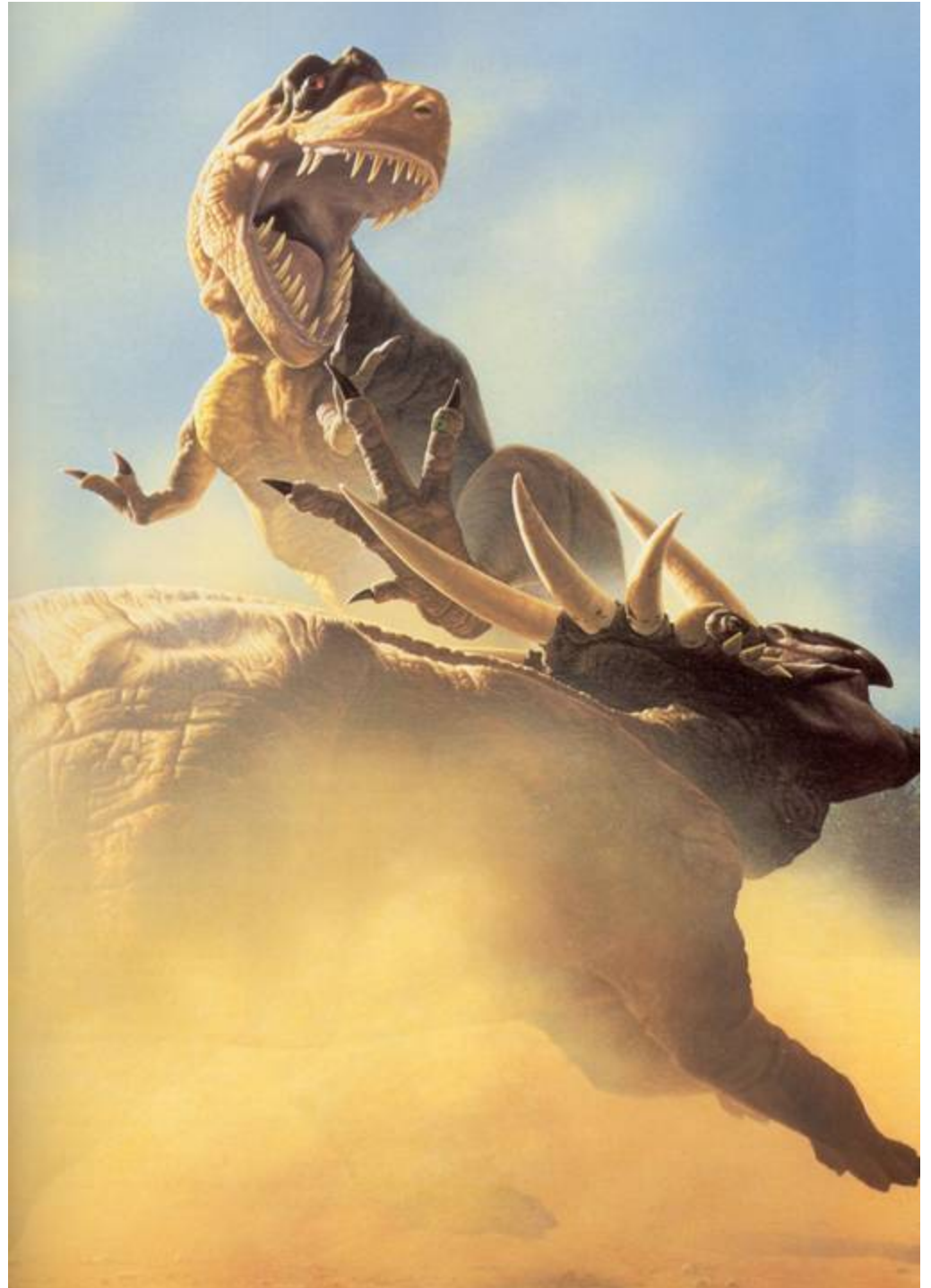
***Tarbosaurus
baatar***
(Asian form)

Considered by some to be ***Tyrannosaurus baatar***.



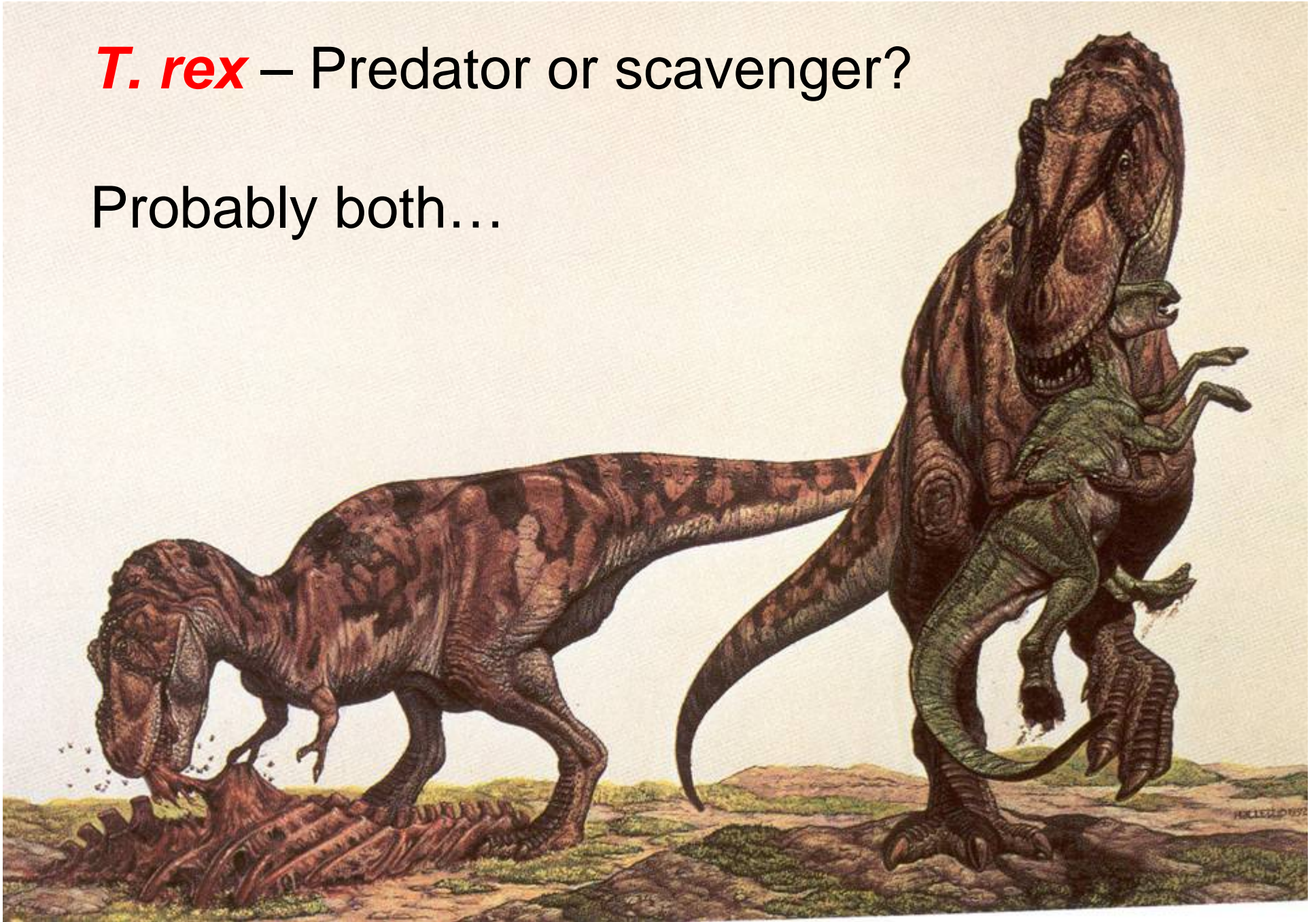
Gorgosaurus – thought by some to be ***Albertosaurus***,
a very close relative of *Tyrannosaurus*

Daspletosaurus



T. rex – Predator or scavenger?

Probably both...

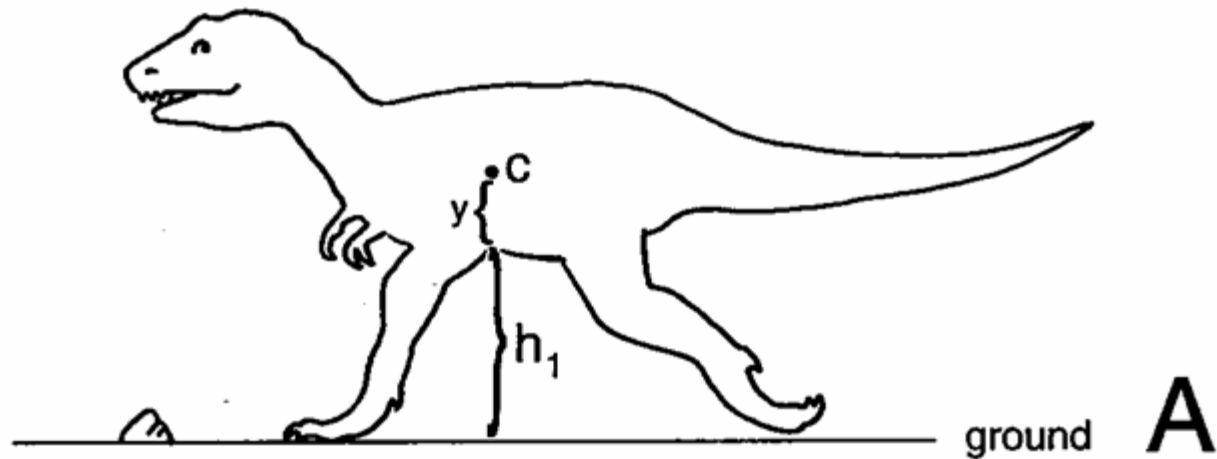




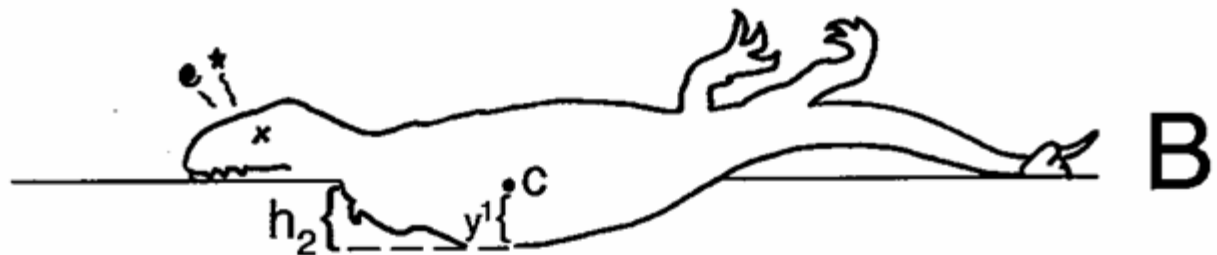
Copyright © Luis Rey 2002

How fast could *T. rex* really run?

Could it run 25 miles per hour?
40?



Taking animal mass and the strength of both bone and soft tissue into consideration, ***T. rex*** tissues and bones would shatter if moving much over ten miles an hour...

