

# Theropod Skulls

Air sacs in antorbital fossa ~ lateral aspects of skull (primitive characteristic lost in Ornithischia)

Also found in Theropods, Sauropods, Pterosaurs, and Crocodylians

Pneumatization of snout

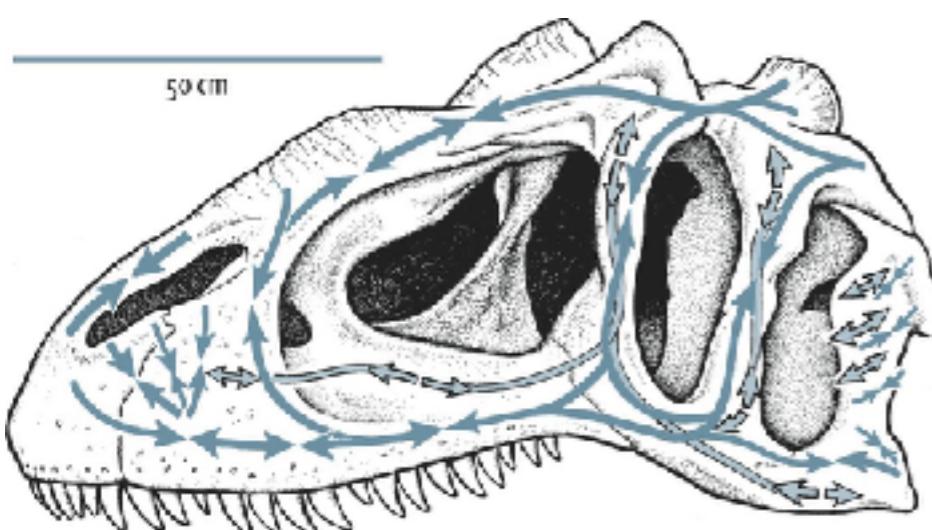
Accessory antorbital openings

Why?

Potentially > respiratory efficiency

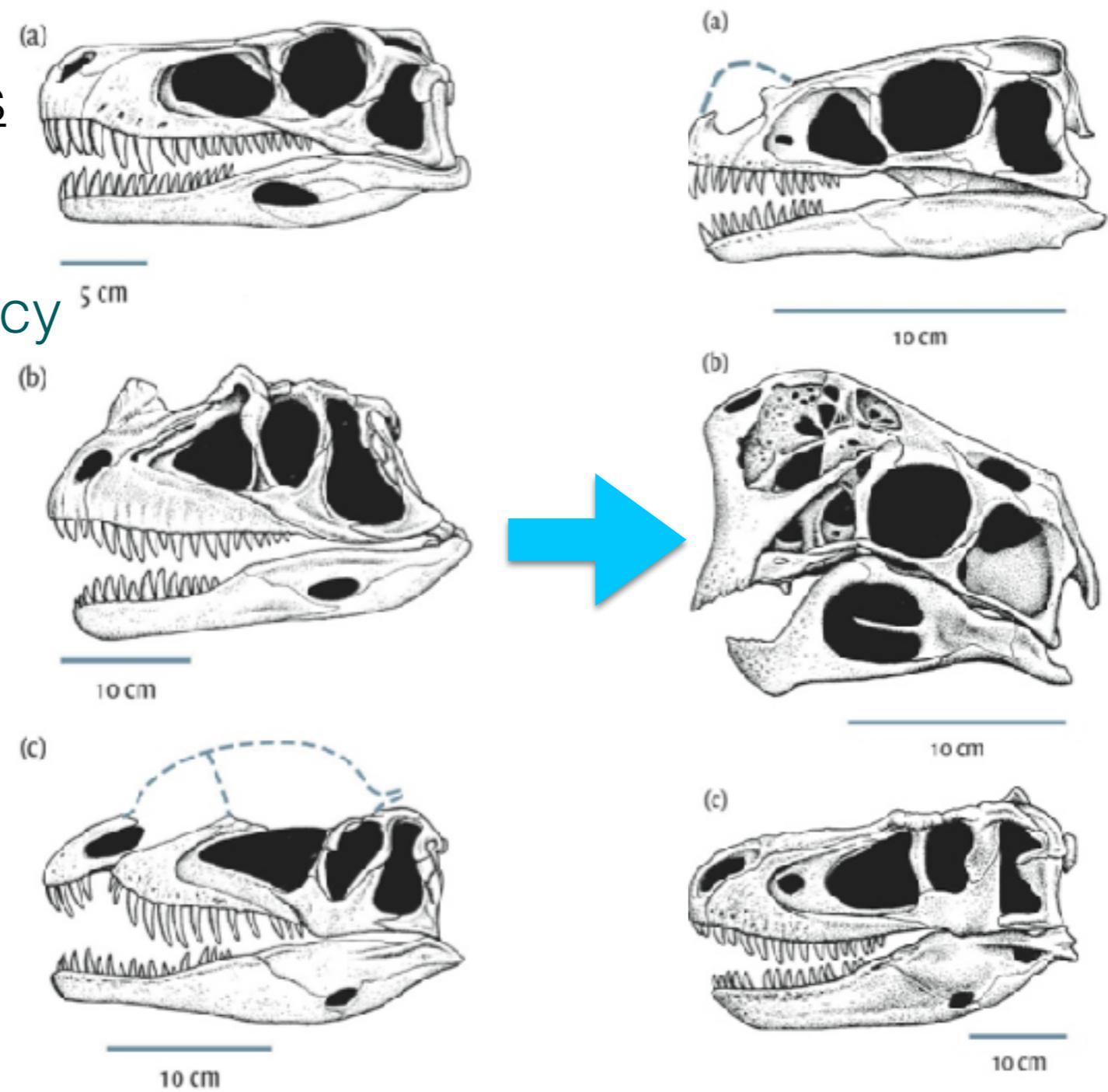
Early forms: brute force

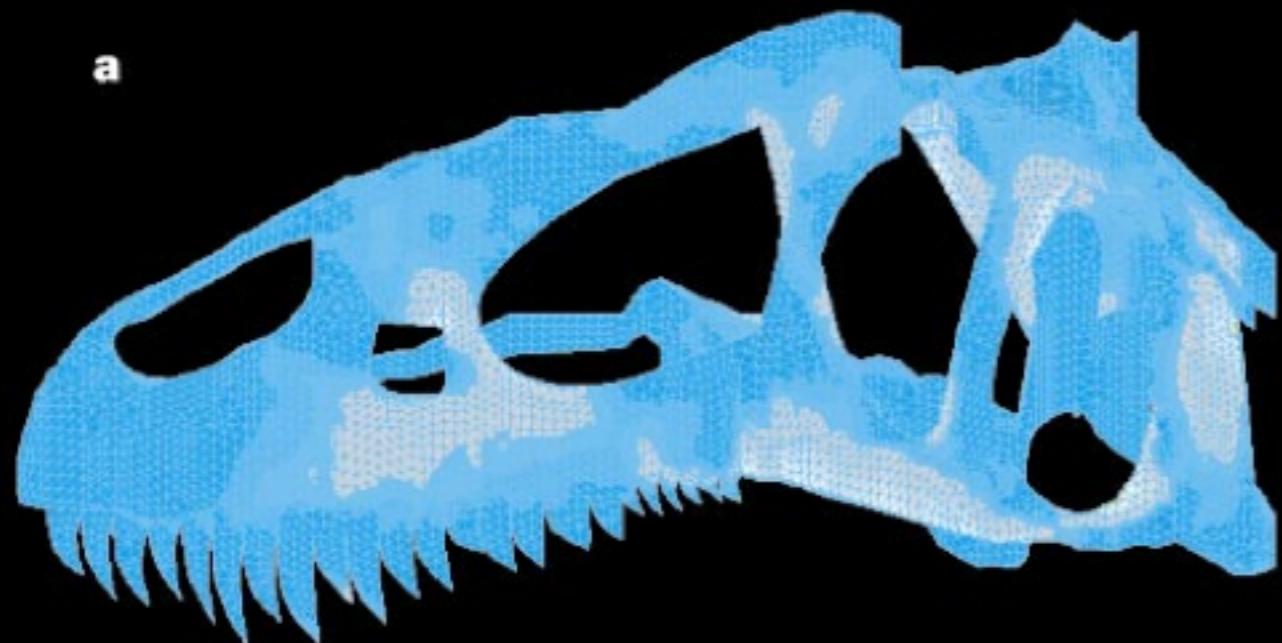
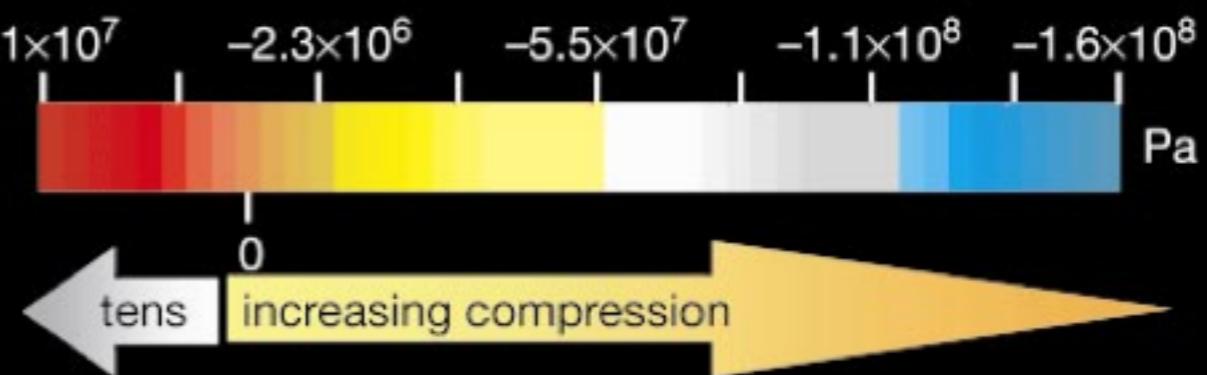
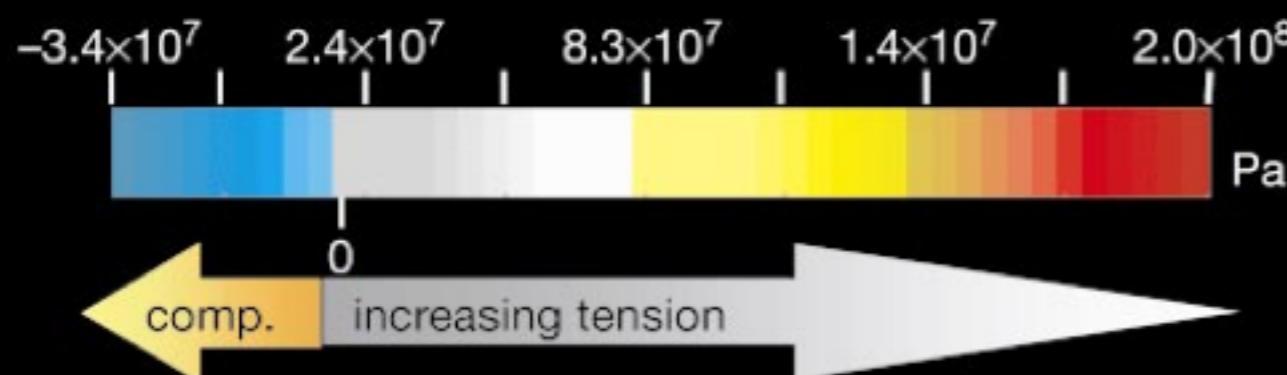
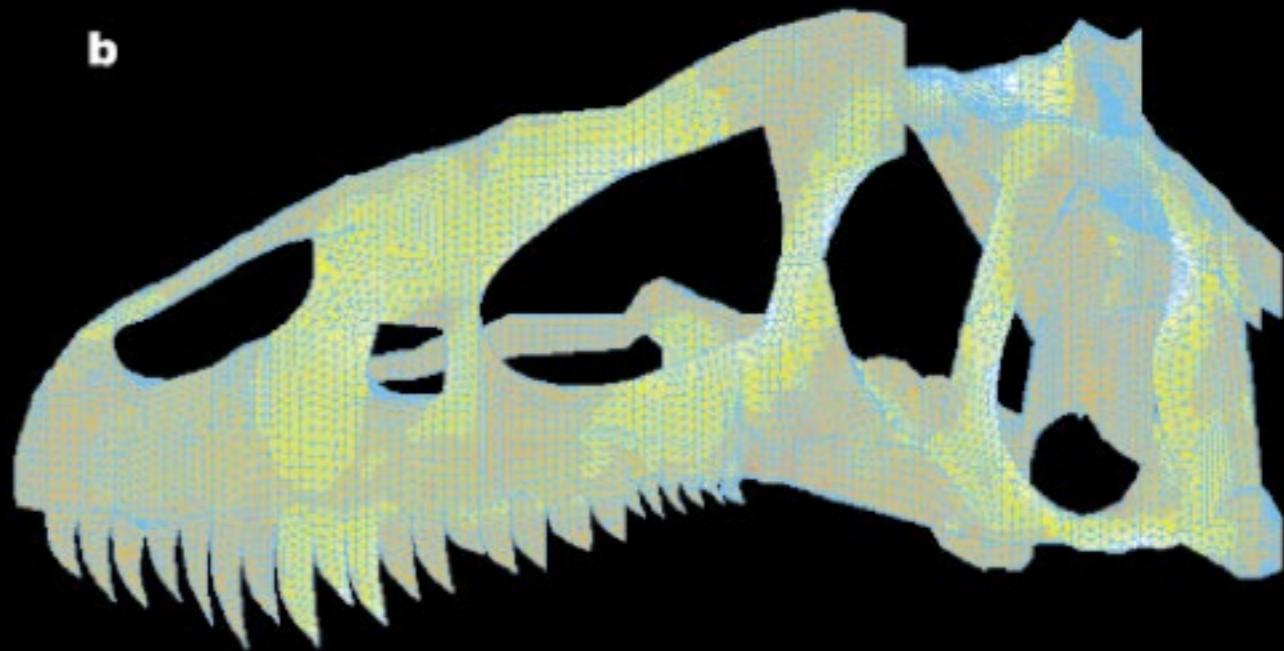
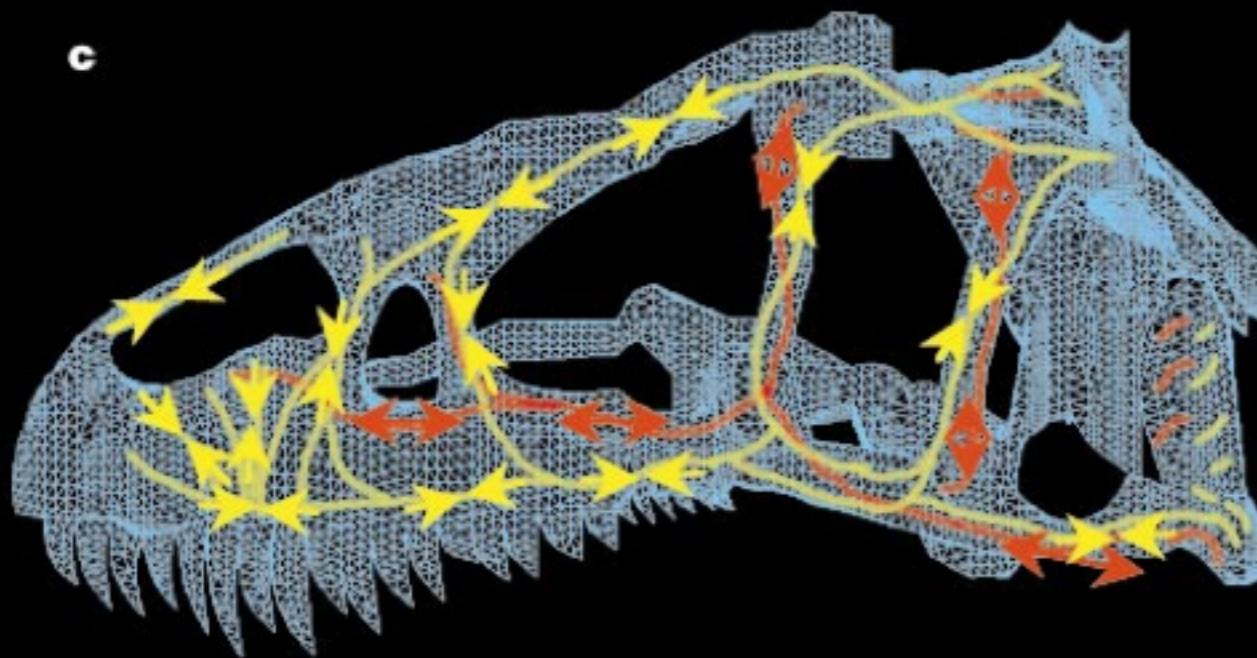
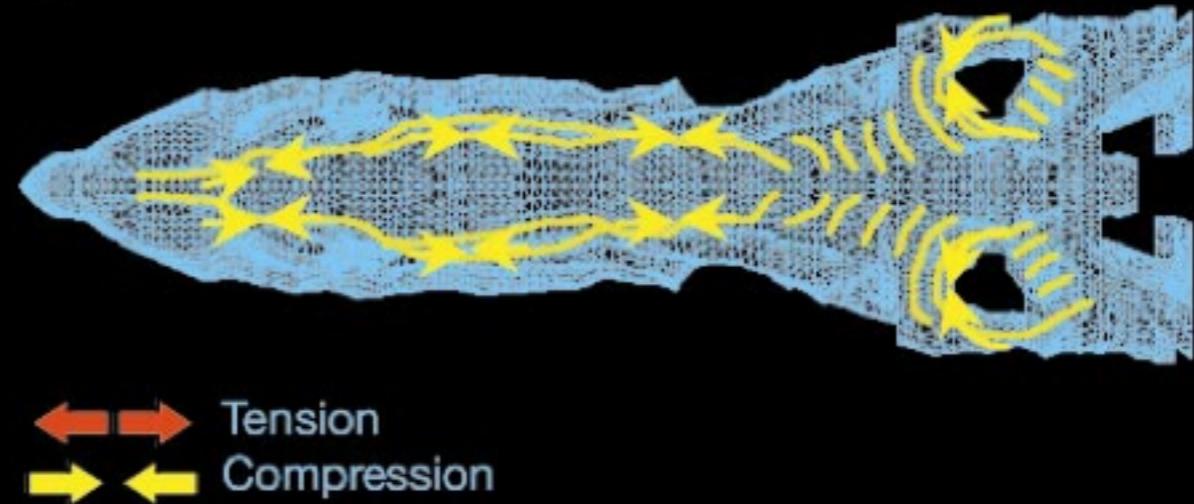
Later forms: Thrashing/tearing



←→  
Compression

↔↔  
Tension



**a****b****c****d**

↔ → Tension  
↔ ← Compression

# Theropods: Evolutionary Trends

## SKULL

Pneumatization of snout

Accessory antorbital openings

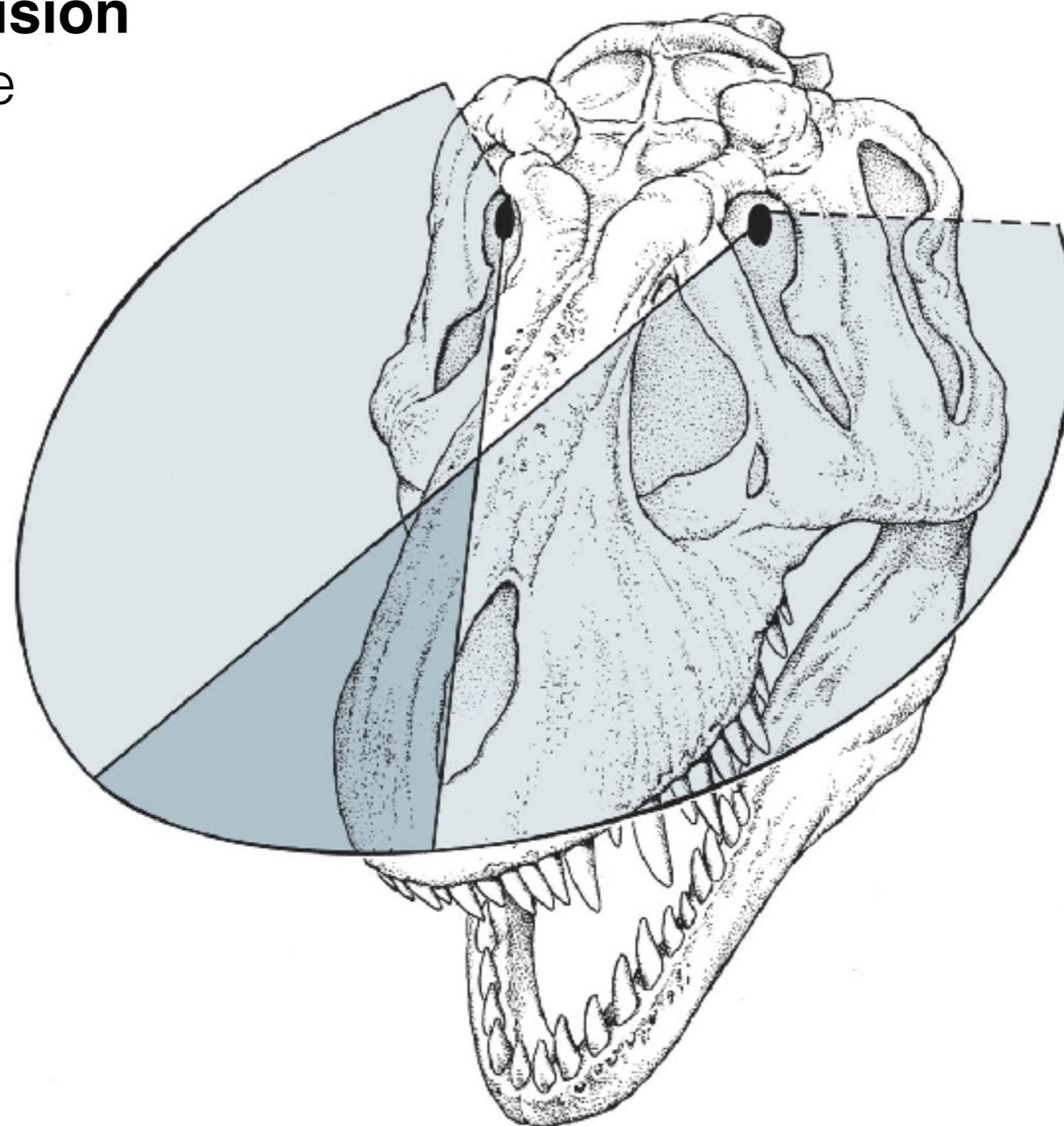
## **Stereoscopic Vision**

Larger Brain size

## AXIAL SKELETON

Finger Elongation

Limb Elongation (faster)





Copyright Universal Studios

# Theropods: Evolutionary Trends

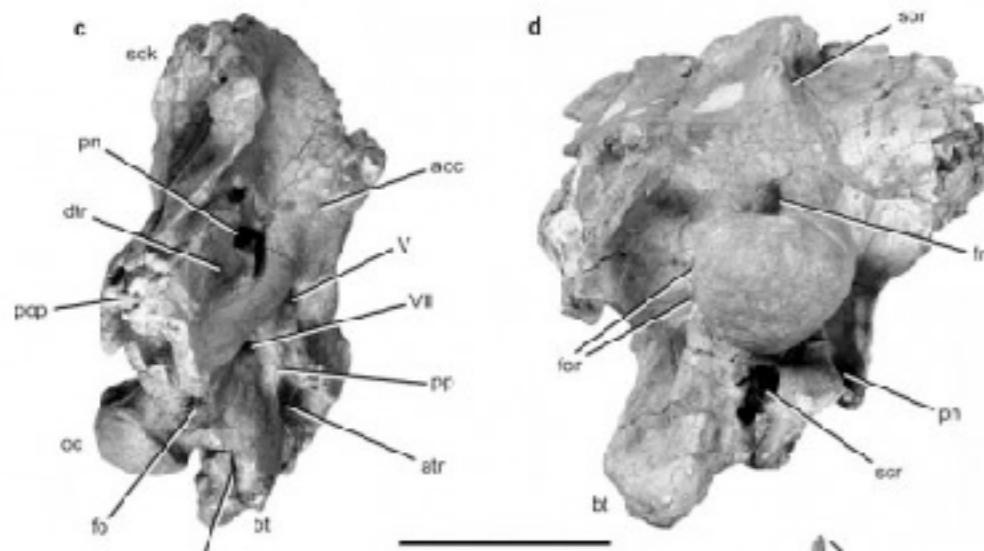
## SKULL

Pneumatization of snout

Accessory antorbital openings

Stereoscopic Vision

## Larger Brain size



*Shauchilong*



Emphasize olfactory  
and visual lobes

Troodontids had the  
largest relative brain  
size of any dinosaur

## AXIAL SKELETON

Finger Elongation

Limb Elongation (faster)



# Theropods: Evolutionary Trends

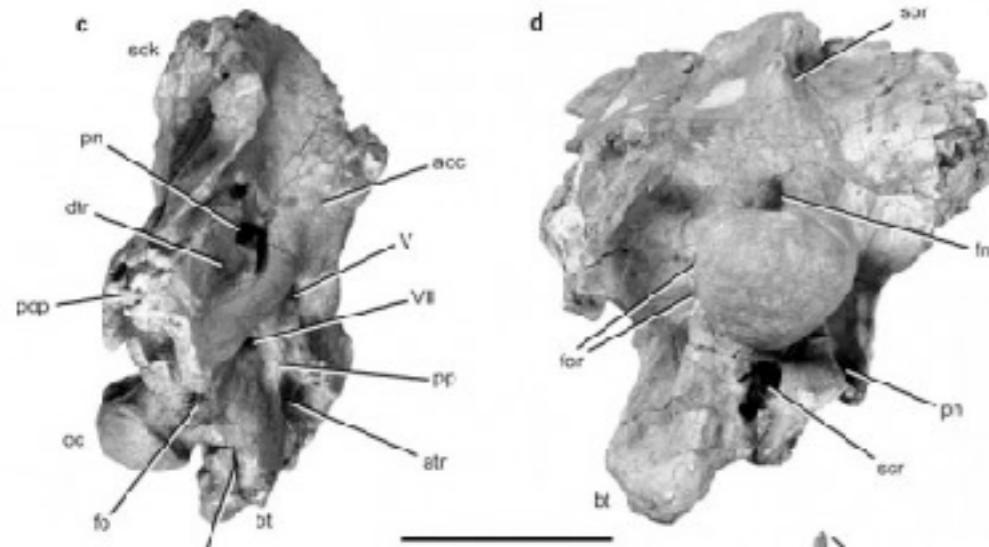
## SKULL

Pneumatization of snout

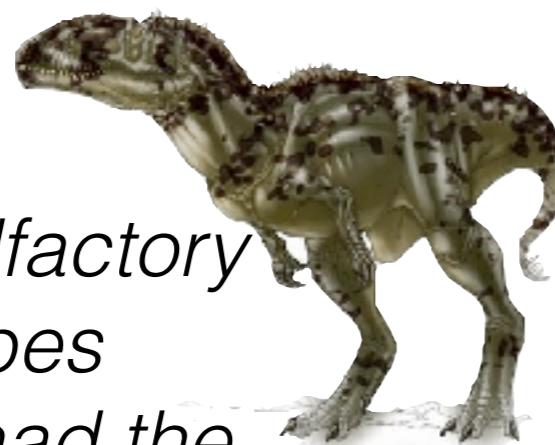
Accessory antorbital openings

Stereoscopic Vision

## Larger Brain size



*Shauchilong*



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# Theropods: Evolutionary Trends