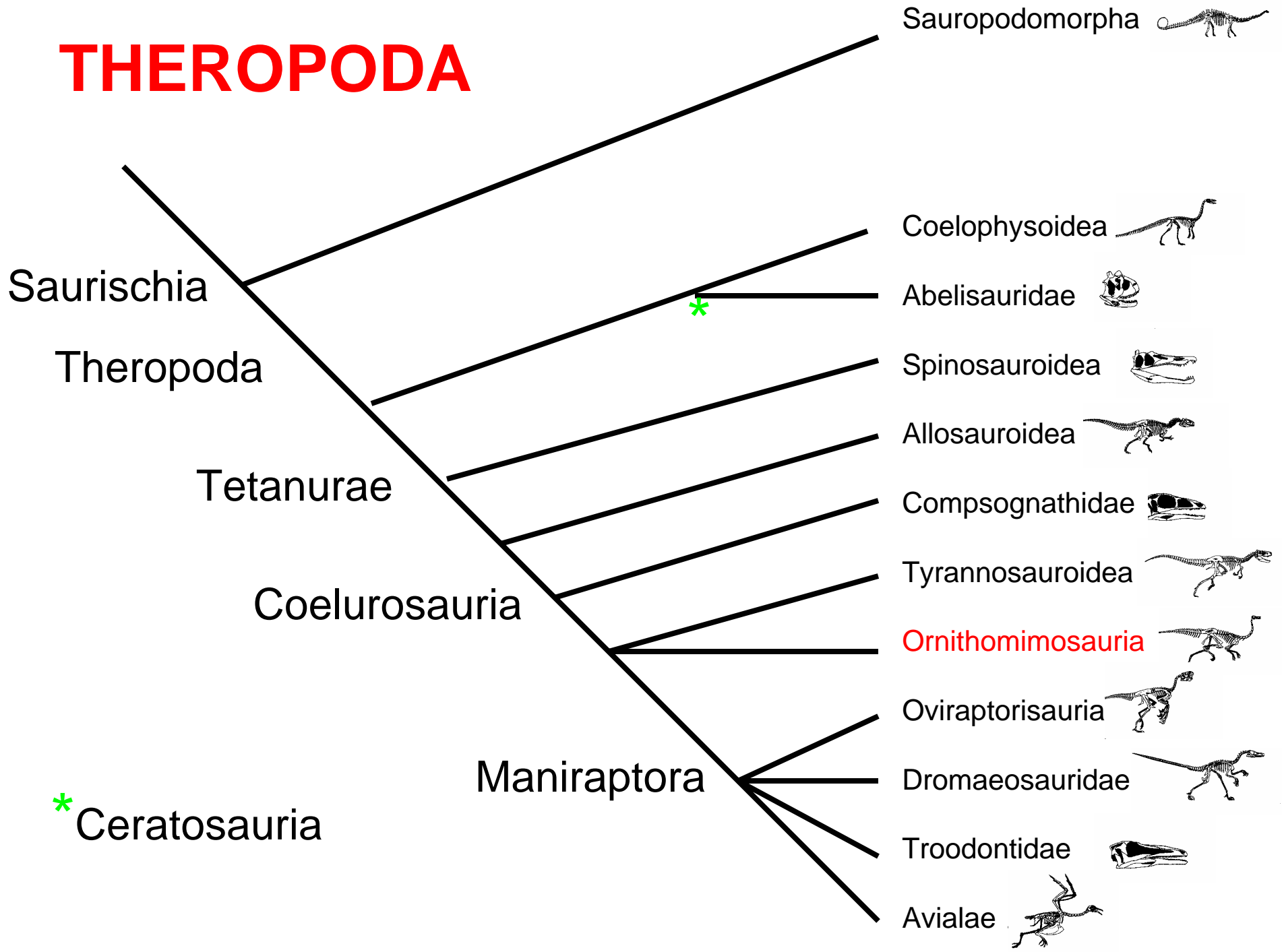


Simple model of the vertical force acting on an animal as it hits the ground at the end of a fall. The model can be applied either to the torso of the animal or to its head.

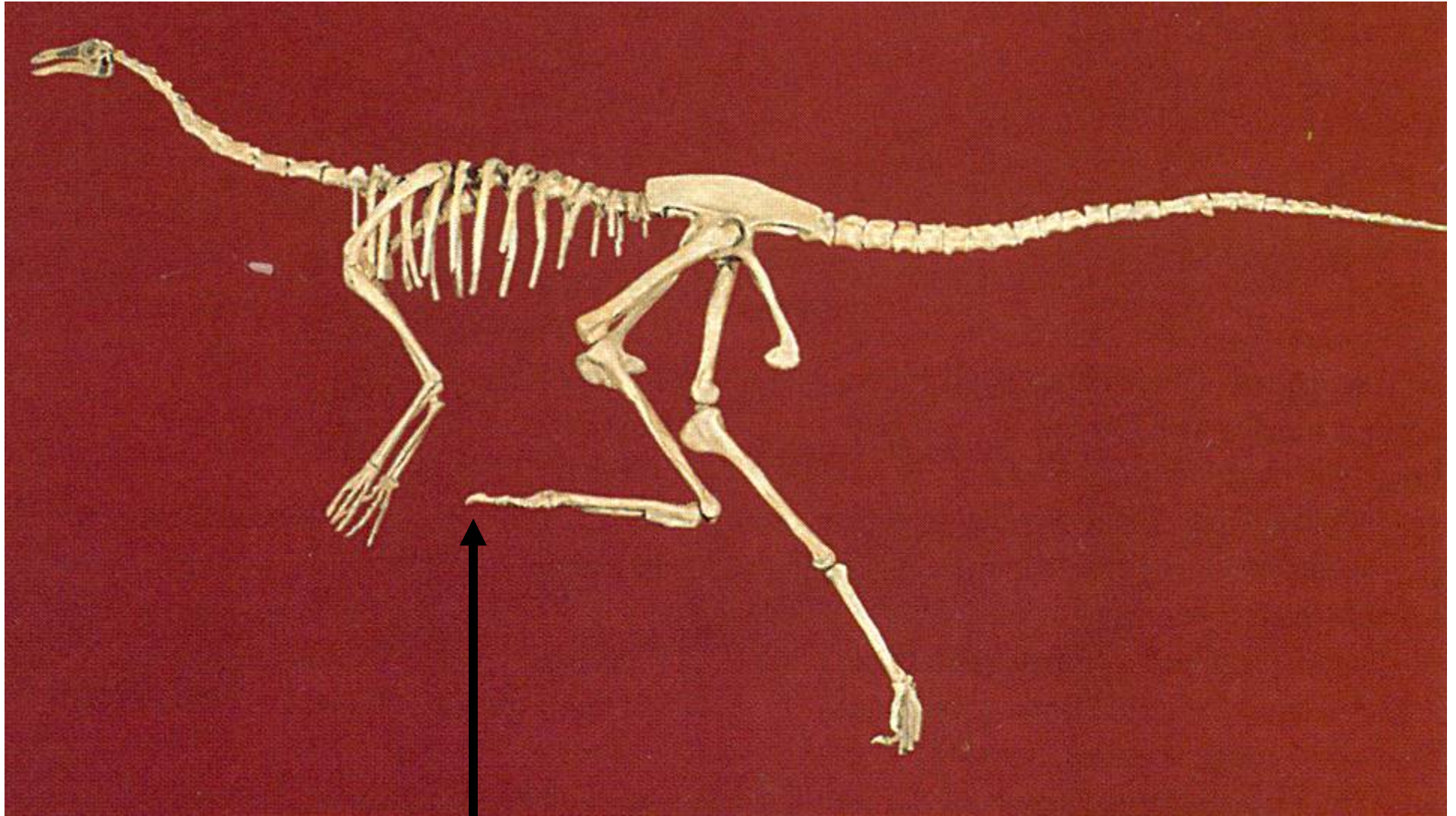
For *T. rex* to be able to travel at 20 m.p.h. the amount of leg muscle mass required to generate that much force would be about 95% to 110% its total body mass. Clearly impossible.

If legs are allowed to account for 40-50% of body mass (very generous), a conservative estimate for “cruising speed” is **11 miles per hour**. Quick burst would have been 15 miles per hour at most.