## SKULL

# Pneumatization of sinuses

# Accessory antorbital openings

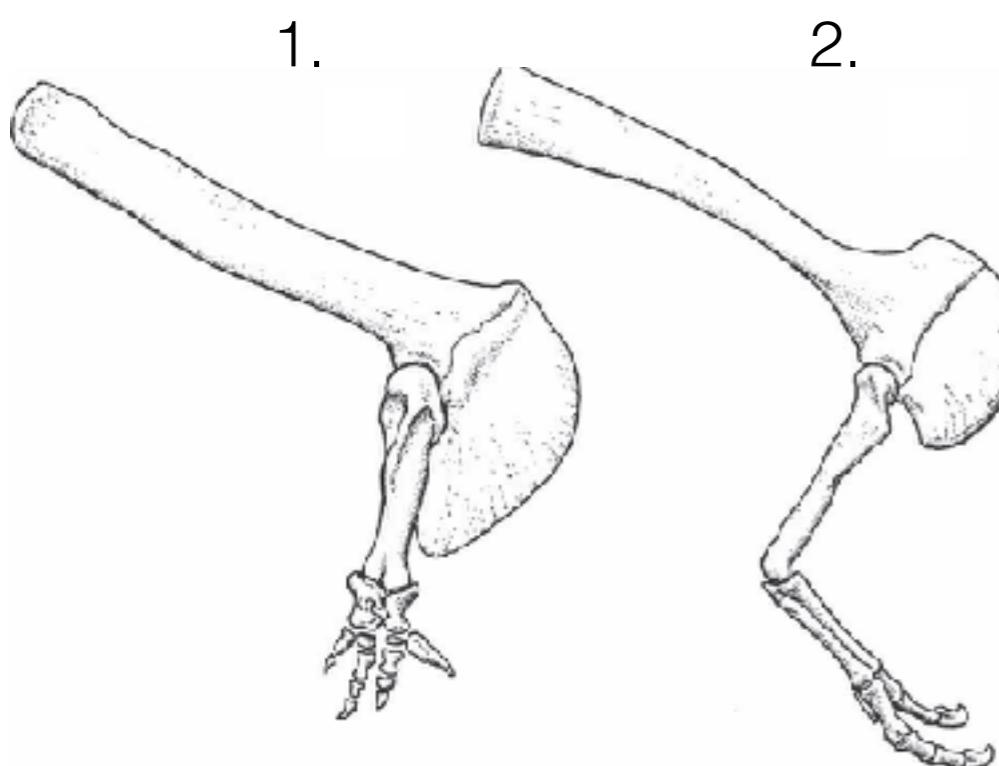
# Stereoscopic Vision

## Larger Brain size

# AXIAL SKELETON

# Finger Elongation

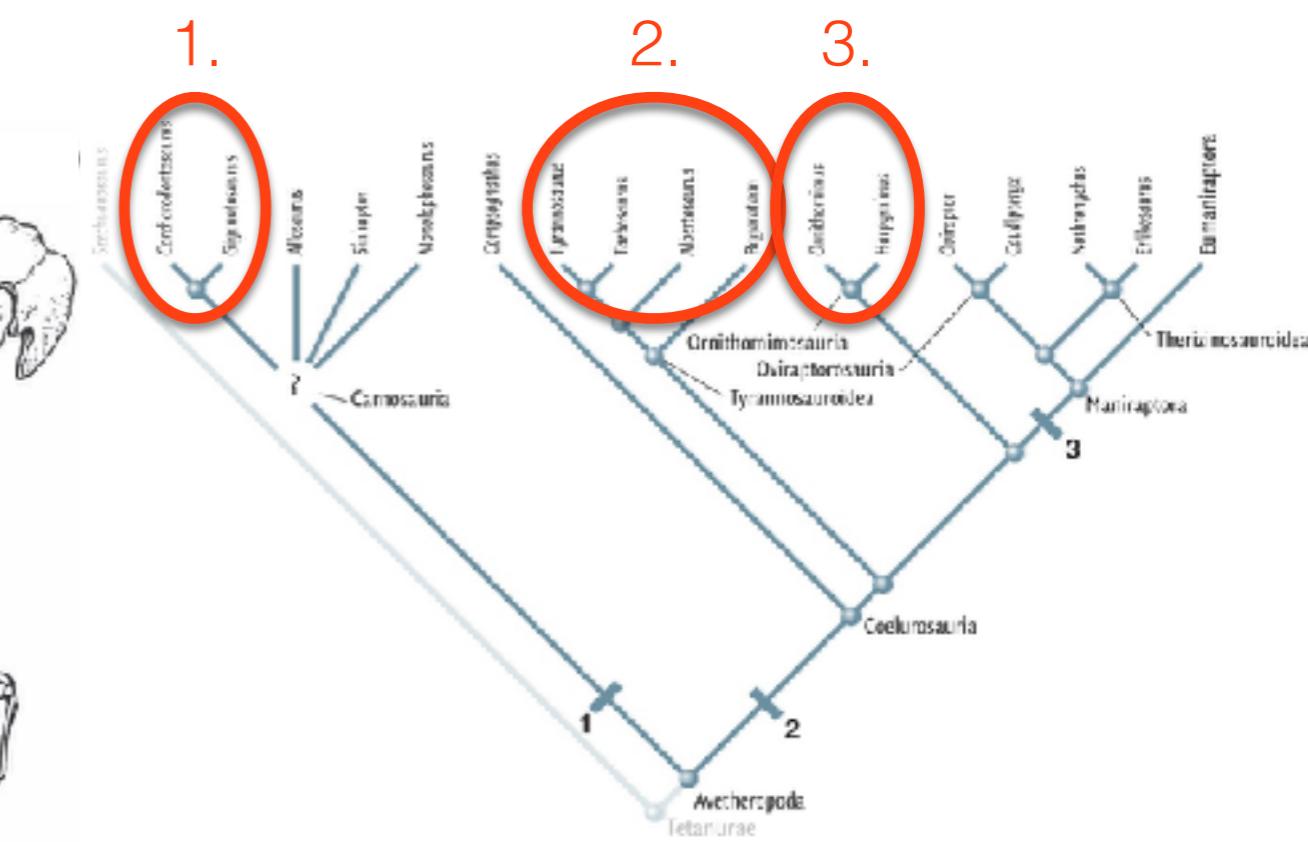
## Limb Elongation (faster)



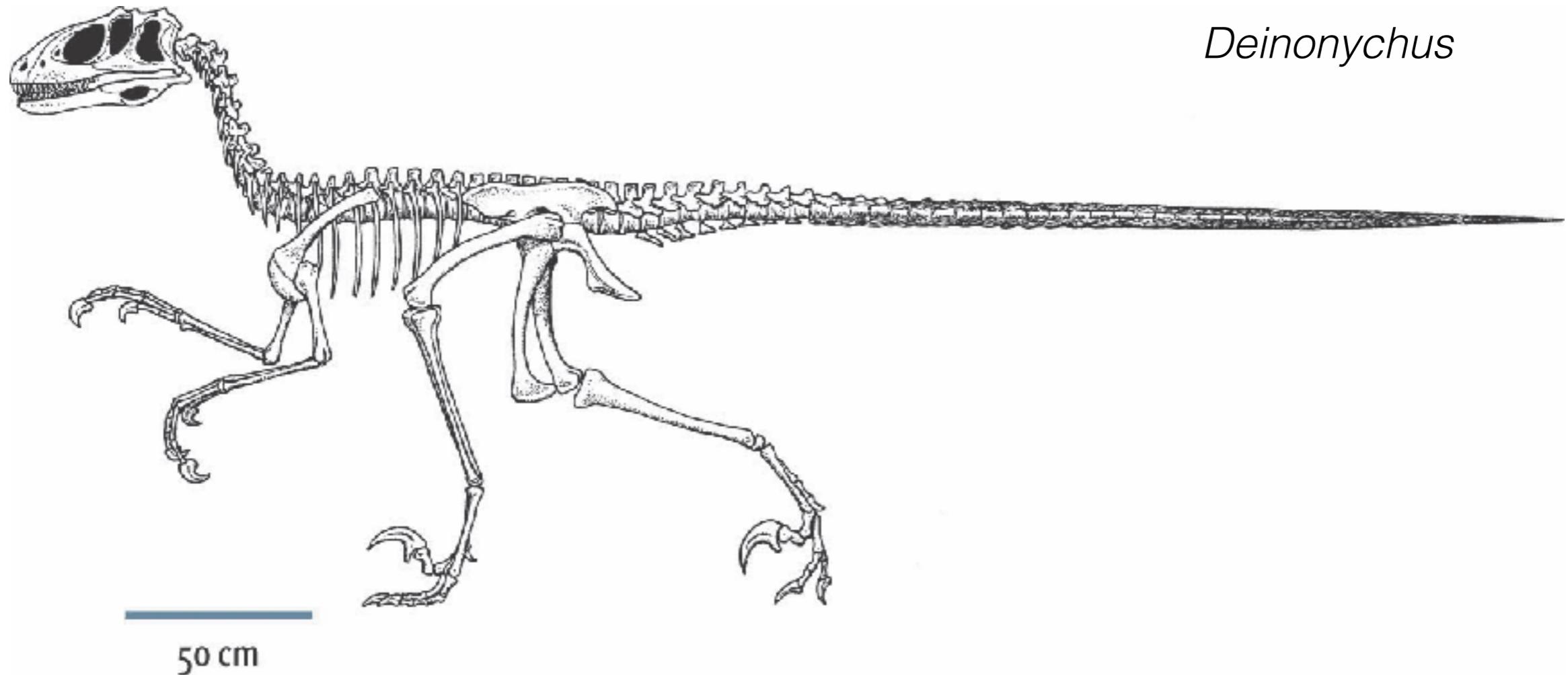
# Ceratosaur

# Tyrannosaurus

# Ornithomimid



# Theropods: Balance and speed



Near horizontal vertebral column

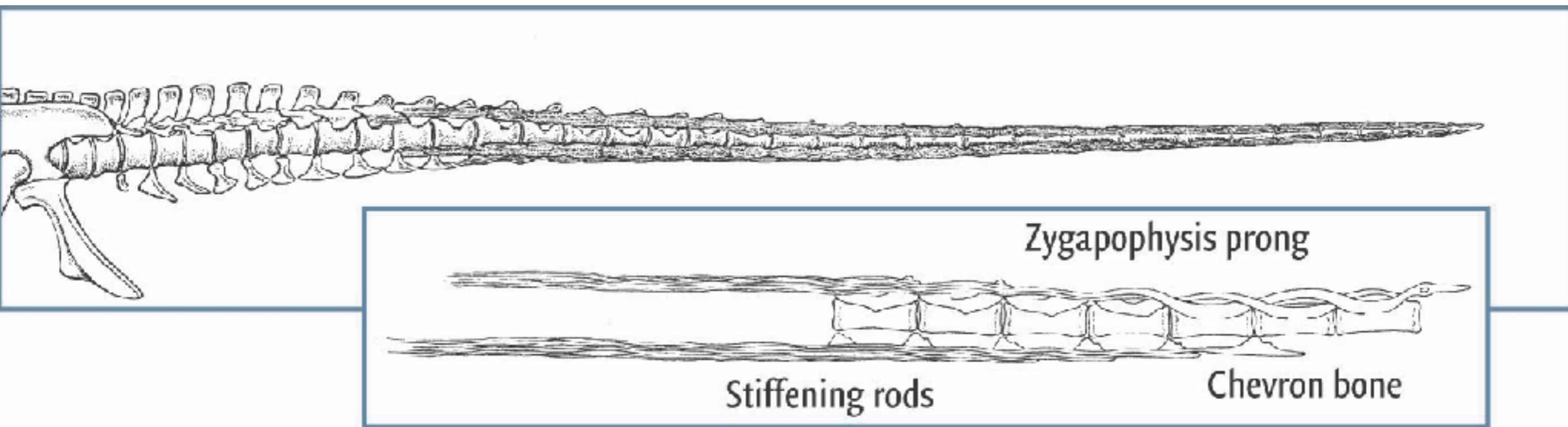
Center of gravity positioned at hips

allowed for quick pivoting

Some derived theropods had tails stiffened by elongate processes on neural arches

Tail flexible at base for dynamic counter balance (cheetah)

# Theropods: Balance and speed







Persistence hunting:  
a bipedal invention

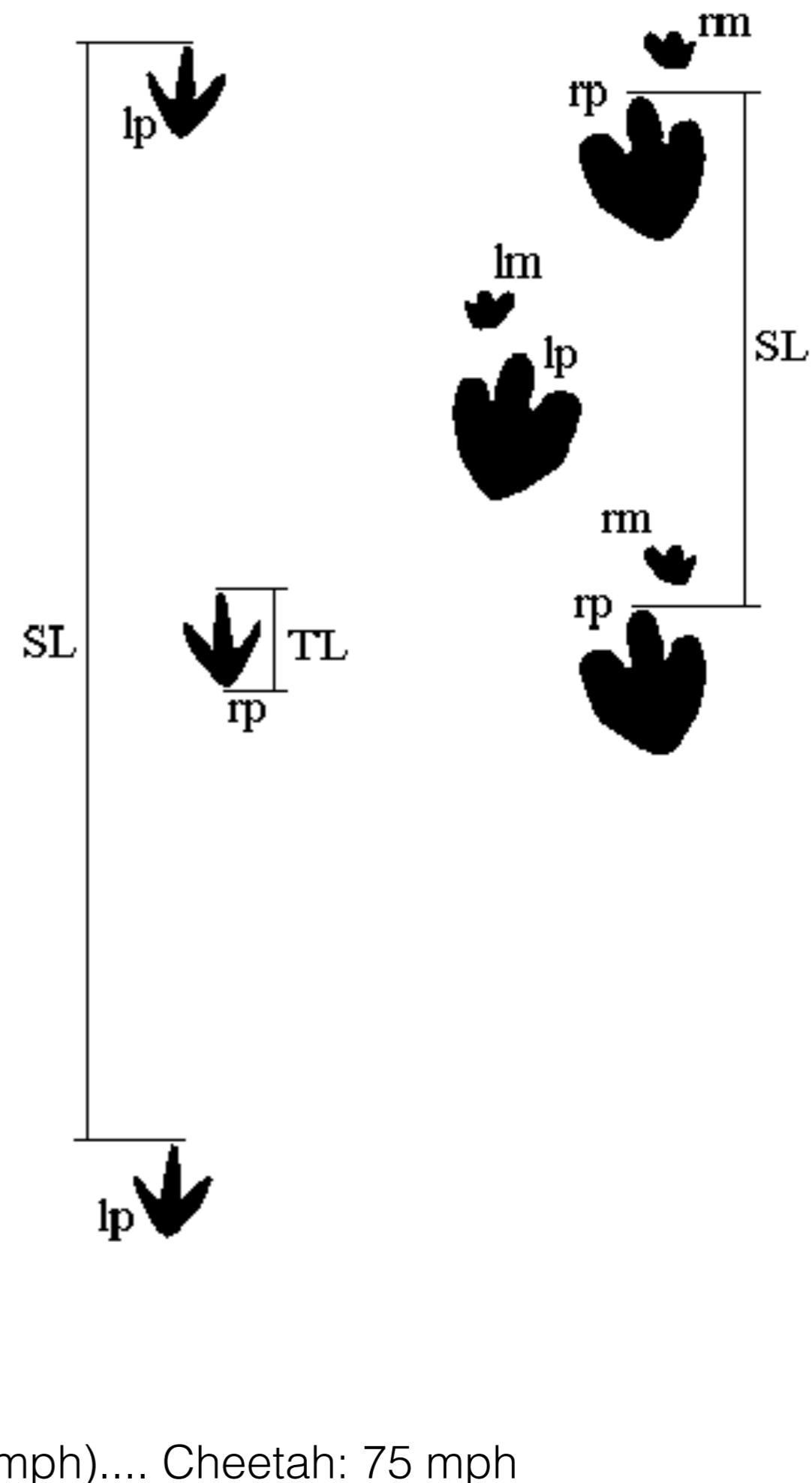
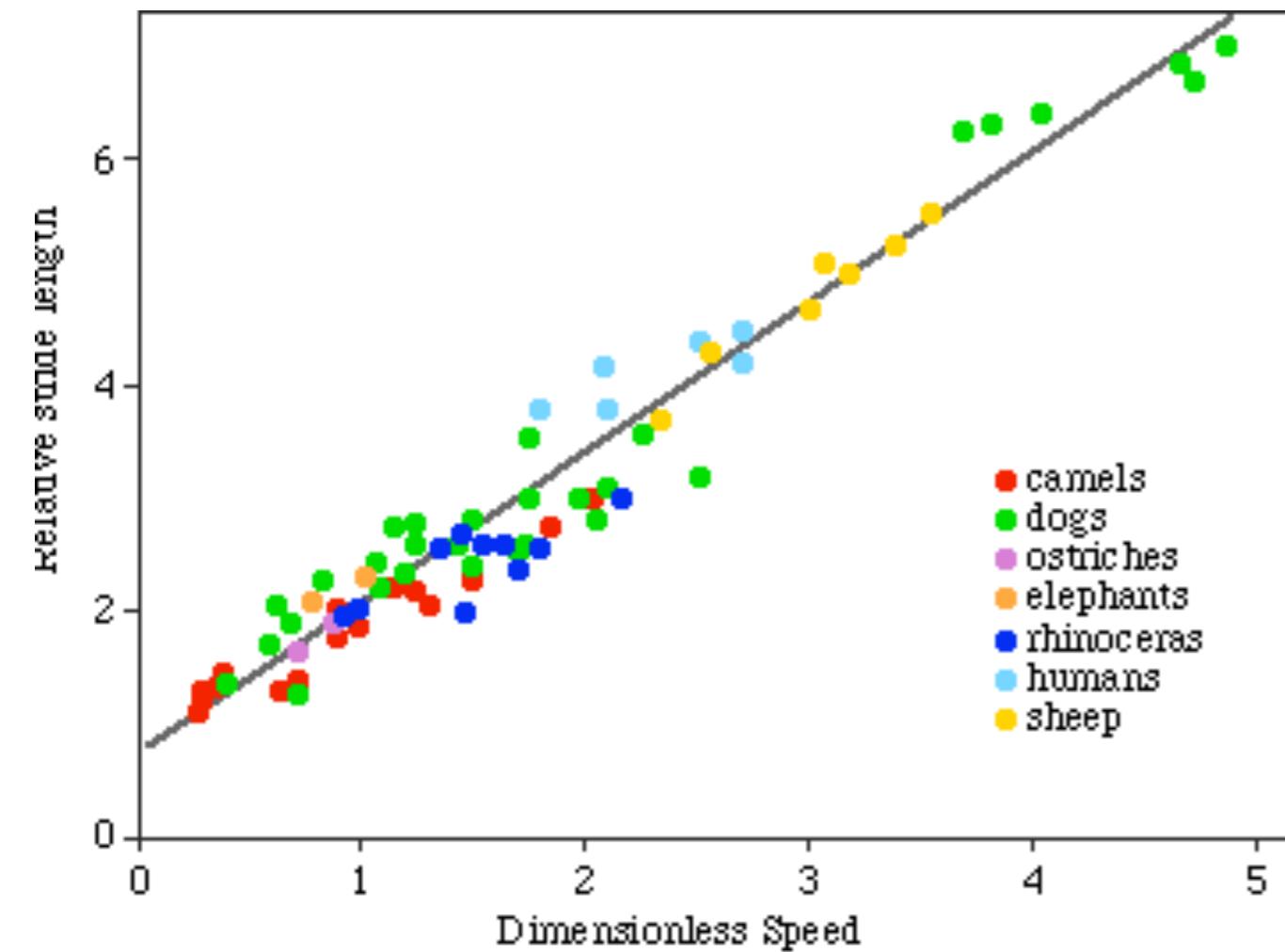


BBC





# Theropods: Balance and speed



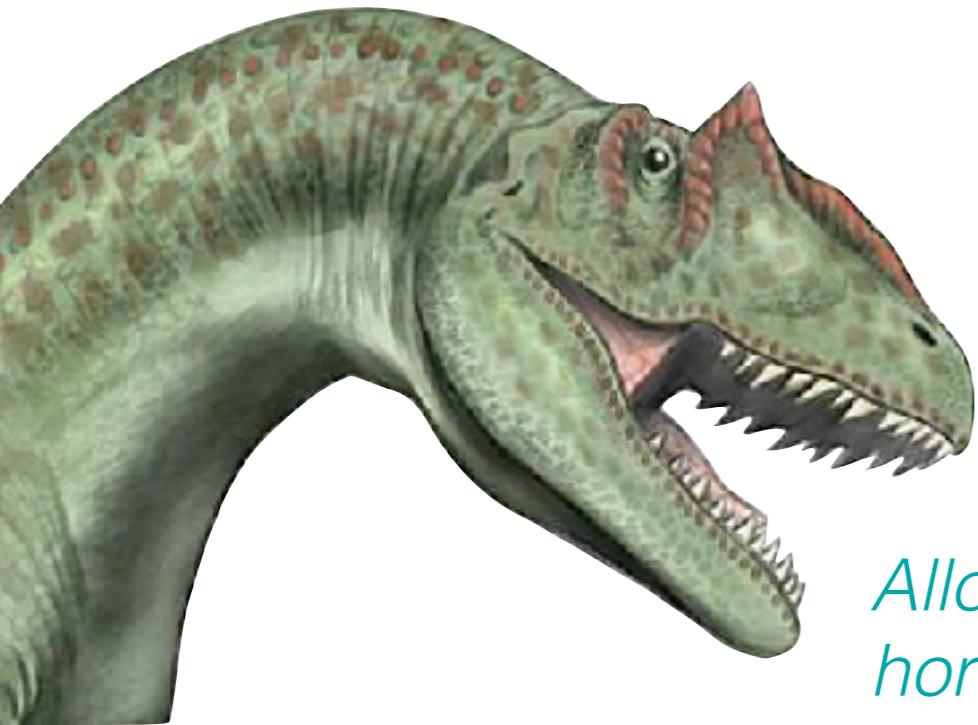


# Theropods: Specializations

## Cranial Ornamentation



*Ceratosaurus: Nasal Horn*



*Allosaurus: Frontal-Eye horns*

*Tyrannosaurus: Rugosities on head*



The most famous crested theropod...



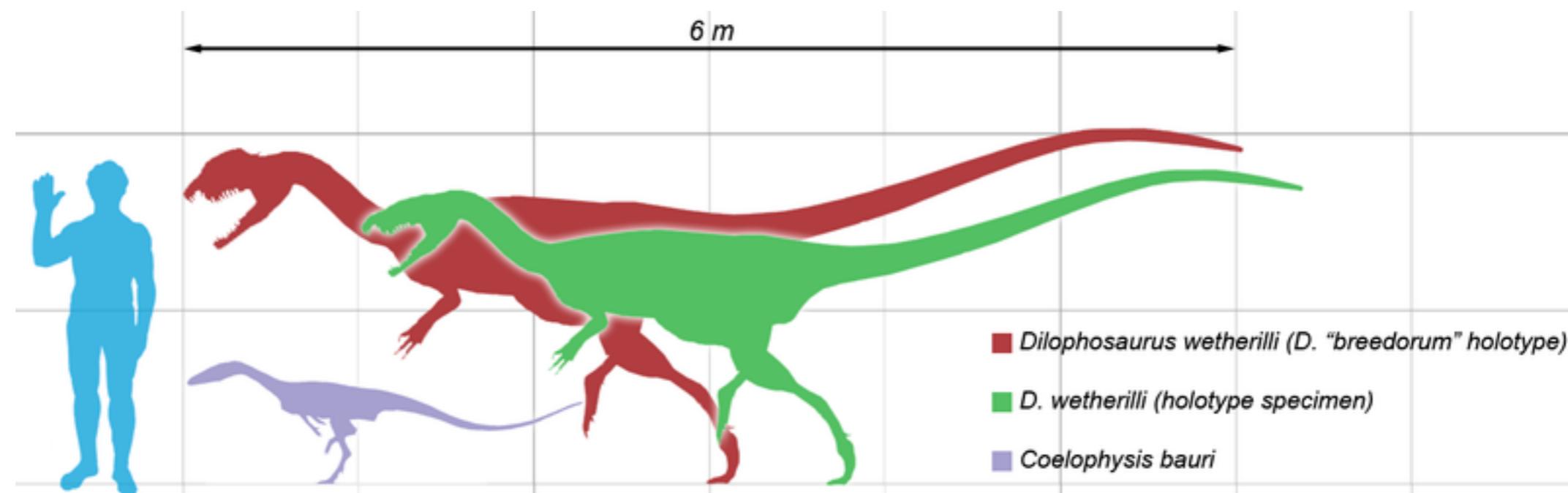
# Theropods: Specializations

## Cranial Ornamentation

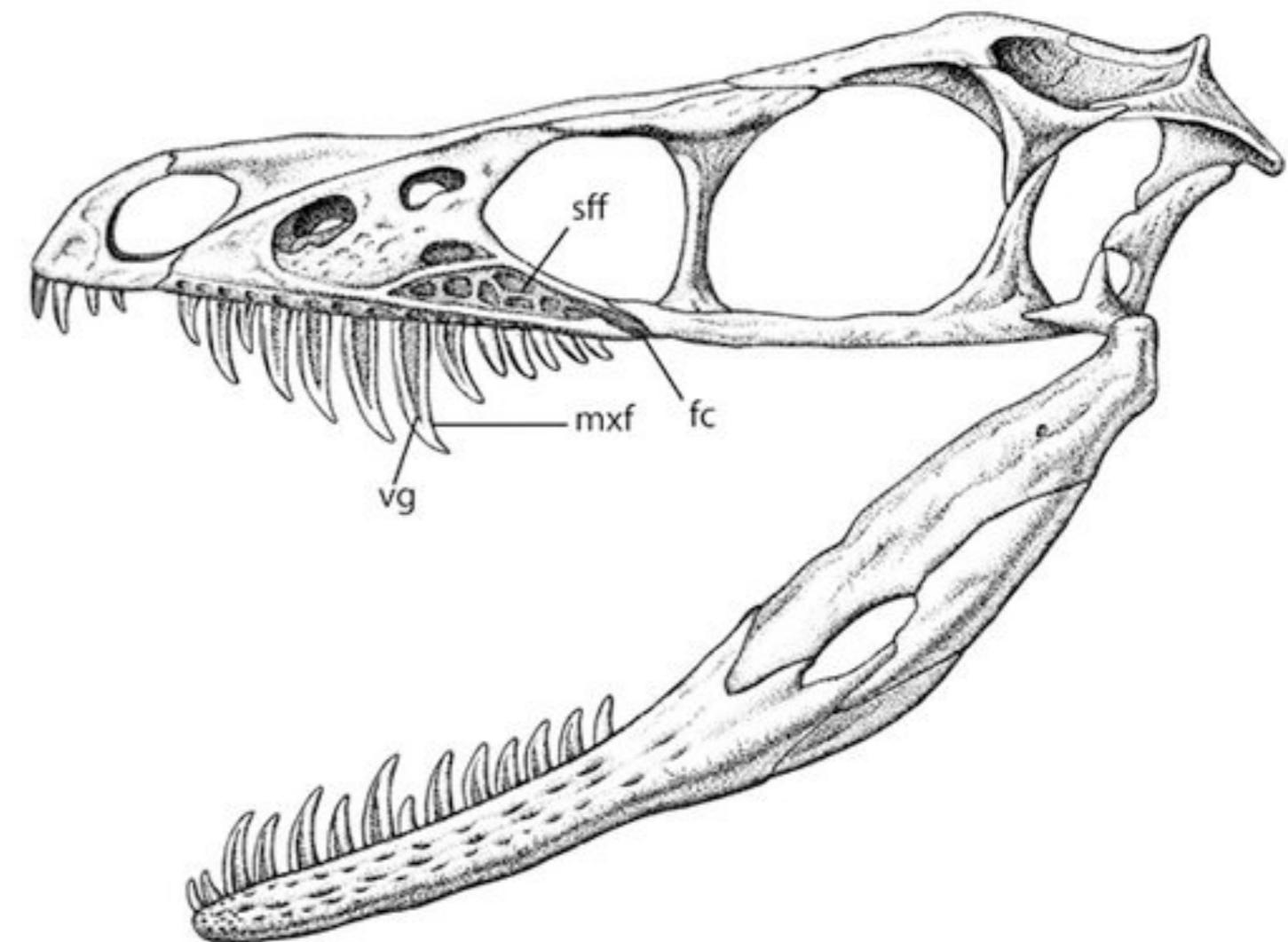
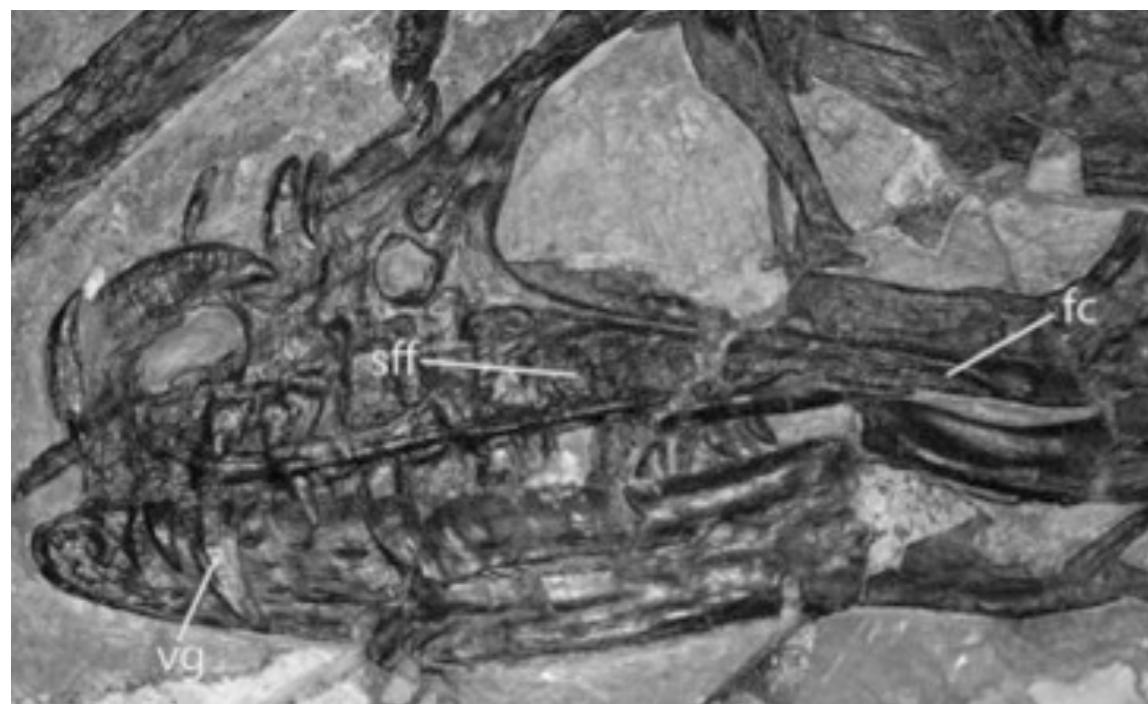
No evidence for frill  
or venom glands