THEROPODA



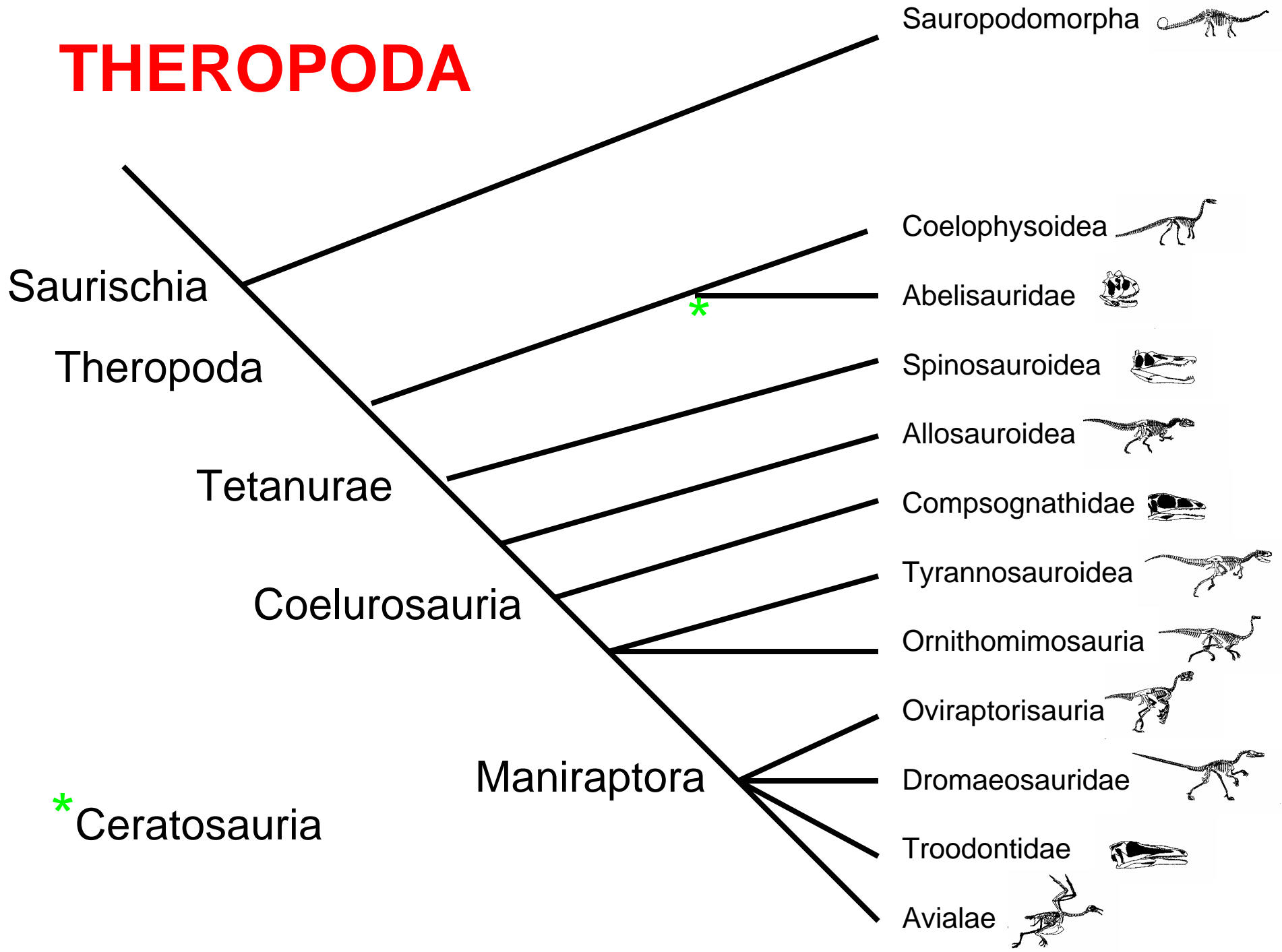
* Ceratosauria



Flat claws on feet

**ORNITHOMIMOSAURIA –
THE “BIRD MIMCS”**

THEROPODA

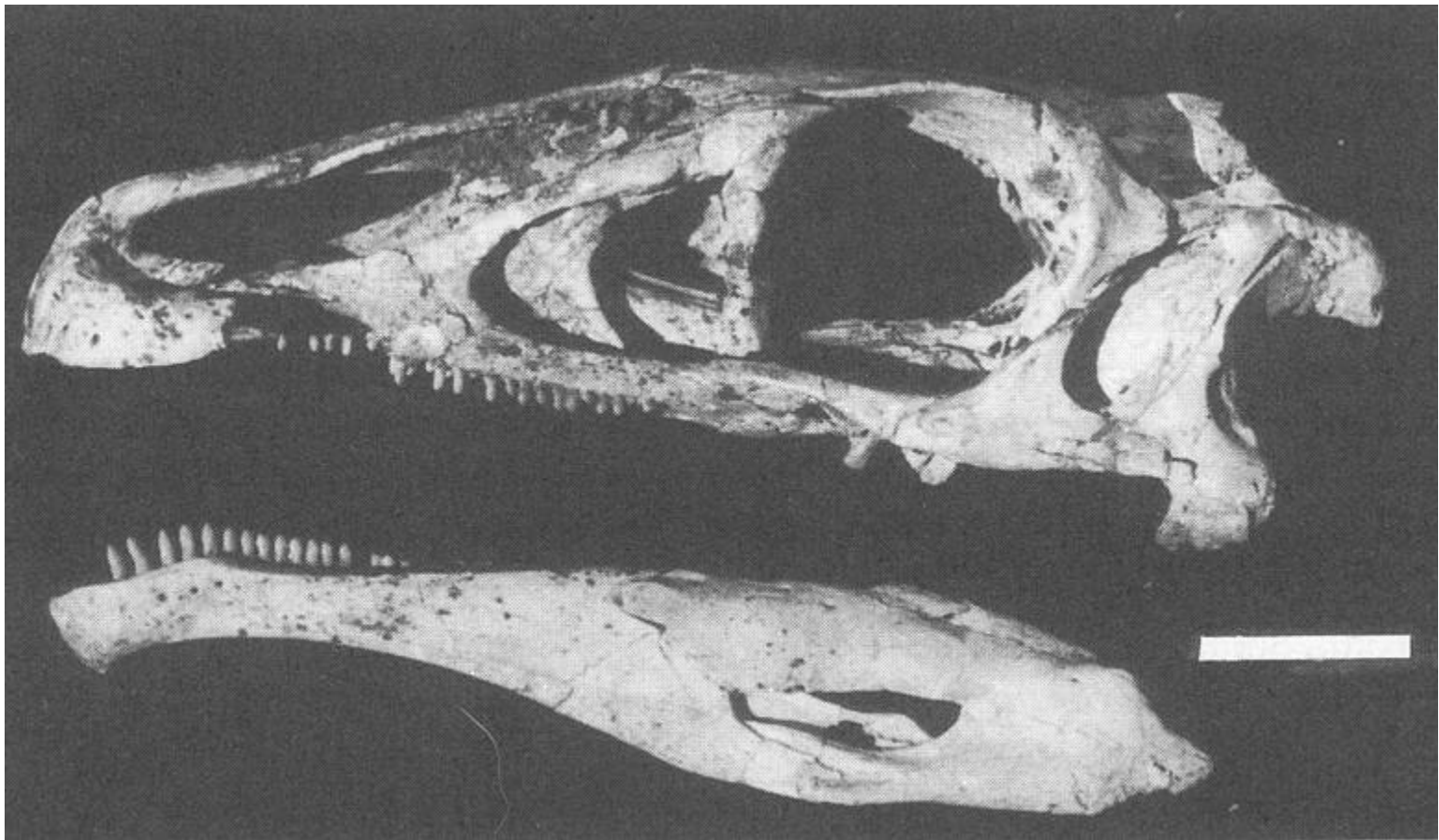


* Ceratosauria

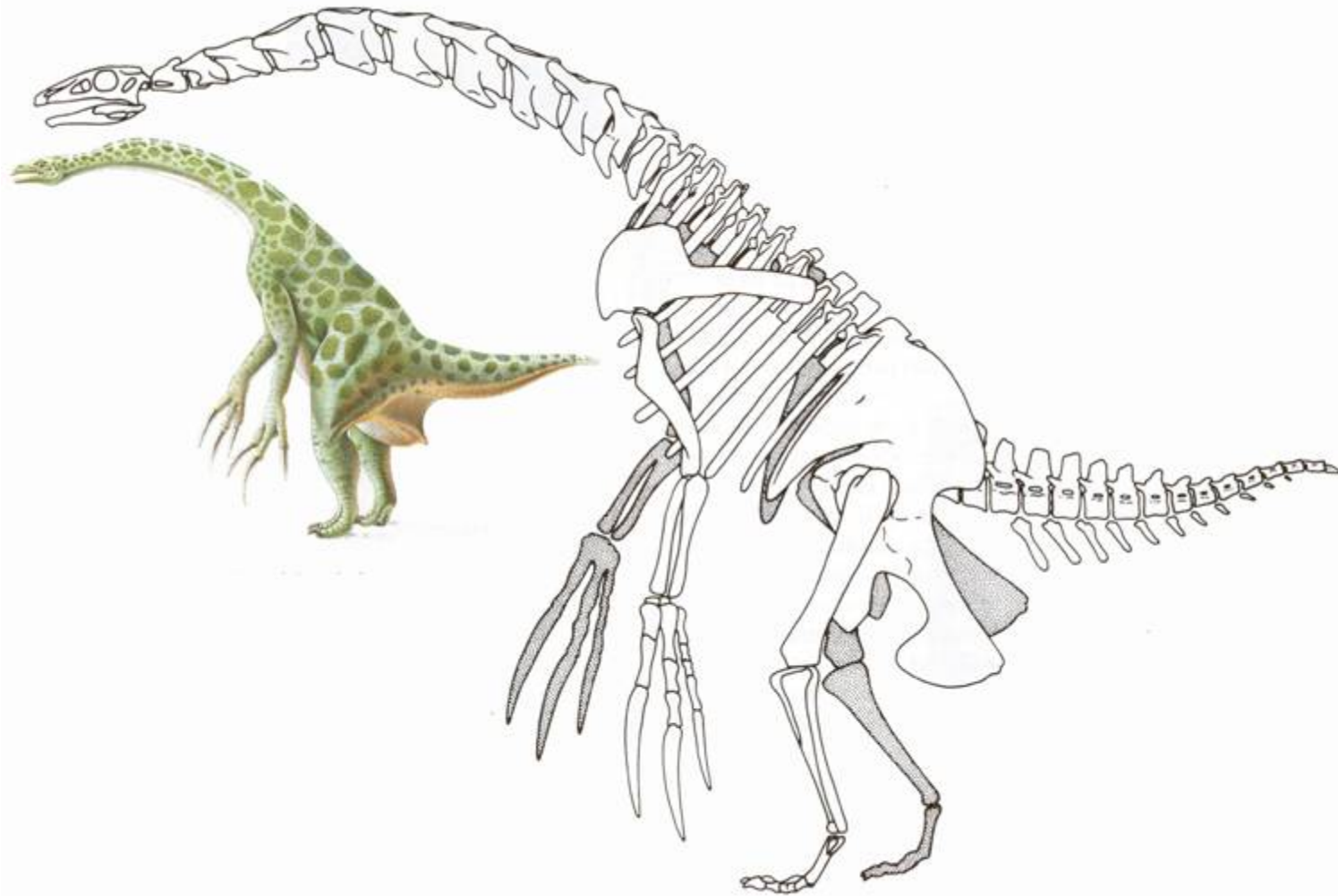
THERIZENOSAURS:

We don't know if they are more closely related to ornithomimosaur or oviraptorosaurs...

Whatever they are, they are amongst the strangest of all theropods.