*Dilophosaurus: Basal Theropod*



No evidence for frill or venom glands in  
*Dilophosaurus*... but: *Sinornithosaurus*  
(Dromaeosaur) 2009



Rear-fanged  
Rear-fanged snakes don't inject venom; toxin flows down a groove  
Stupifying venom?



“The dragon's venom rapidly decreases blood pressure, expedites blood loss, and sends a victim into shock, rendering it too weak to fight.”

# Theropods: Specializations

## Cranial Ornamentation



*Cryolophosaurus: Early Jurassic,  
Antarctica*

*Monolophosaurus: Mid Jurassic,  
China*

*Pneumatic connections w/ nasal  
cavities*

*Resonating chamber?*



# Theropods: Specializations

## Cranial Ornamentation



Suggests some form of sociality  
If they lived in groups and hunted in packs,  
we might expect sexual dimorphism

Only known for *Syntarsus* and *Coelophysis*  
(both Coelophysids, or basal theropods)

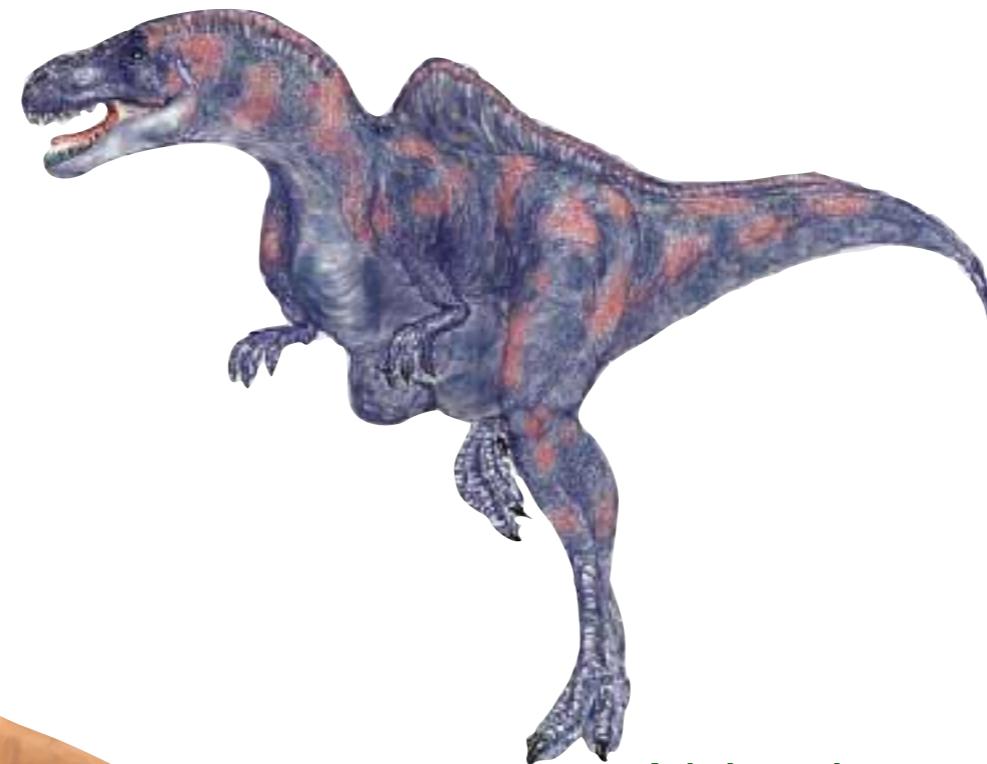


# Theropods: Specializations

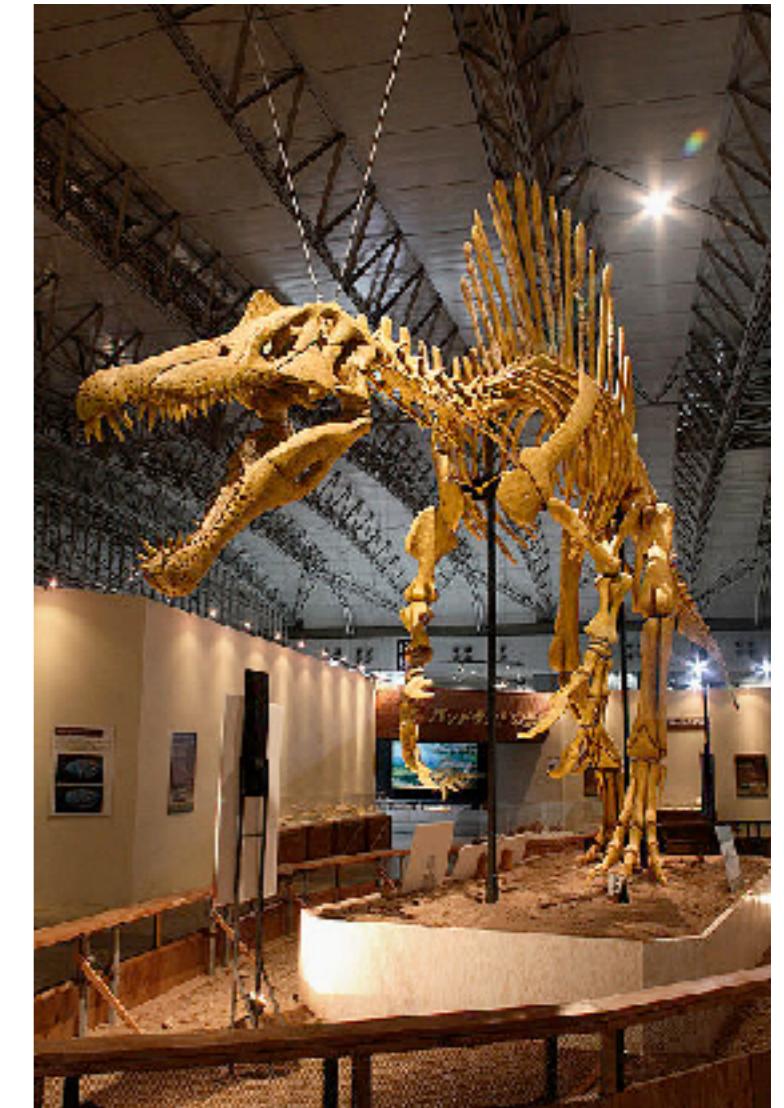
## Vertebral Spines



*Acrocanthosaurus*



*Altispinax*



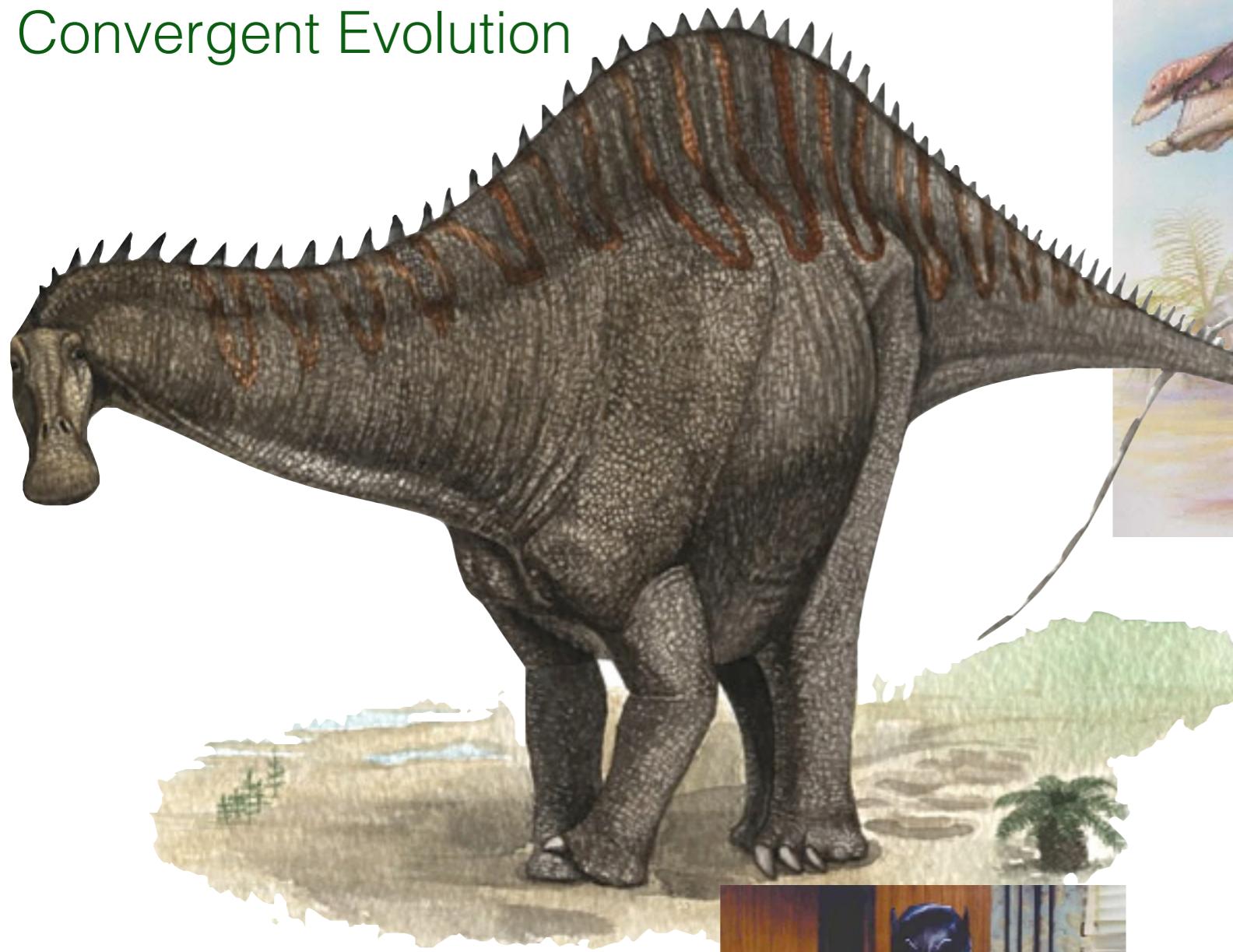
*Spinosaurus*

*All lived at sea level  
All lived near ocean  
Thermoregulation?*

# Theropods: Specializations

## Vertebral Spines

Convergent Evolution

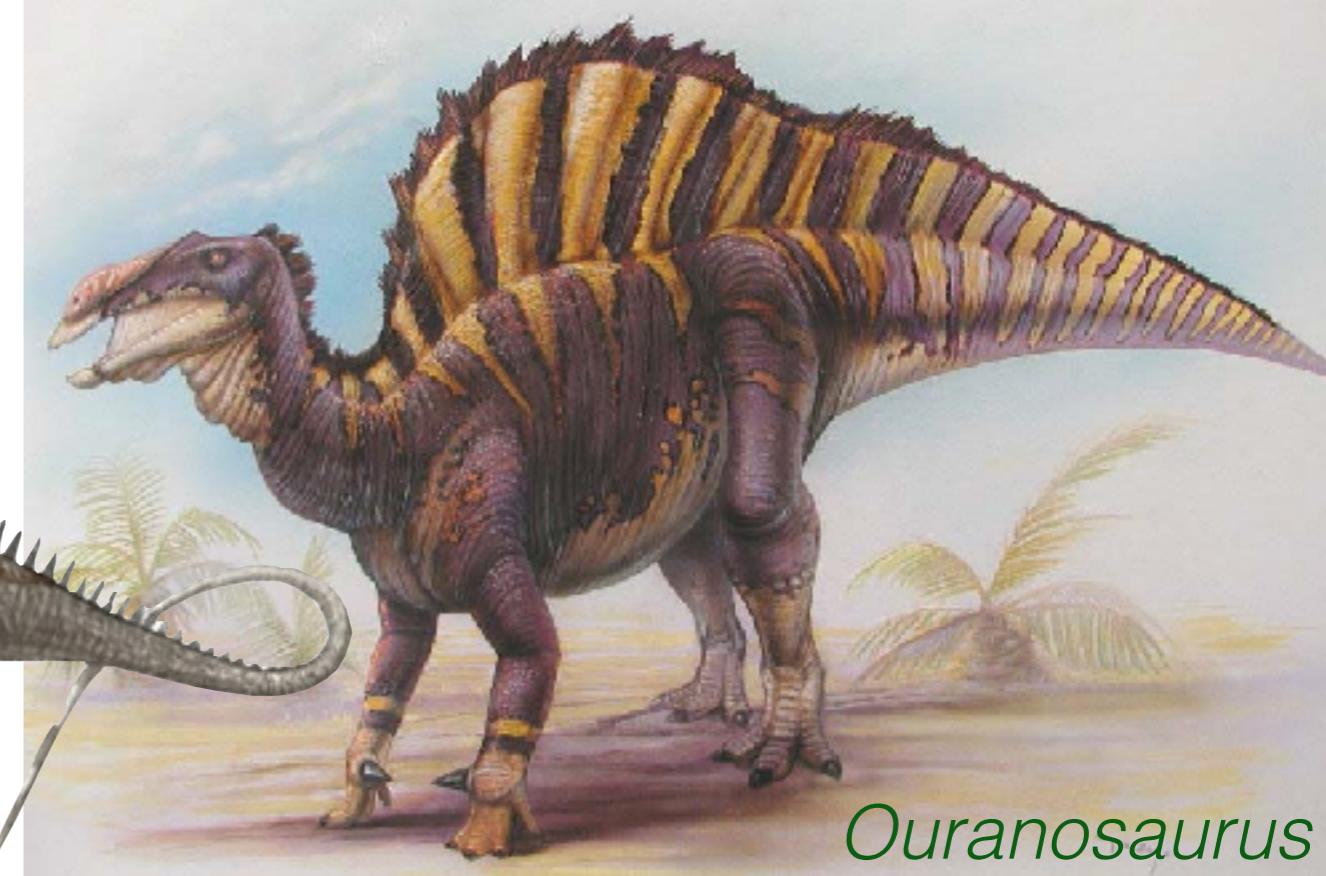


*Rebbachisaurus*

Same bat-time

Same bat-habitat

Same bat-evolutionary forces



*Ouranosaurus*



*Spinosaurus*

# Theropods: Parental Care



# Theropods: Parental Care



# Theropods: Parental Care

## Tyrannosaurus

Young Tyrannosaurs found with adult Tyrannosaurs, but no evidence of gregariousness

Tyrannosaurs were likely altricial (needed parental care)



## Precocial young vs. small Theropods

Large Theropod juveniles (if Precocial) would have competed with smaller fully grown Theropods

Large Theropod juveniles (if Altricial) would have relied on adults for food, lifting competition from other small Theropods

## Hypothesis:

IF Tyrannosaurids raise altricial young, THEN you should find coexisting small-bodied Theropods



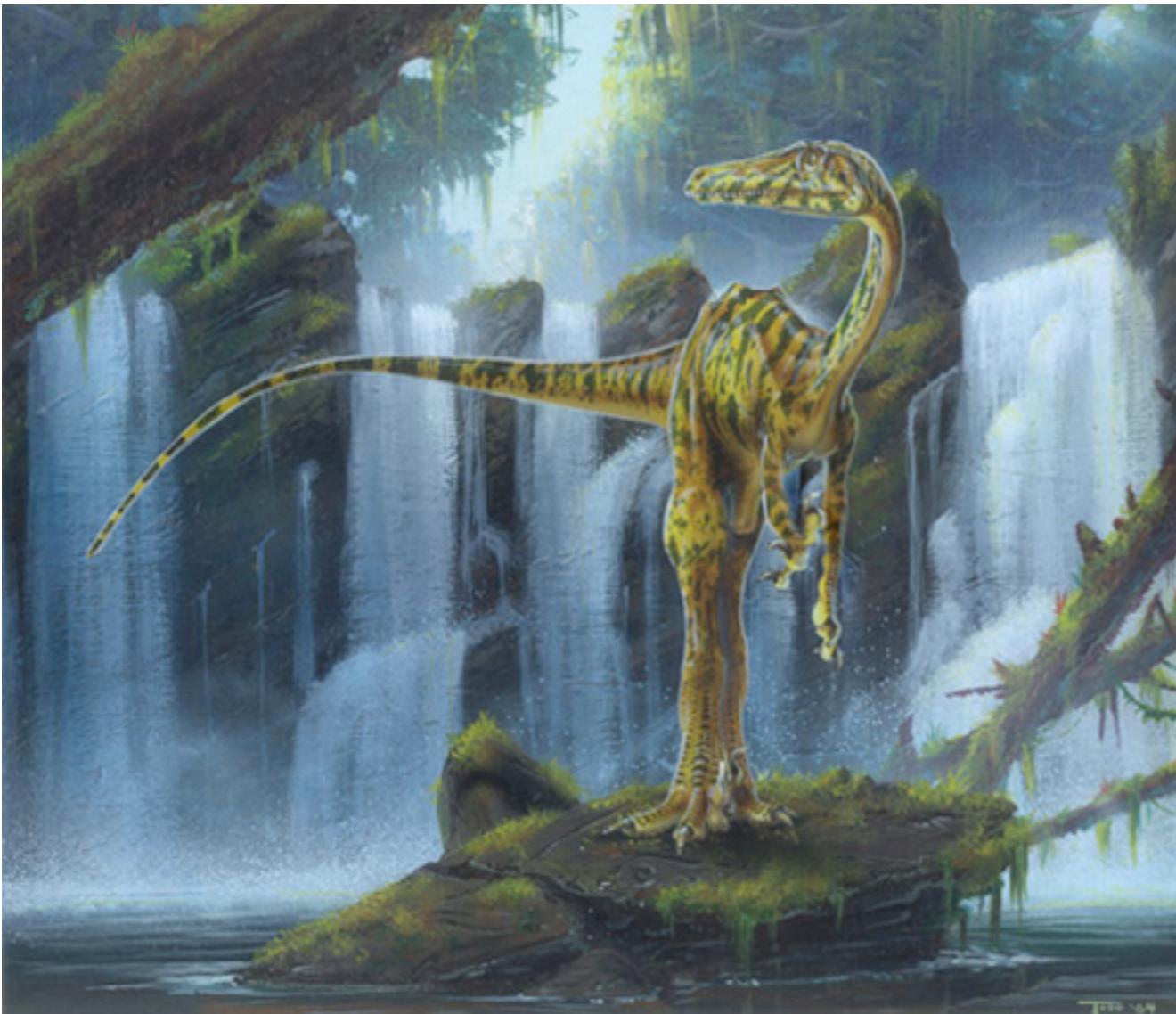
~The greatest diversity of small-bodied Theropods are found within Tyrannosaurids

# Theropods: Specializations

## Claws



# Troodontids

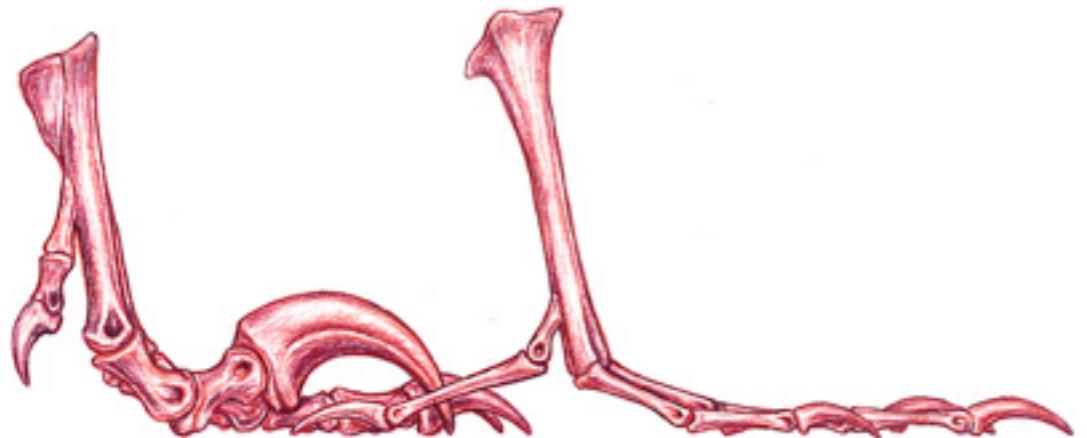


# Dromaeosaurids



*Troodon*





*When muscles were contracted, the large claw retracted (during walking, running)*

*Claw base-to-tip angle maximized the transmission of forces from the leg to the claw tip*

*Maneuverable tail would be used for balance while the front of the body was slashing*

*Small Theropods were almost certainly active hunters.*

*What about Large Theropod dinosaurs?*



# Predators vs. Scavengers

## Active Hunters

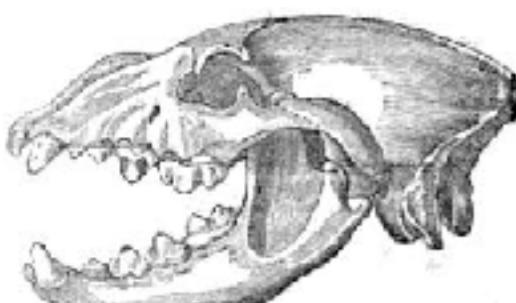
Leg length: efficient runners

Stereoscopic Vision

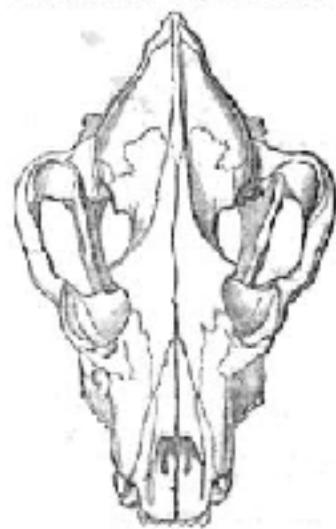
Disproportionately long teeth

Healed bitemarks on Sauropod bones

Direct Evidence



Skull of Spotted Hyena: profile. (Cuvier.)