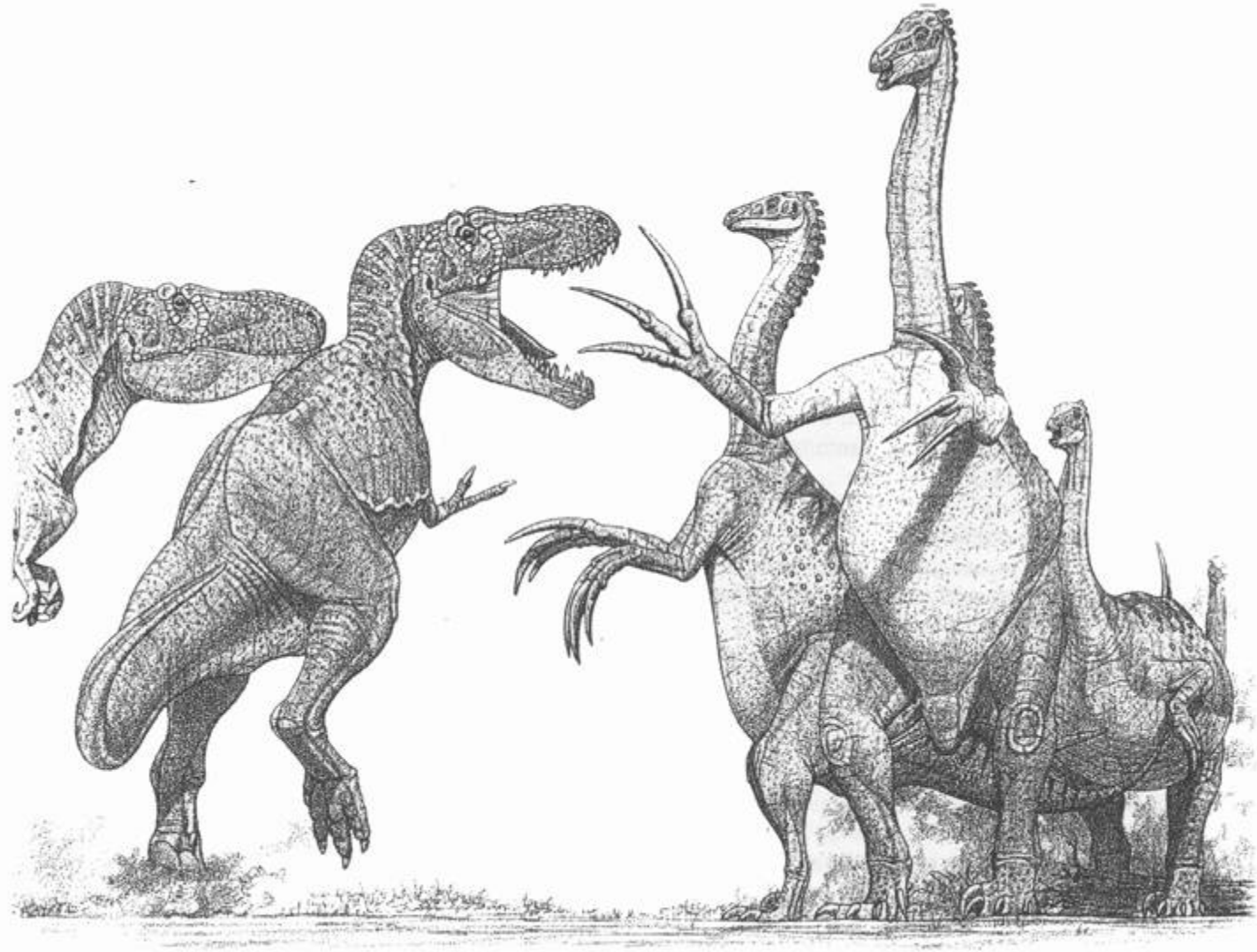


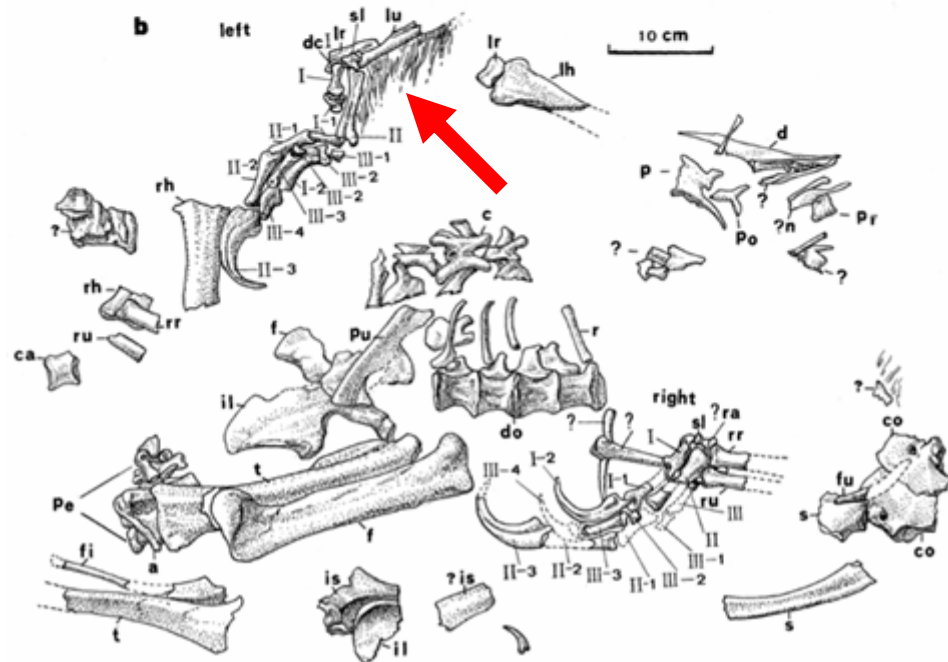
Erlikosaurus – a therizenosaur theropod



Therozinosaurus

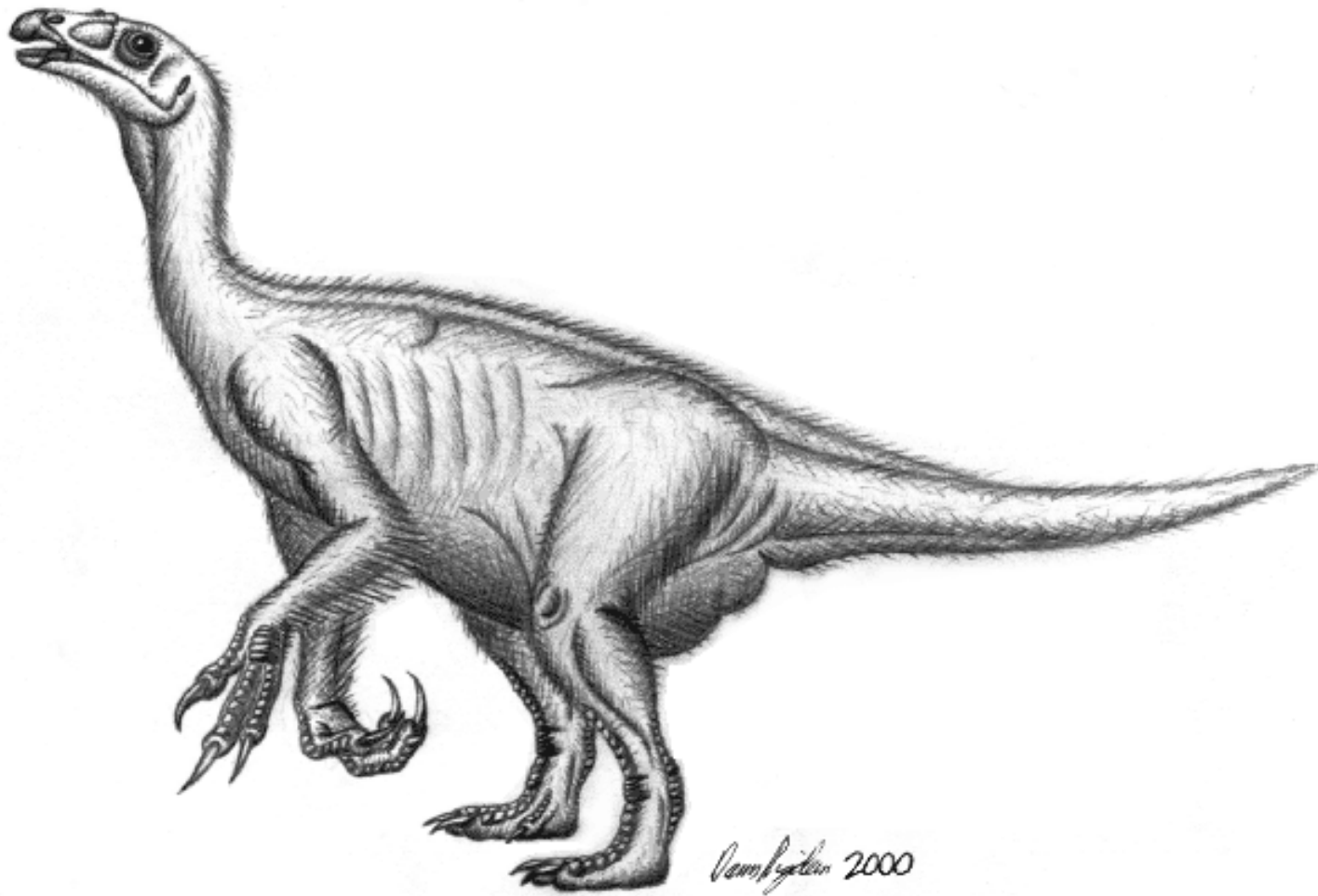
Appear to be large, slow moving analogs to giant ground sloths. They may have been high vegetation browsers.





Beipiaosaurus
 Specimen and
 reconstruction of
 limb

Beipiaosaurus





Beipiaosaurus

MANIRAPTORA

Includes small to moderately sized theropods that are increasingly similar to birds.

- Adaptations of the hand for extreme mobility (rotatory ability of hand)*.
- Furcula (clavicle) – (but tyrannosaurs may have one too...)

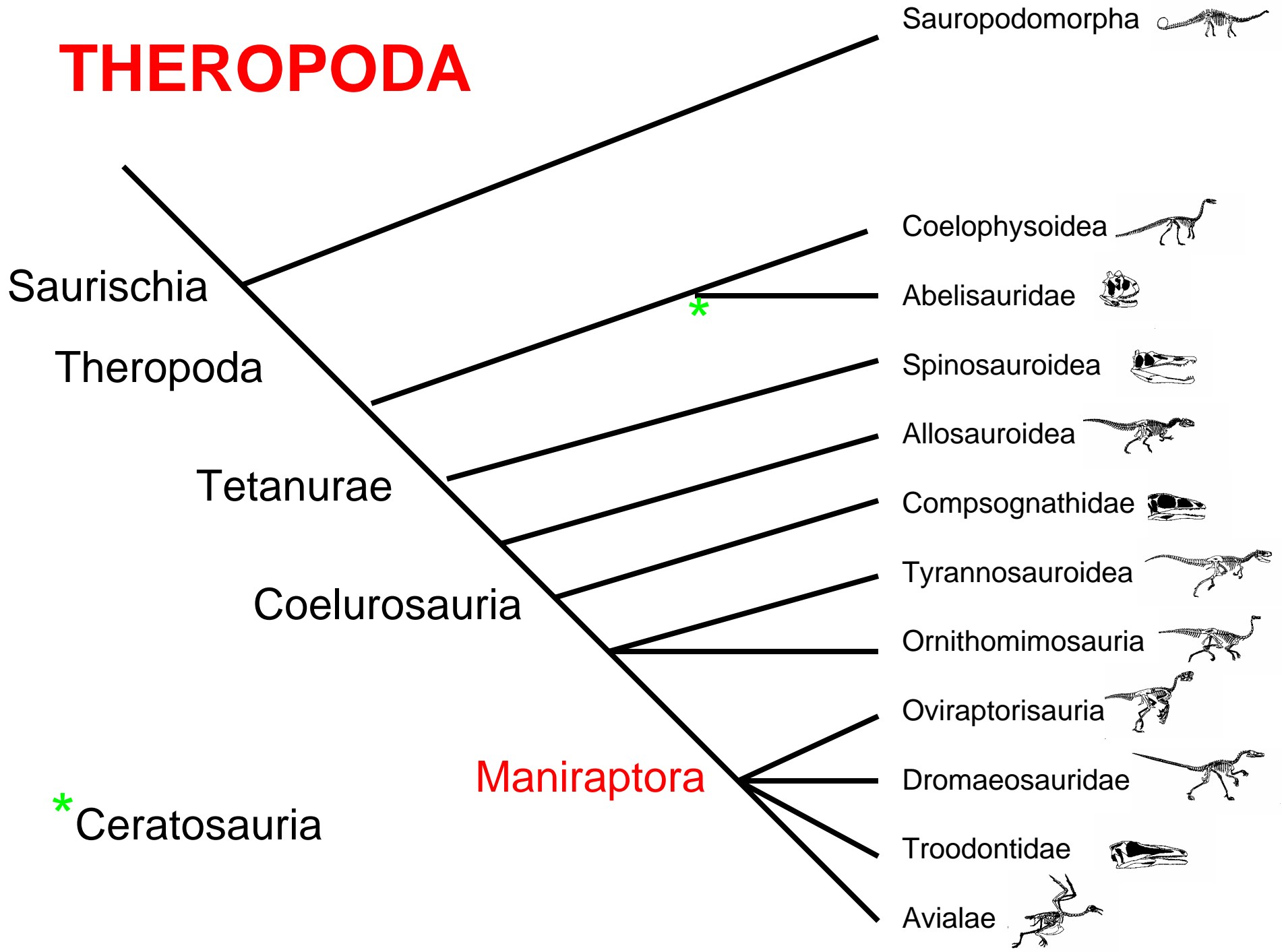
*This becomes “preadaptive” for wing beat movement.

In our phylogenetic scheme, the **Maniraptora** consists of a polychotomy of four equally related groups:


- Oviraptorisauria
- Dromaeosauridae
- Troodontidae
- Avialae (birds)

If we had to hazard a guess, troodontids are most similar to birds.