Skull of Spotted Hyena, seen from above. \*

## Scavengers

Rounded teeth

Small arms

Large olfactory lobes in brain



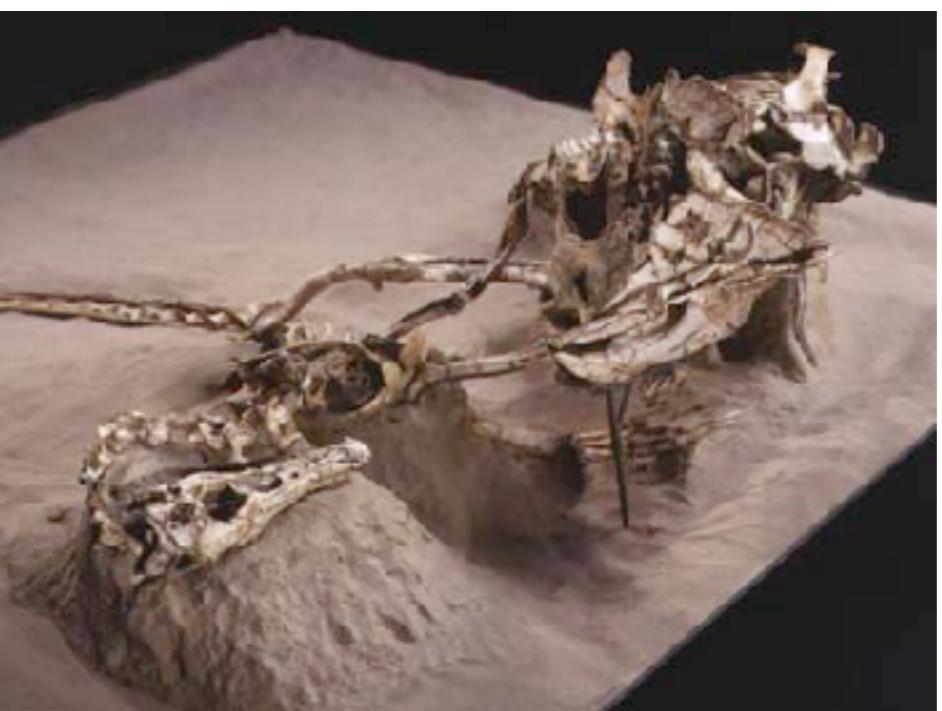
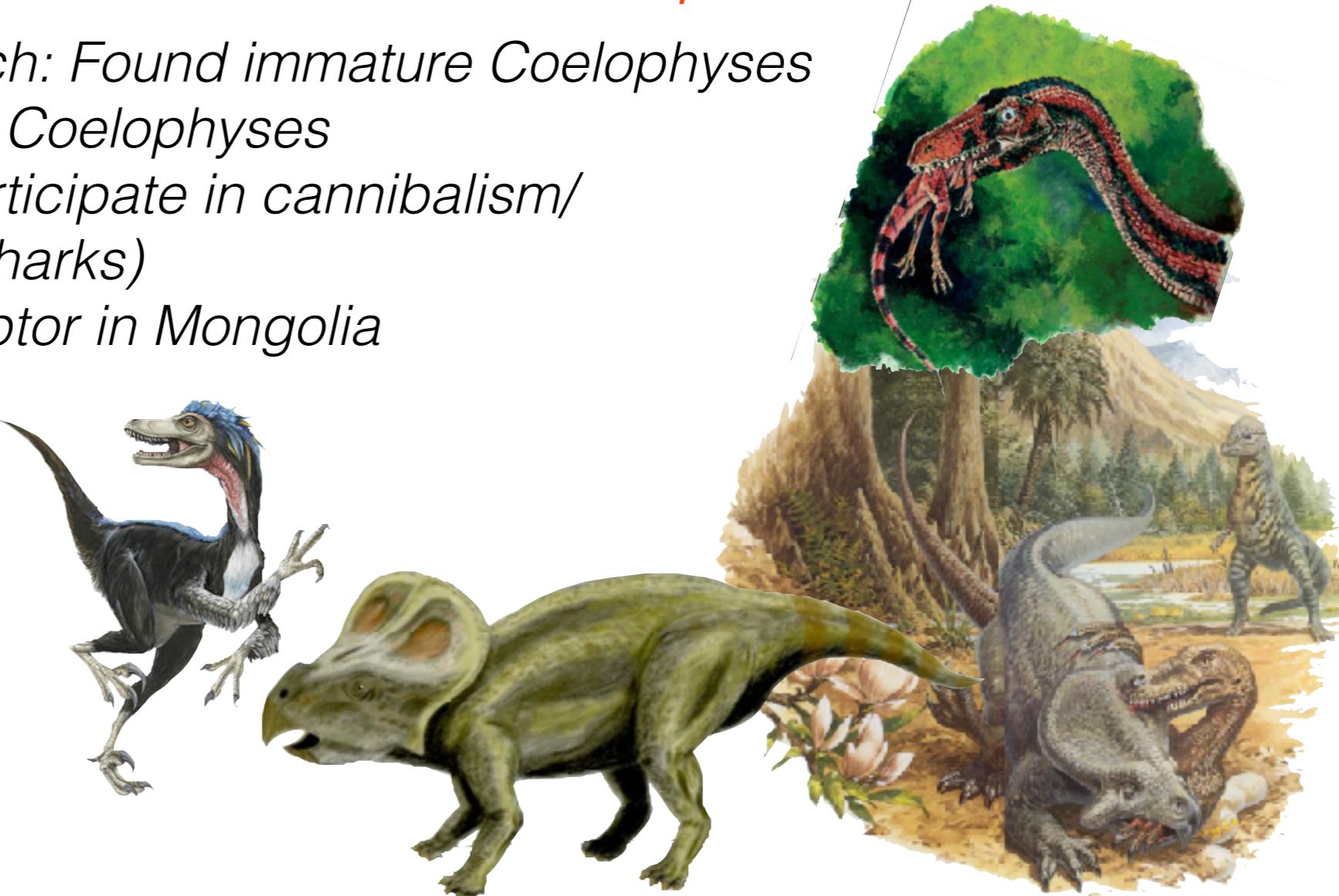
Hyenas: modern scavenger ‘specialists’  
Typically only scavenge prey 30% of the time

# What is the tangible evidence for Dinosaur predation?

1) Coelophysis @ Ghost Ranch: Found immature Coelophyses in the stomach of larger male Coelophyses

Lots of modern animals participate in cannibalism/  
intraspecific killing (lions, sharks)

2) Protoceratops vs. Velociraptor in Mongolia



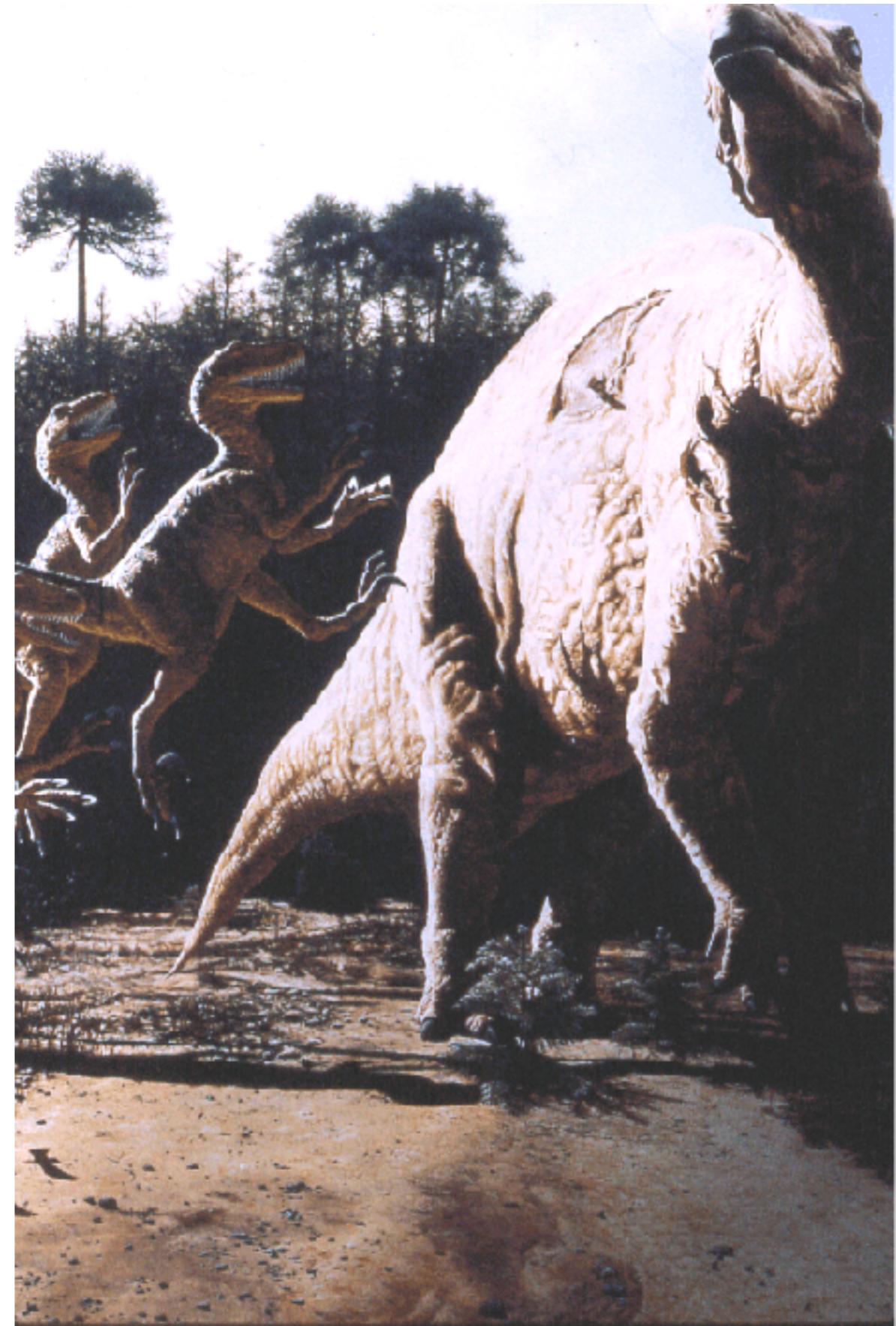
Lion Ambush



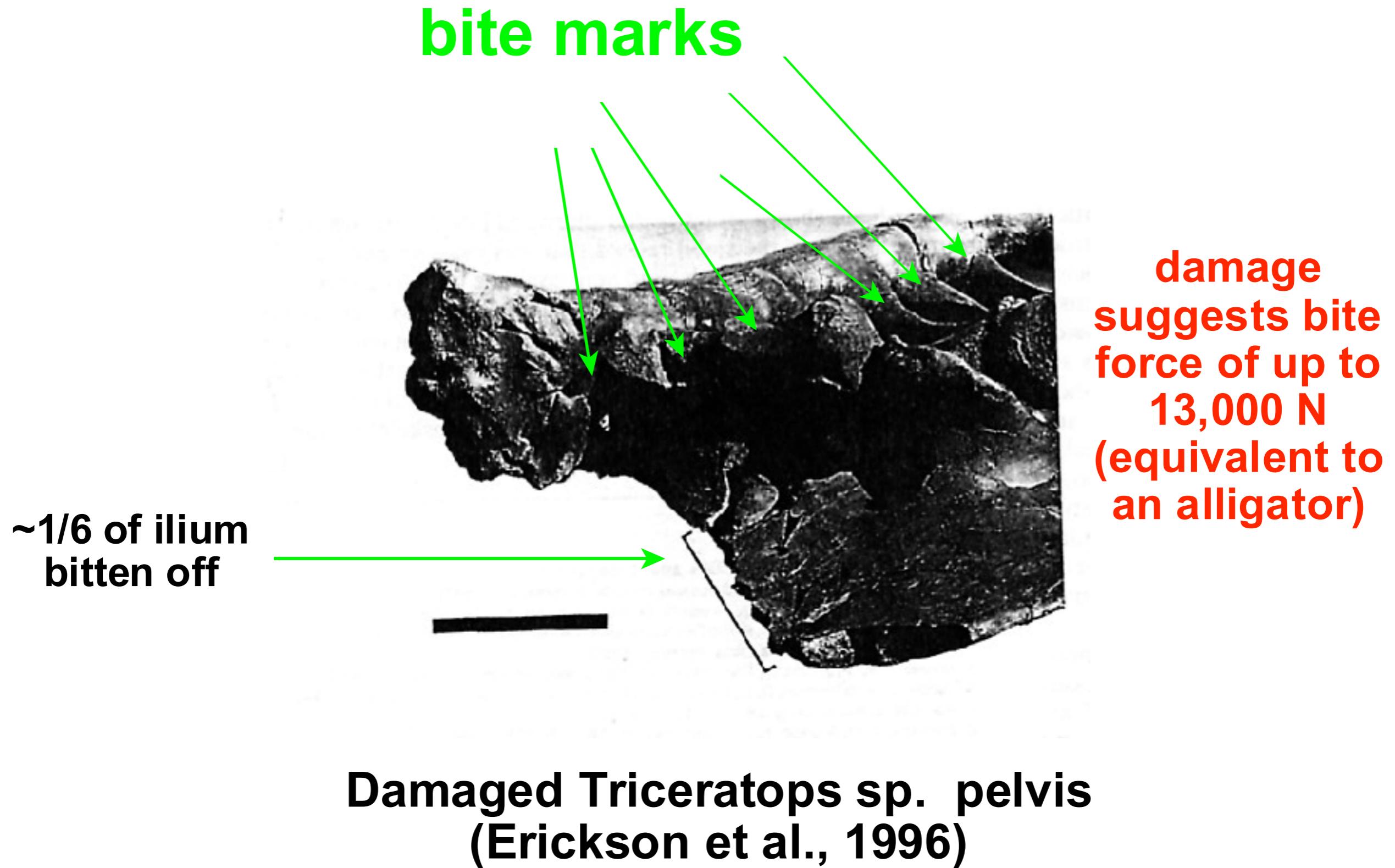
## What is the tangible evidence for Dinosaur predation?

3) Three *Deinonychus* found underneath a *Tenontosaurus* ornithopod that had apparently been predated upon by other *Deinonychus* dinos

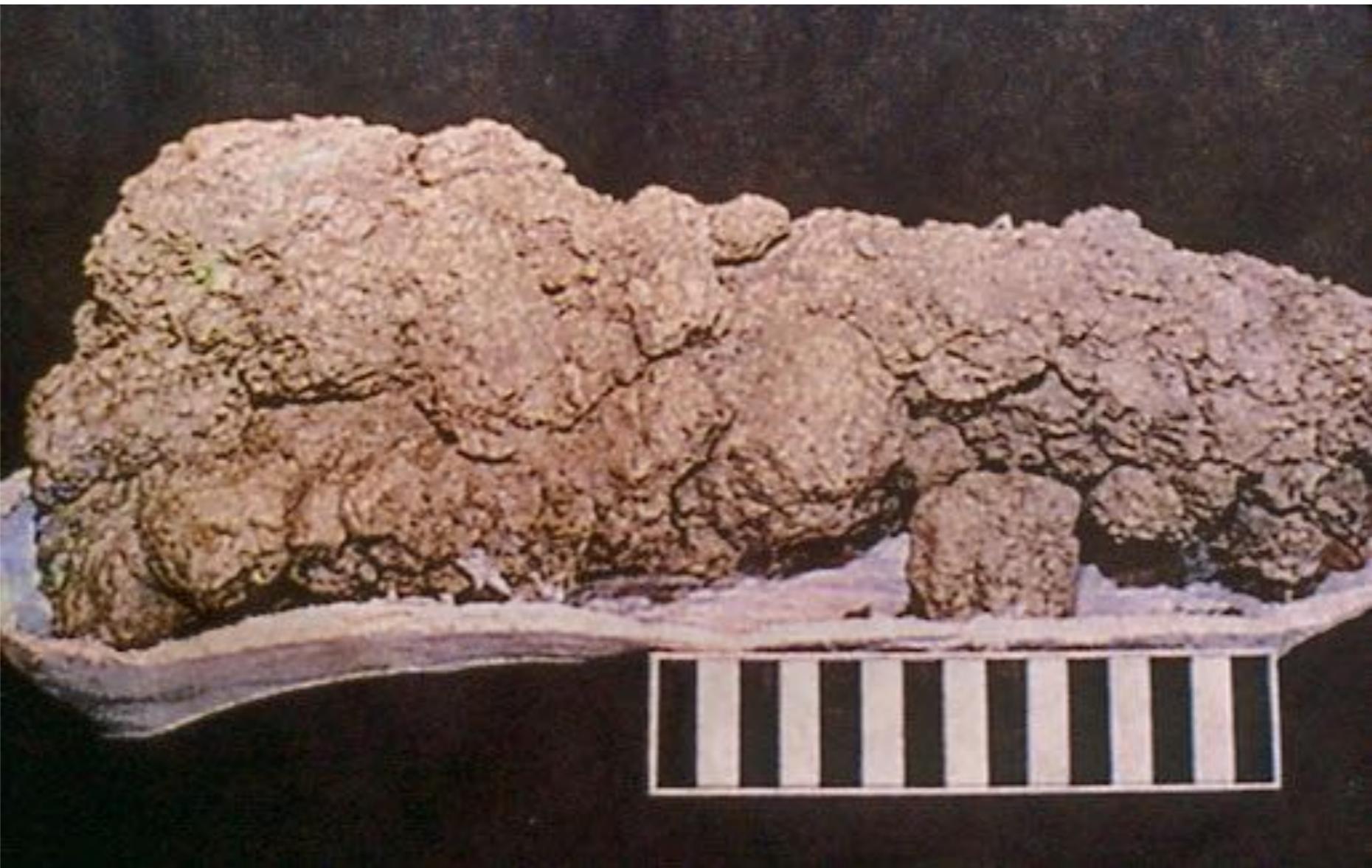
- Suggests not only predation
- But PACK HUNTING