THEROPODA




Sauropodomorpha 

Coelophysoidea 


Abelisauridae 

Spinosauroidae 

Allosauroidae 

Compsognathidae 

Tyrannosauroidae 

Ornithomimosauria 

Oviraptorosauria 

Dromaeosauridae 

Troodontidae 

Avialae 

Saurischia

Theropoda

Tetanurae

Coelurosauria

* Ceratosauria

Maniraptora

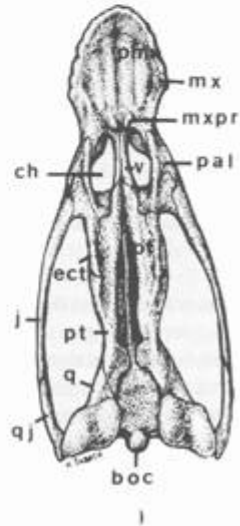
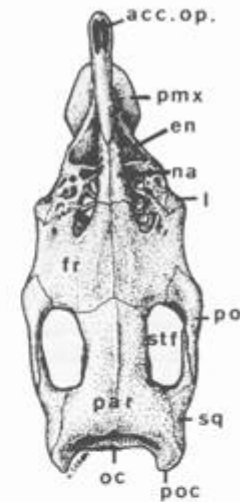
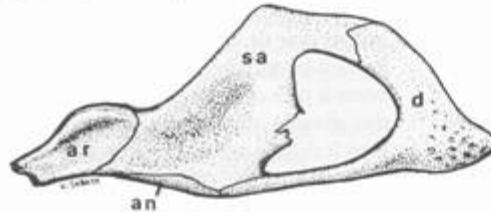
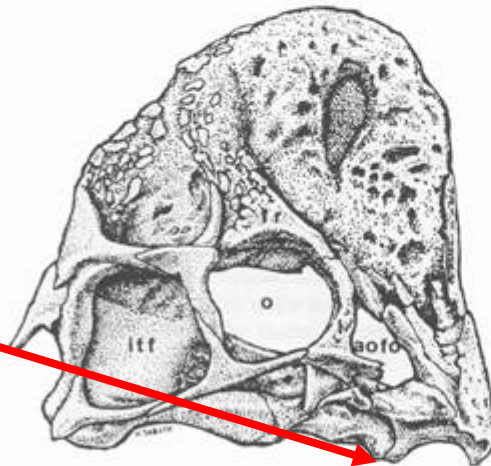
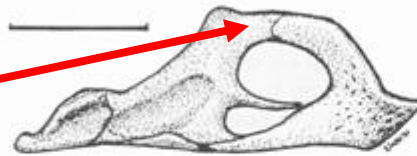
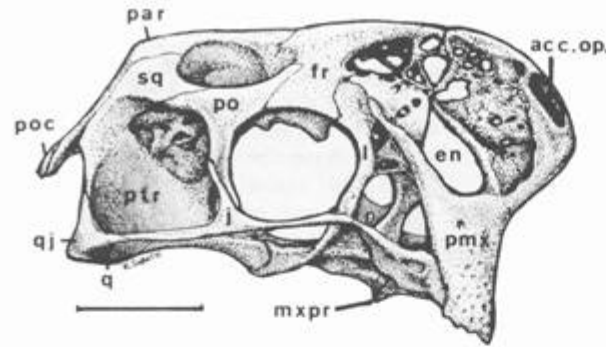
MANIRAPTORA: OVIRAPTORISAURIA ("Bird Mimics")

Late Cretaceous group of small to moderately sized maniraptorans.

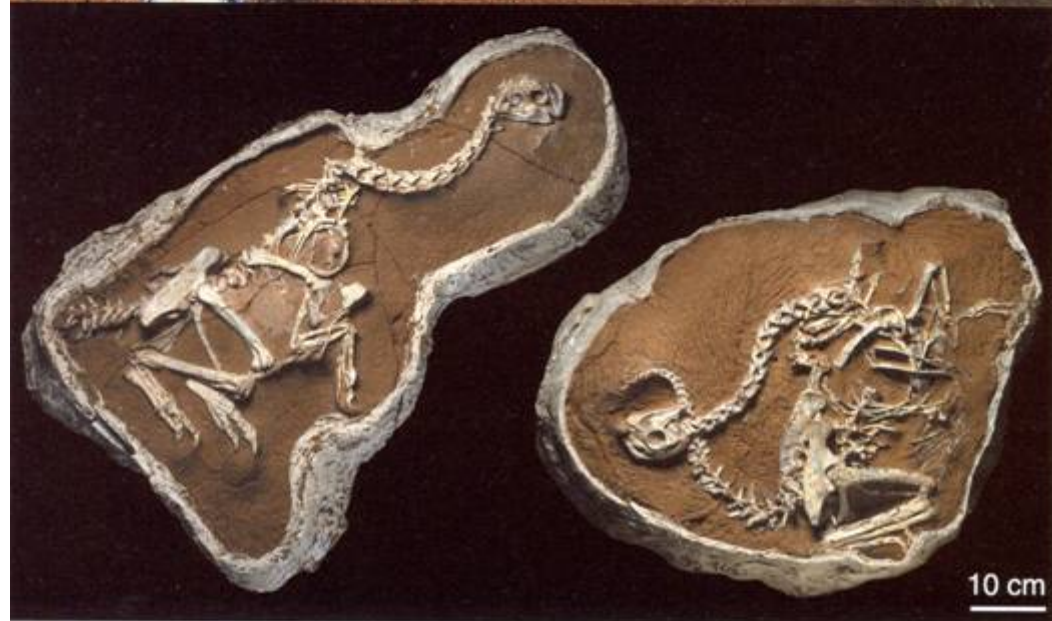
- Toothless jaws that supported a horny beak – a lot like a bird.

MANIRAPTORA:
OVIRAPTORISAURIA
Oviraptor skulls

- Toothless jaws that supported a horny beak.



Khaan –
An
oviraptor
from
Mongolia





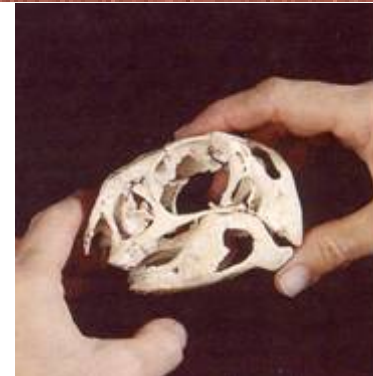
Oviraptor -- incubating, not stealing, eggs.



Oviraptor egg with enclosed embryo.



Ingenia – an oviraptor
from the Gobi desert



Hand of *Caudipteryx*



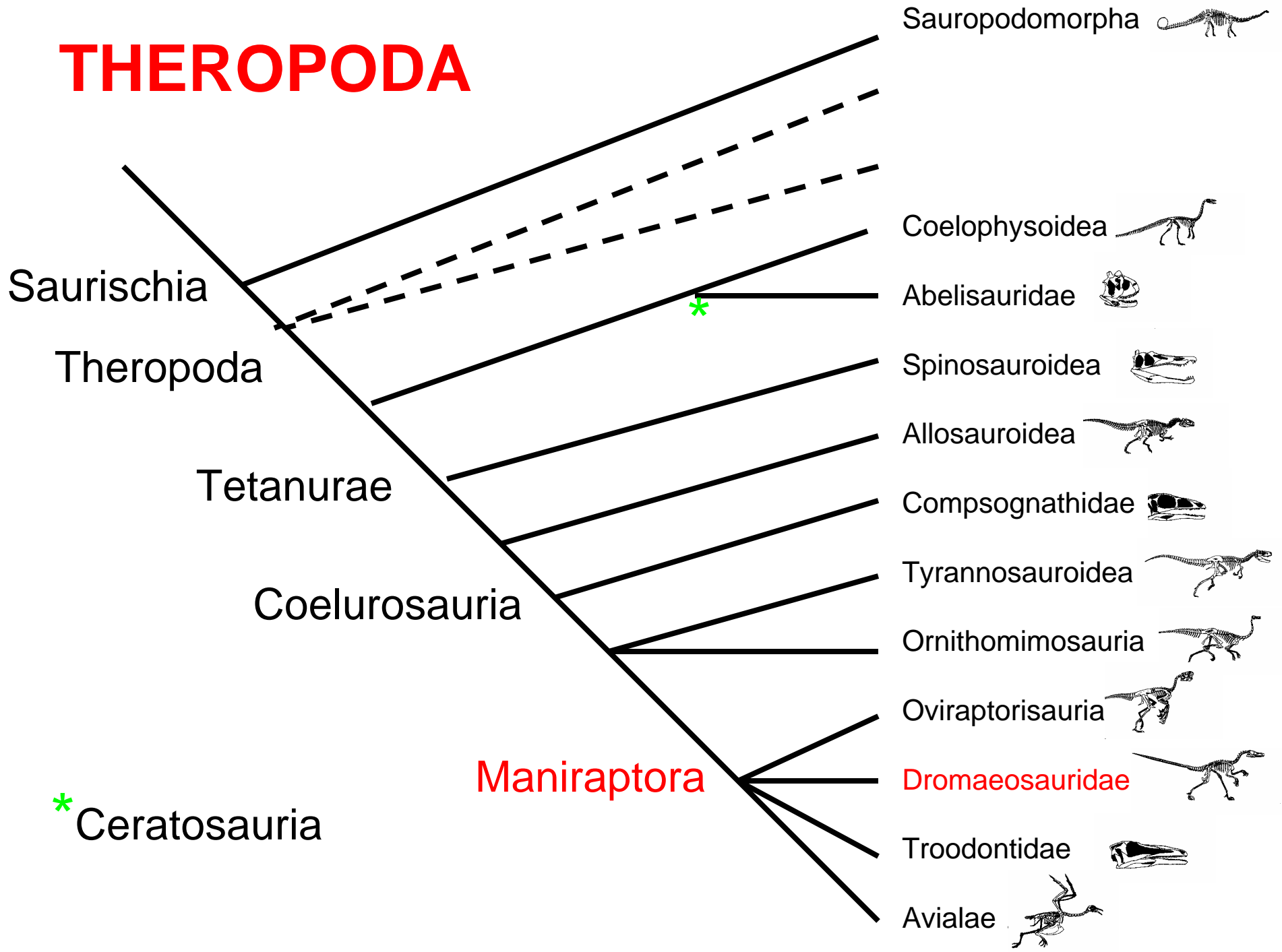


Reconstruction of ***Caudipteryx*** – another dinosaur with feathers.

Reconstruction of *Caudipteryx*

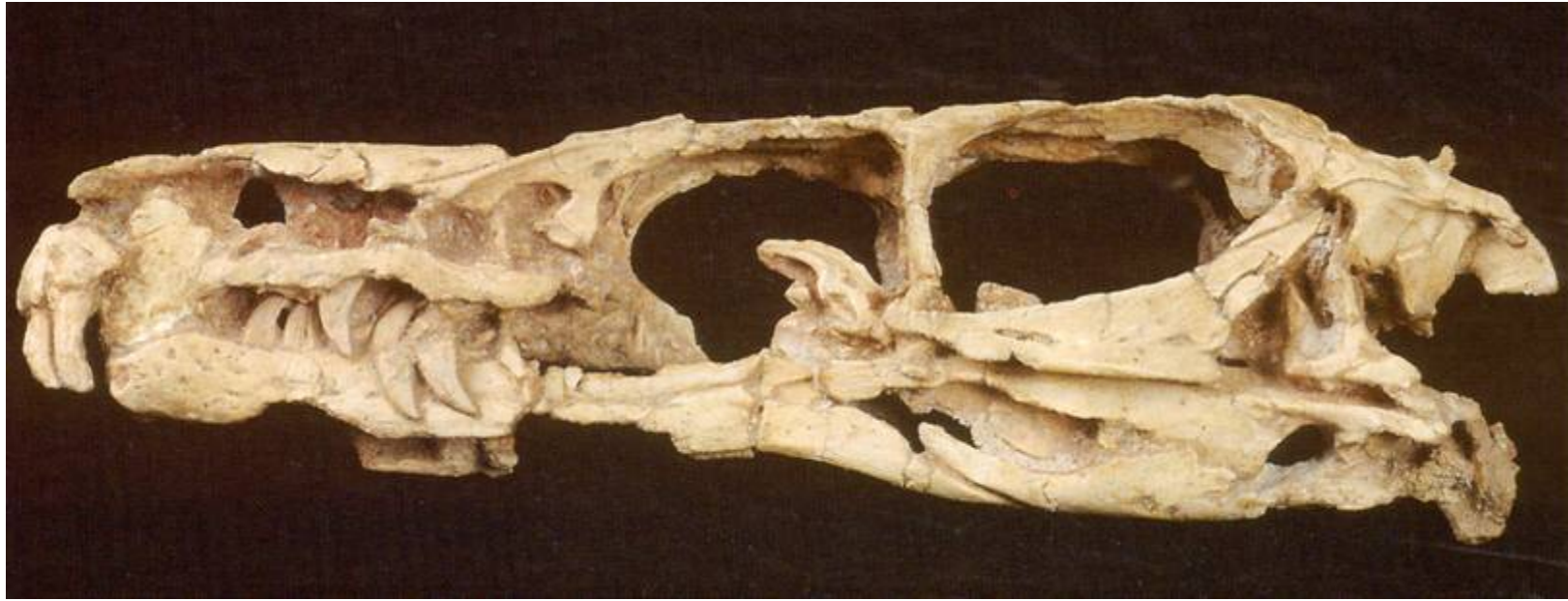


THEROPODA



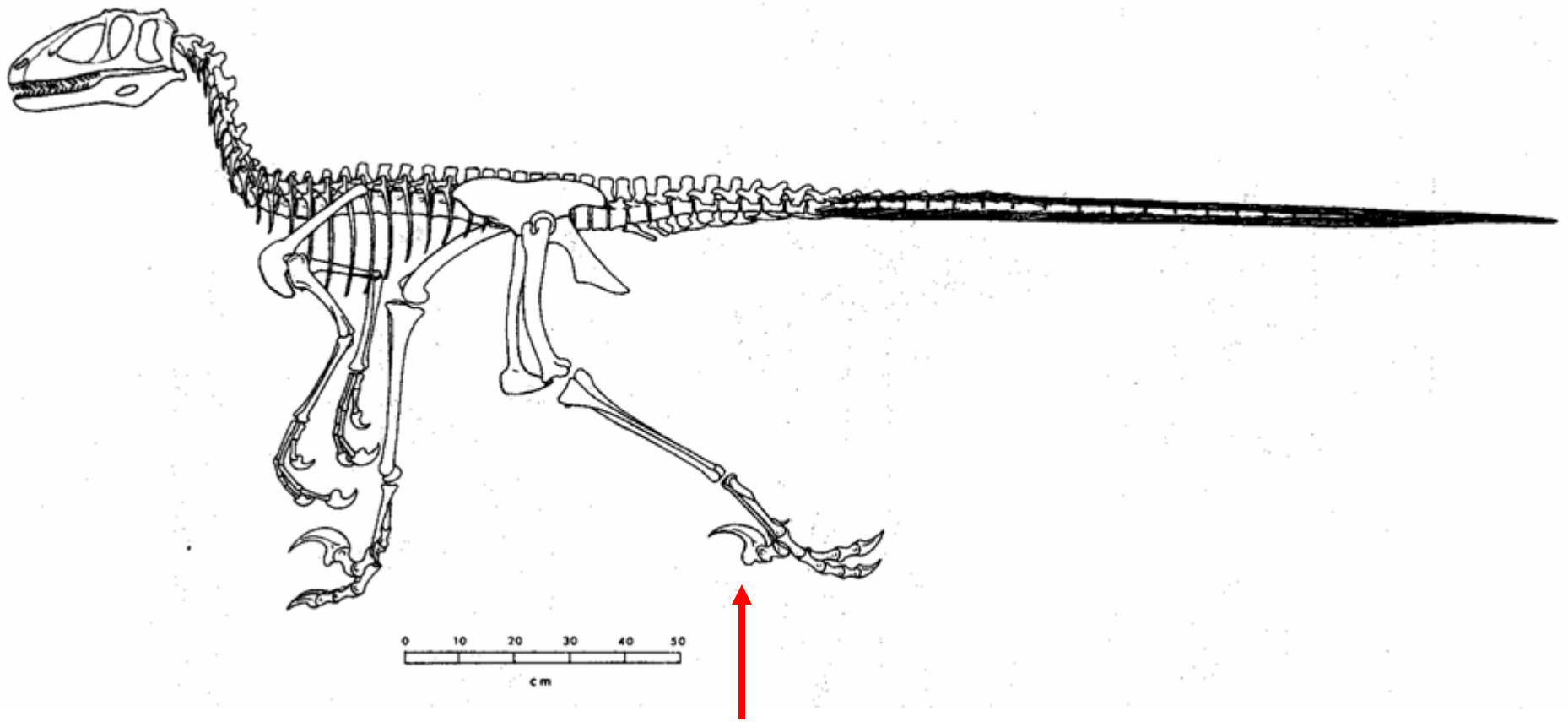
MANIRAPTORA: DROMAEOSAURIDAE

- Extremely developed sickle-like claw on foot.



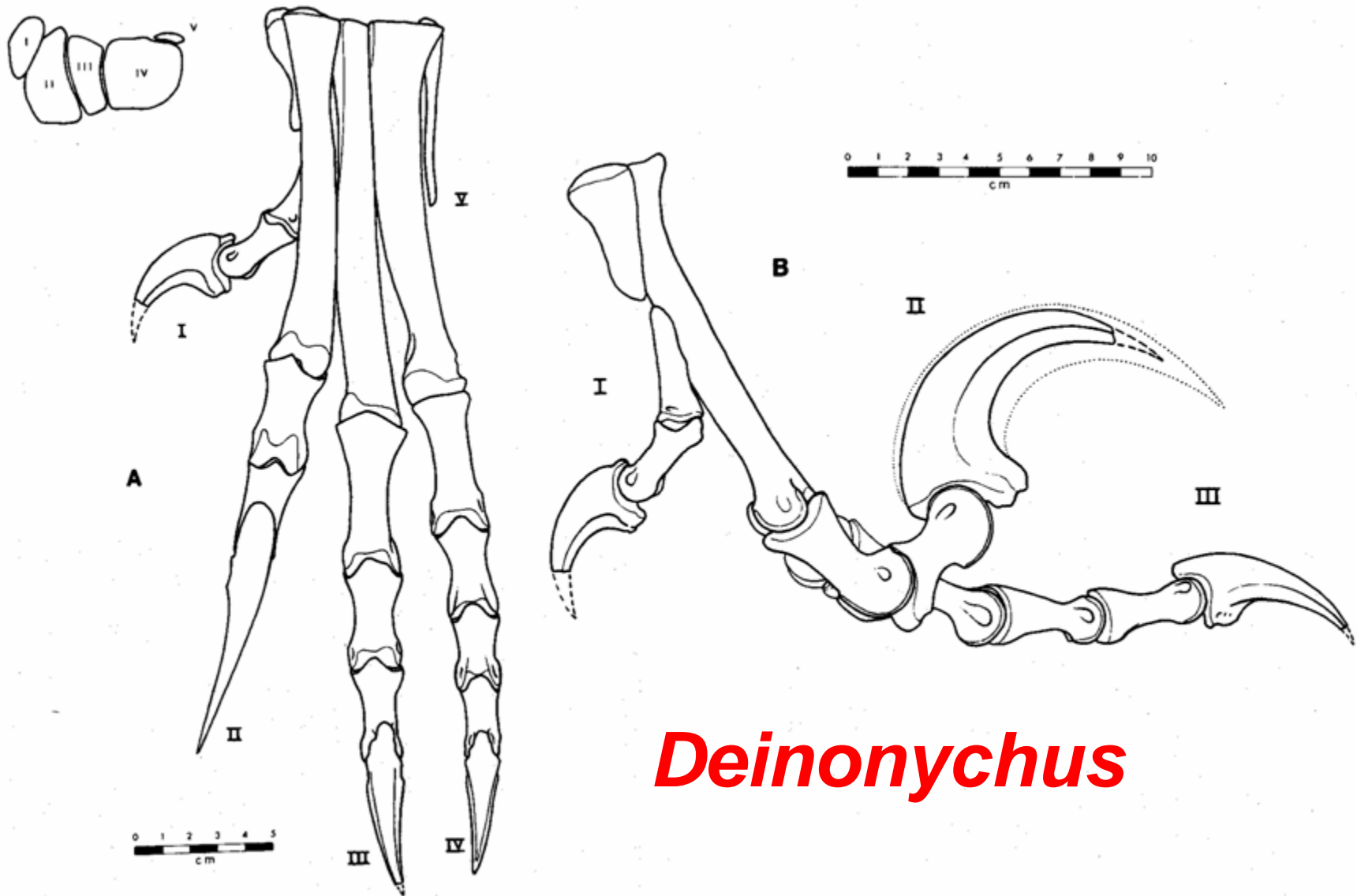
Velociraptor





Extremely developed sickle-like claw on foot.

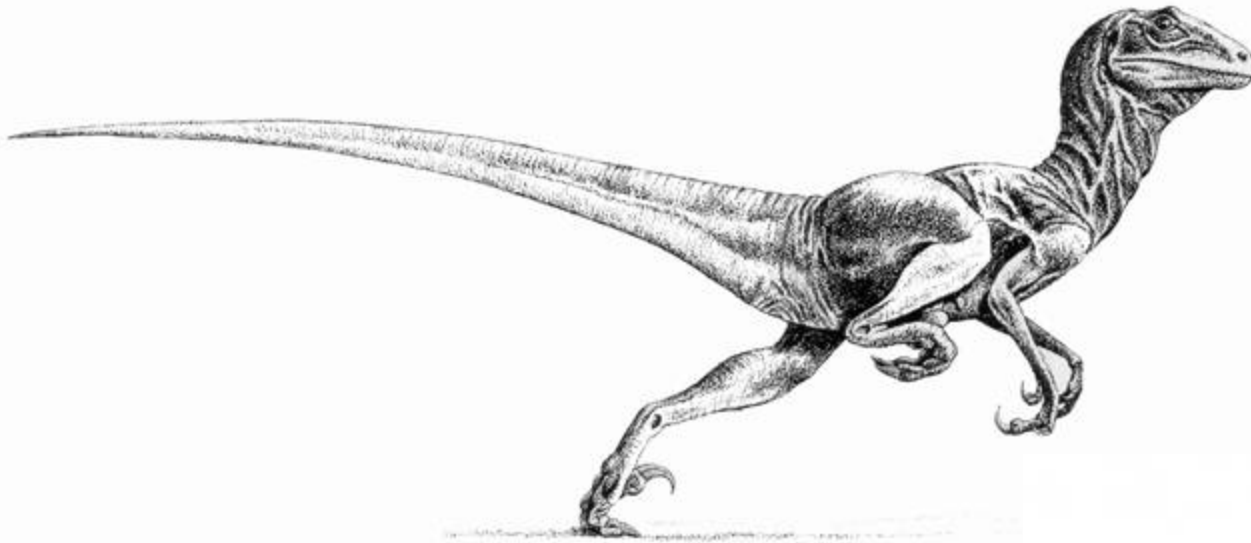
Deinonychus



Extremely developed sickle-like claw on foot.



Deinonychus



Deinonychus





Utahraptor. larger than *Velociraptor*, but incompletely known. Only limbs are known.



Sinornithosaurus:

A feathered dromaeosaurid
from China



Sinornithosaurus:

A feathered
dromaeosaurid from
China



Sinornithosaurus:

Feathers on skull



Feathers on tail



Photo Credit: AMNH

Juvenile Sinornithosaurus ?

Microraptor

Smallest known dinosaur ever
found
(39 cm).

Also had feathers.

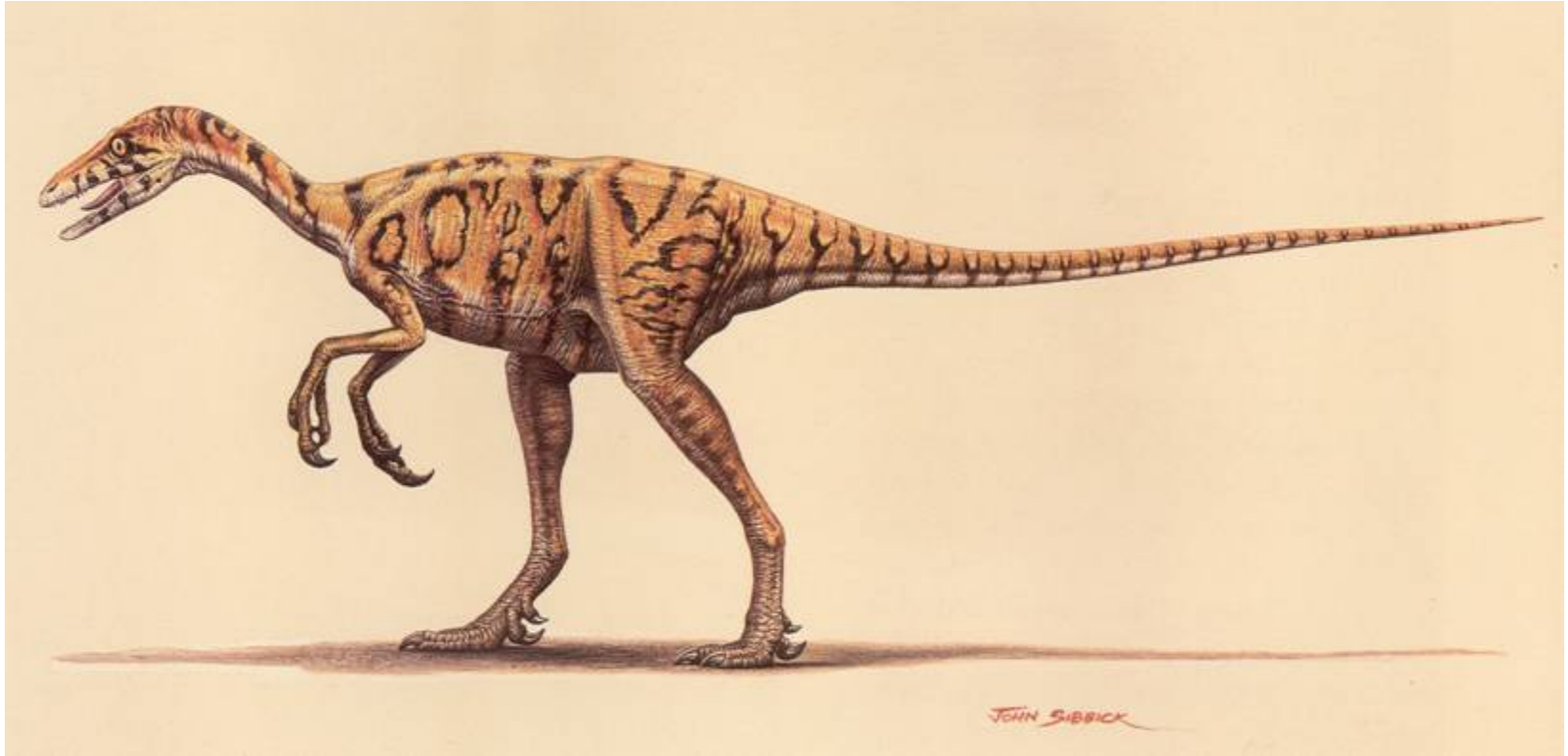
MANIRAPTORA: TROODONTIDAE

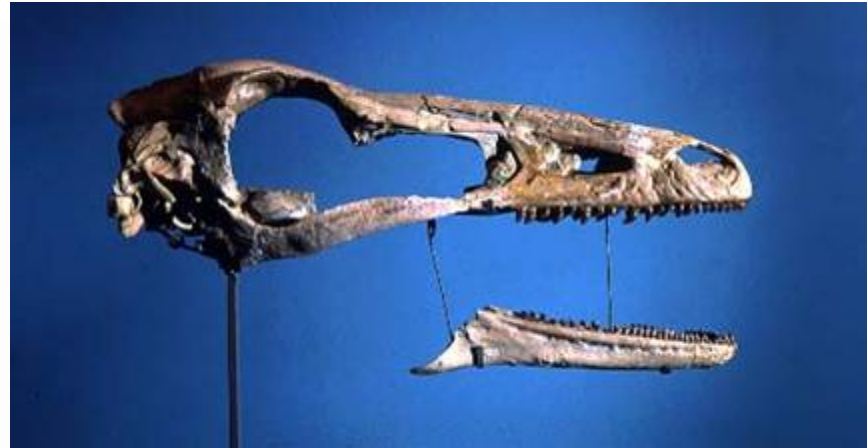
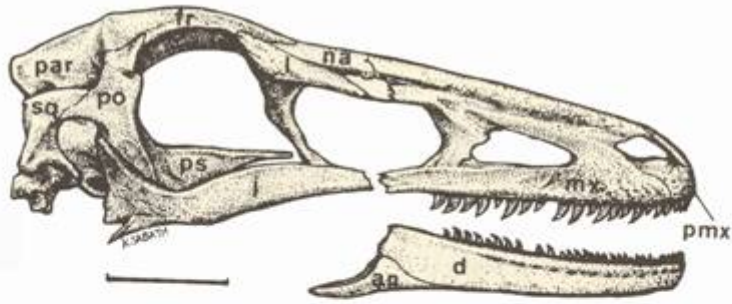
Late Cretaceous of North America and
Asia

- Complex system of pneumatic (air-filled) sinuses (much like birds).

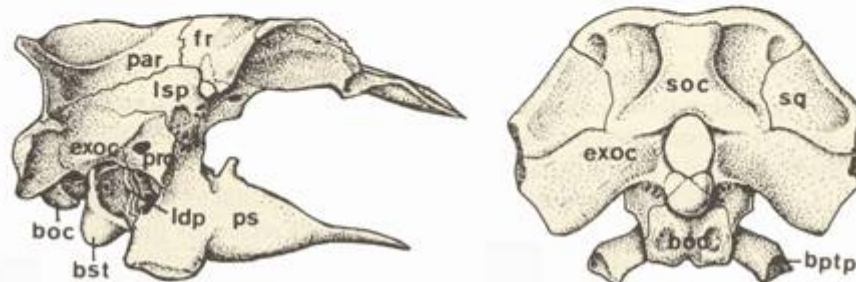
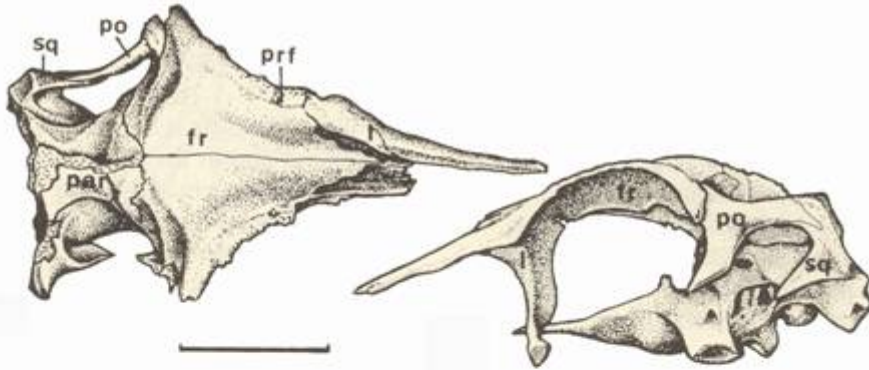
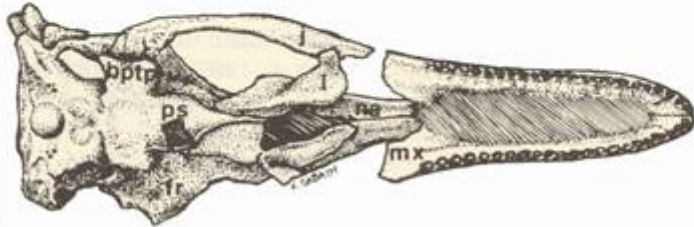


Sinovenator changii – a chicken-sized troodontid with feathers from the Jurassic of China.



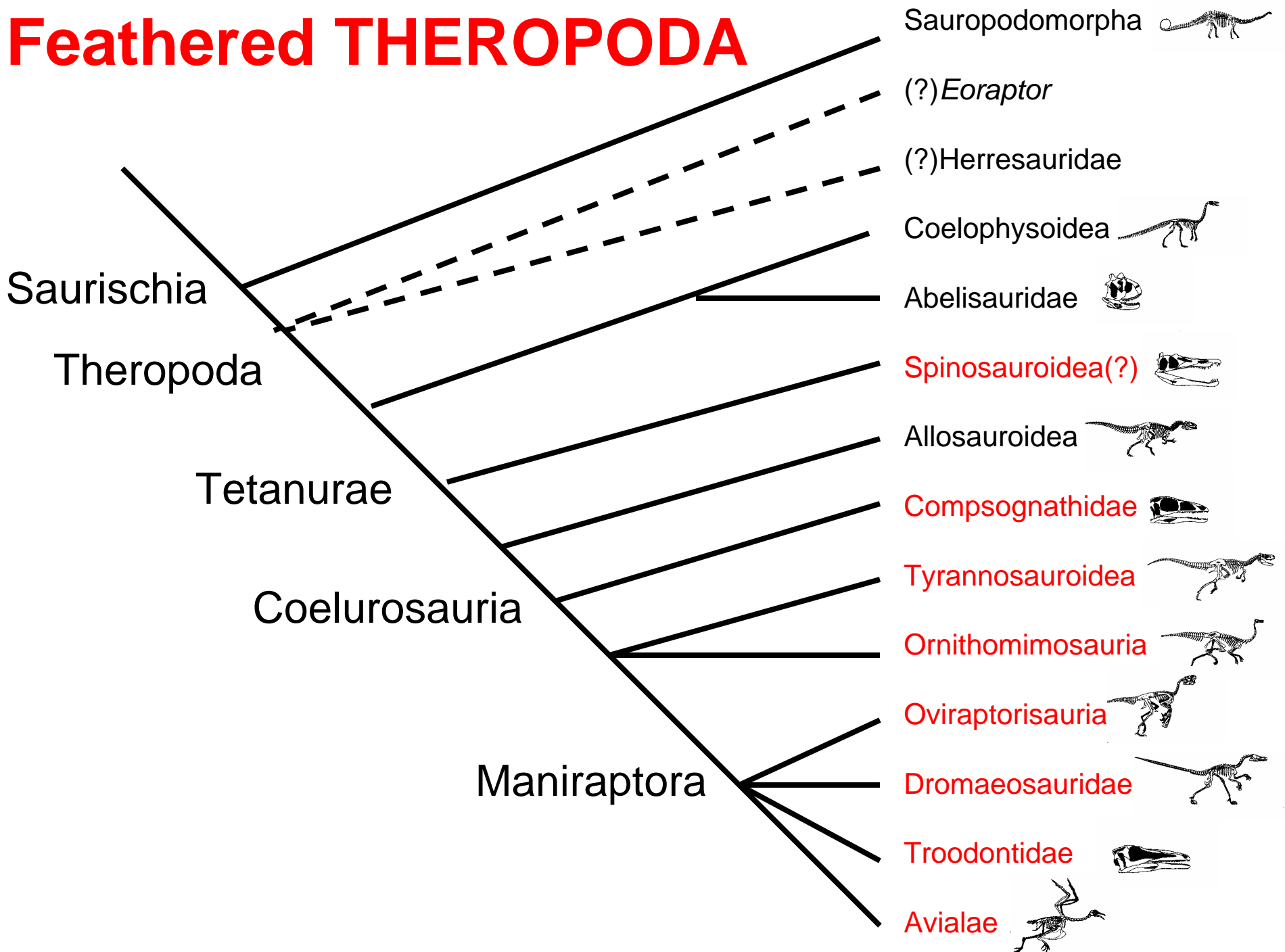


Sinornithoides



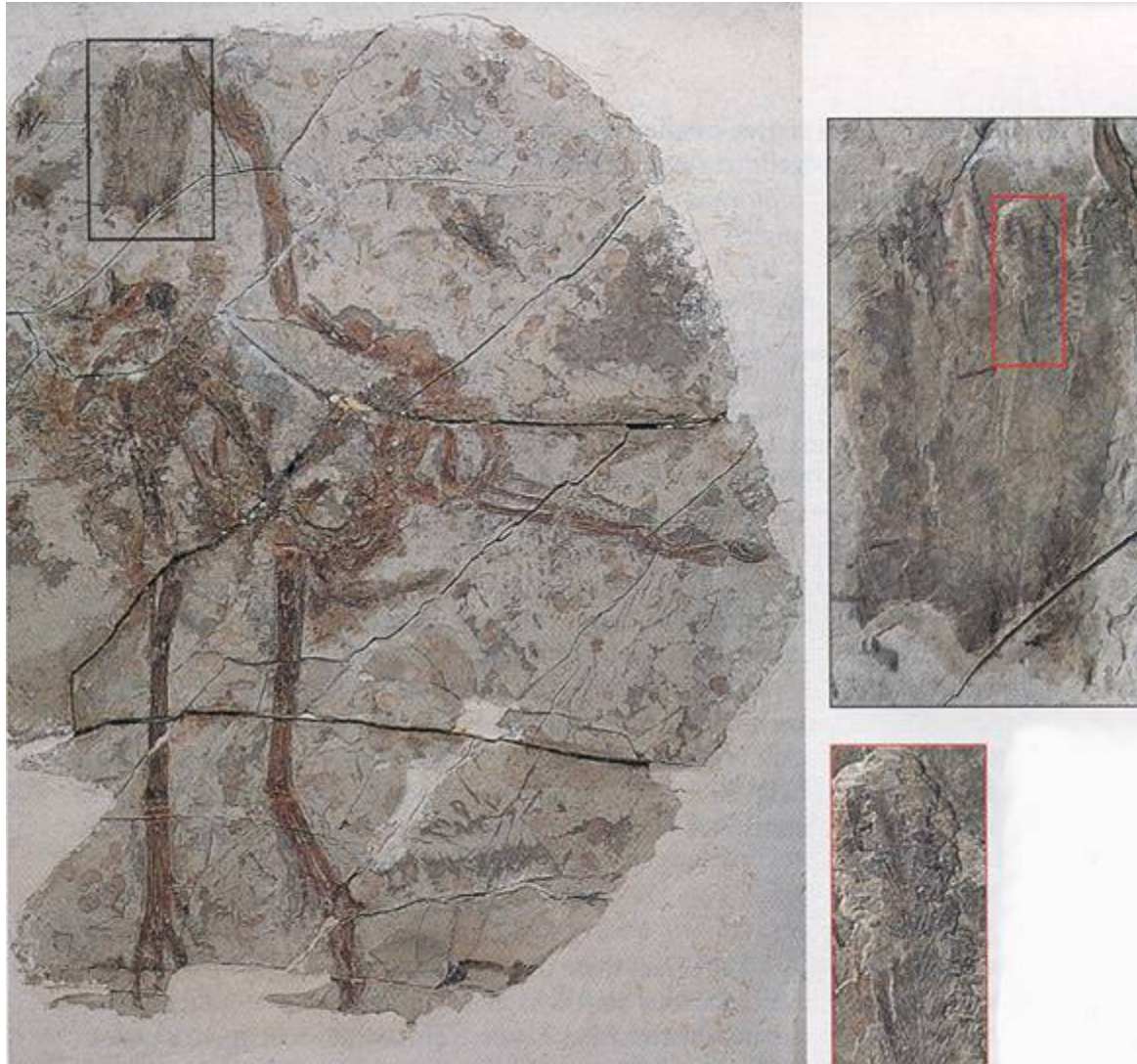
Troodon

Feathered THEROPODA



AVIALAE: TRUE BIRDS

Protoarchaeopteryx



Archaeopteryx lithographica
(Late Jurassic)



Specialized Bills and Bill Shapes



BIRD WING SHAPES



Albatross



Swift



Falcon



Swallow



Sparrowhawk



Old World vulture



Pheasant



Hummingbird



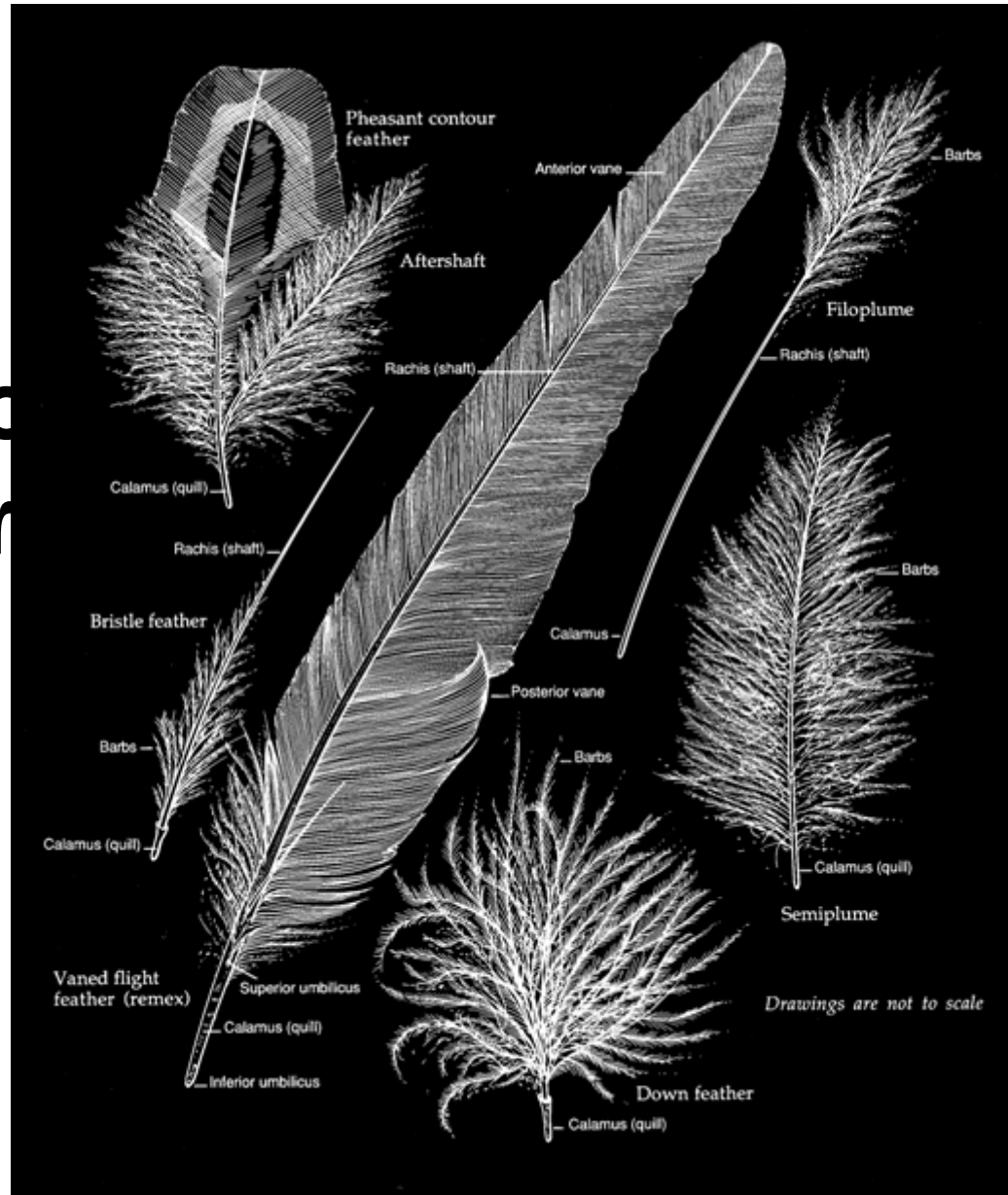
Penguin

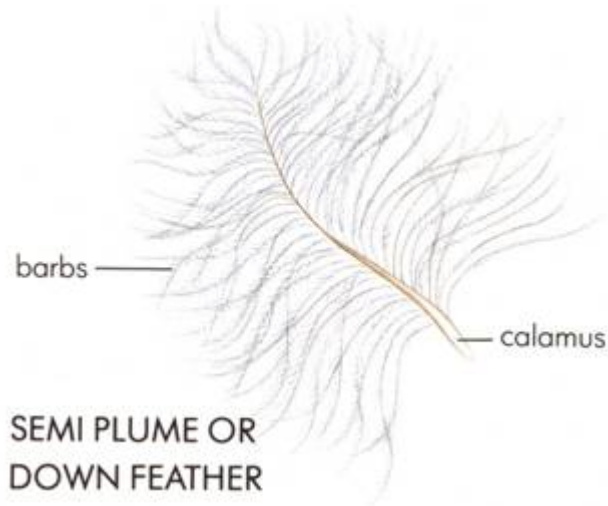




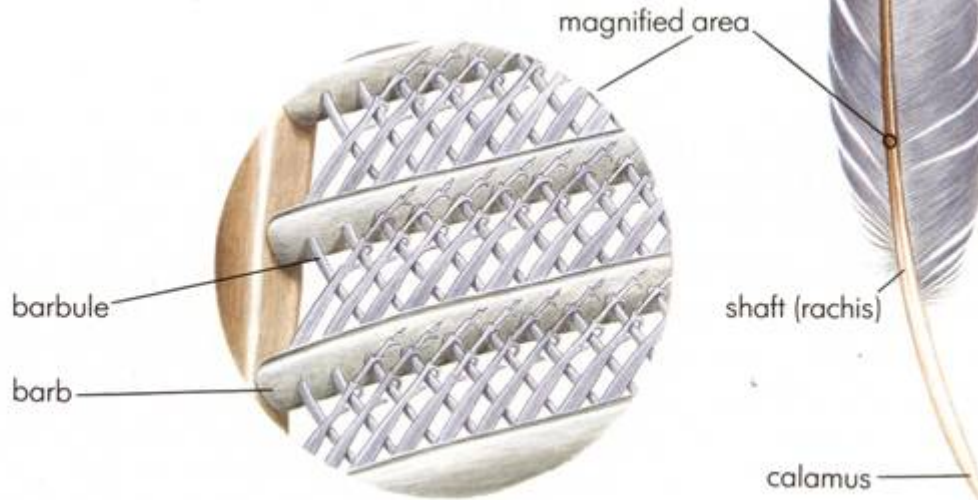
The “wishbone” (furcula, clavicle) acts as a spring during flight.

Many more types of feathers than hair.





FLIGHT OR
CONTOUR
FEATHER



**Individual
feather
more
complex
than an
individual
hair.**





