*What is the tangible evidence for Dinosaur predation?*



*What is the tangible evidence for Dinosaur predation?*

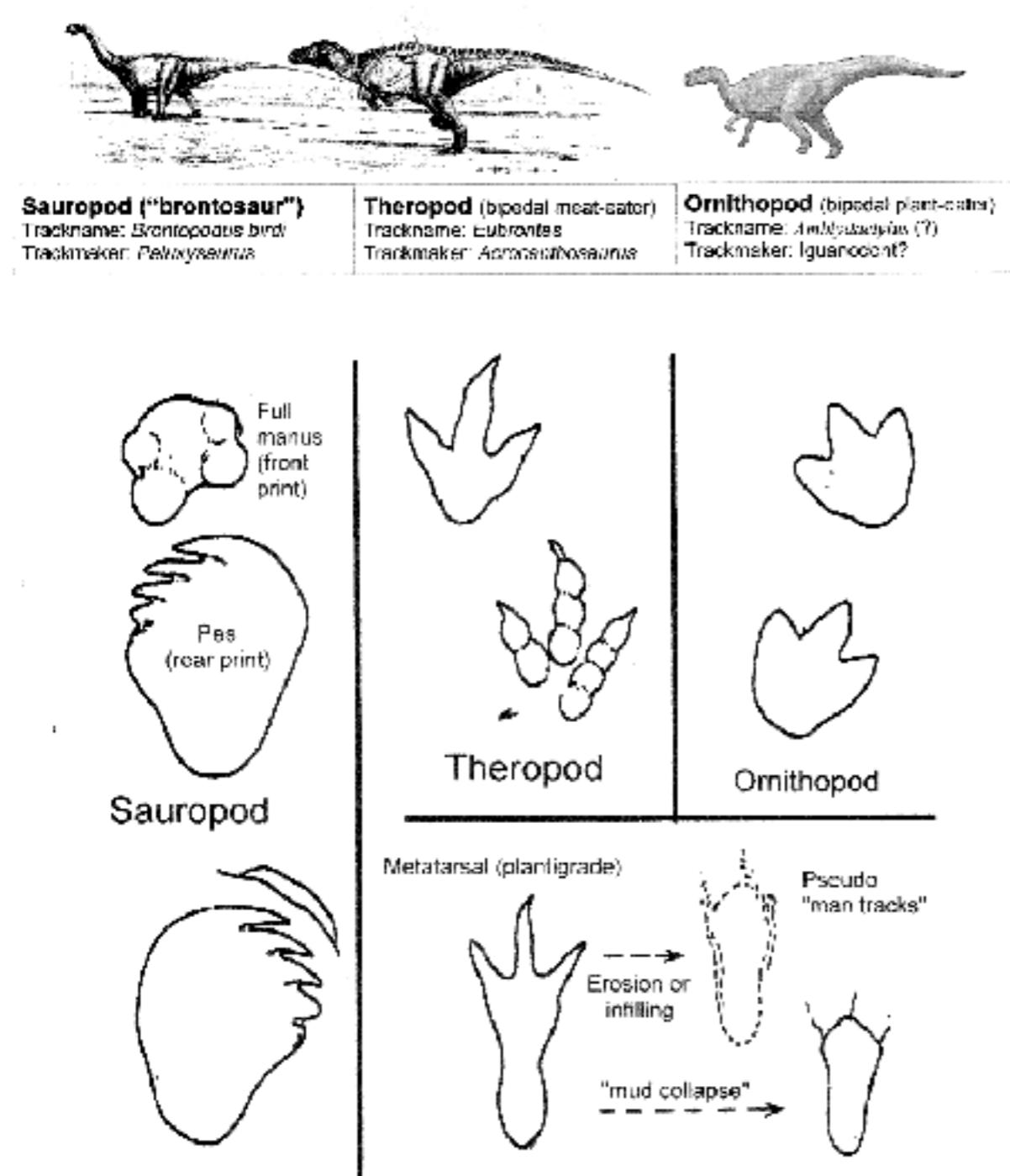


*Bone-filled coprolites*

# What is the tangible evidence for Dinosaur predation?

## Trackways

### Major Types of Dinosaur Tracks in Texas





## Paluxy Valley, Texas

*A large Theropod appears to be following a Sauropod in deposits that were not open to the atmosphere for a very long period of time*

*BEWARE: trackways leave a lot to be INTERPRETED*

# Holyoke, Massachusetts

## Early Jurassic



*Potentially a pack of up to 40  
Theropod dinosaurs*



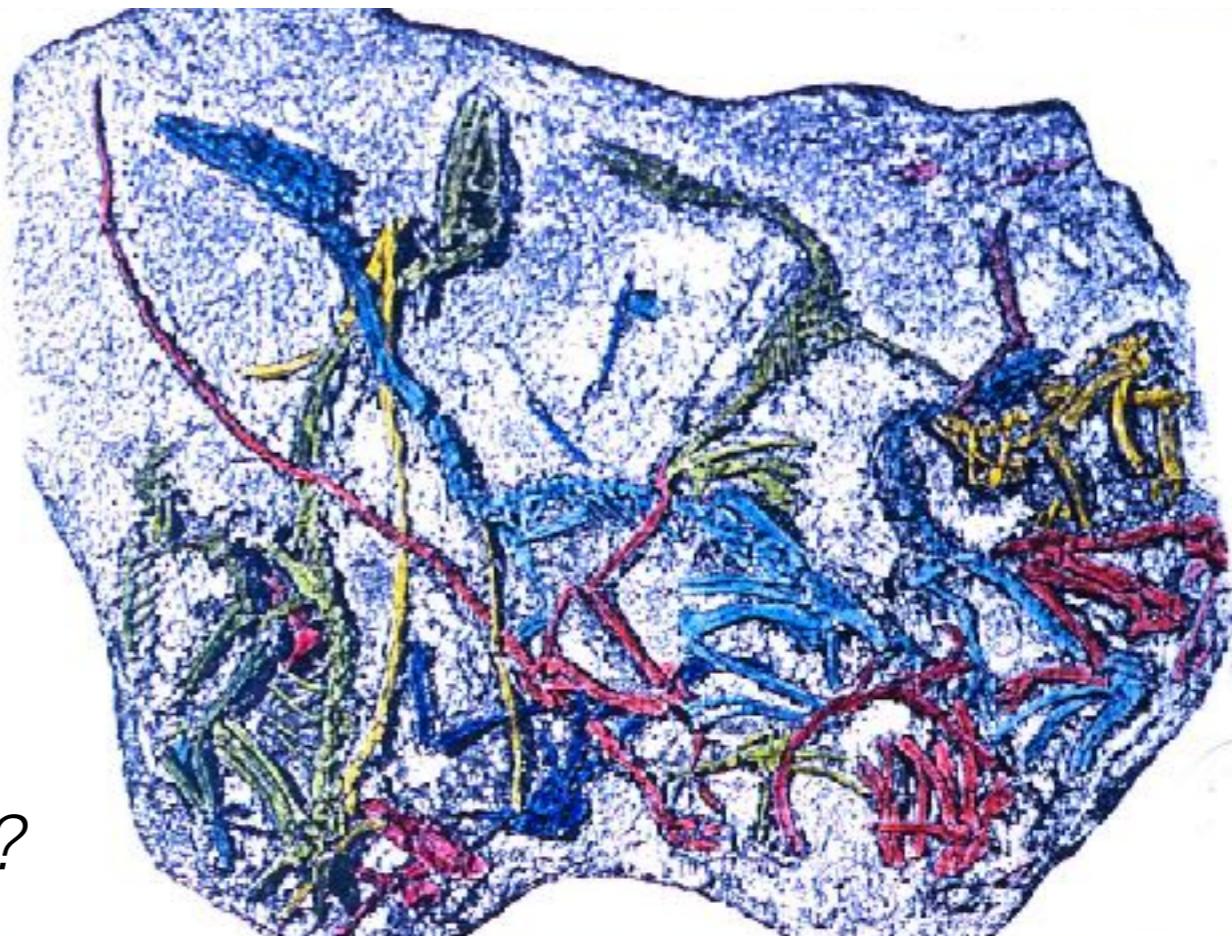
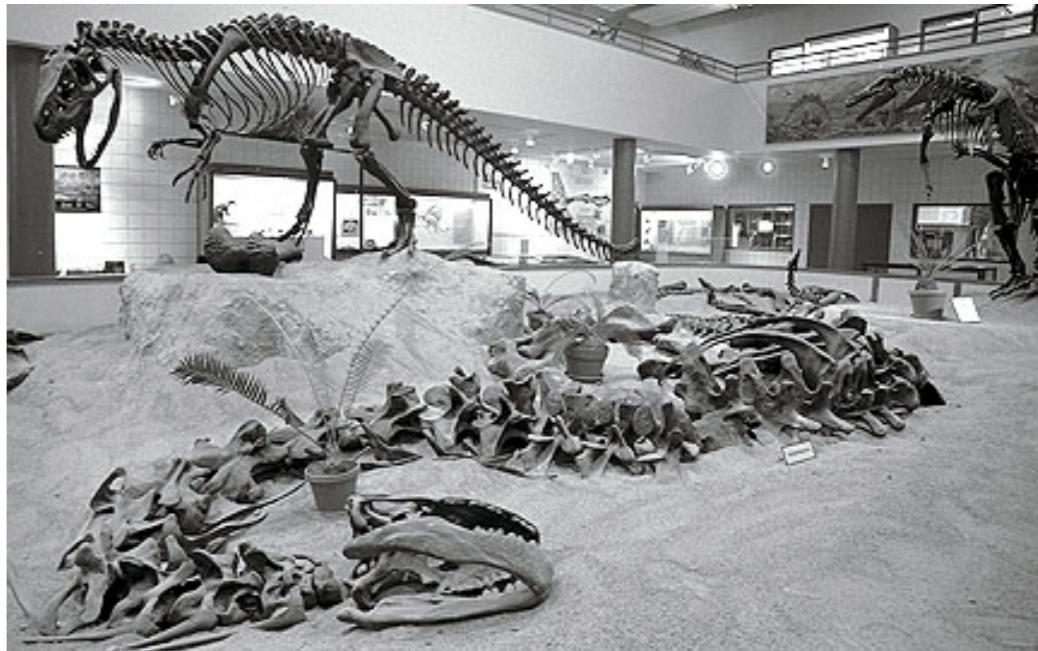


FIGURE 8.6  
Distribution and orientation of excavated bones at the Cleveland-Lloyd dinosaur quarry in Utah where the remains of at least 44 individuals of *Allosaurus* were collected. The bones apparently accumulated in an oval-like depression in the center of the "predator pit" on site.

## Cleveland-Lloyd Dinosaur Quarry, Utah

*Evidence of gregariousness?  
A predator Pit?*

44+  
*Allosaurus*  
skeletons



# Theropods: Ecology

*Where do you find Theropods?  
Wherever you find herbivores.*



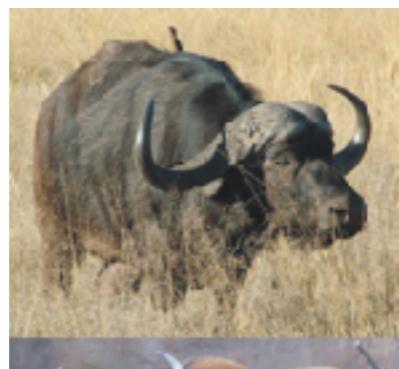
## RULES OF ENGAGEMENT

*Large Theropods tend to associate with large herbivores*

*Environmentally stressed regions (Mongolian deserts) typically have smaller Theropods*

*Specific environmental factors select for specific herbivores*

*But this doesn't always apply to Theropods~ they are far ranging and adaptable  
e.g. Historical distribution of lions*



*Why?*

*Herbivores are more specific in terms of food partitioning*

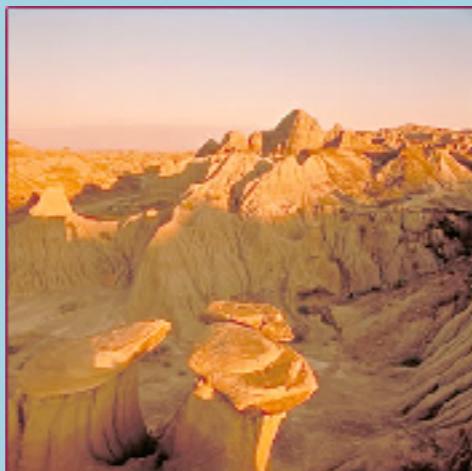
*Accordingly, carnivores are less constrained by climate, vegetation*

*Carnivores rely on larger-scale attributes to partition their resources, such as body size.*

# Theropods: Ecology

Dinosaur Provincial Park  
Alberta, Canada  
vs.  
Devil's Coulee.  
Canada  
*300 Km apart*

Huge difference in  
herbivore assemblage



Dinosaur Park  
Higher Rainfall  
Well watered  
More vegetated



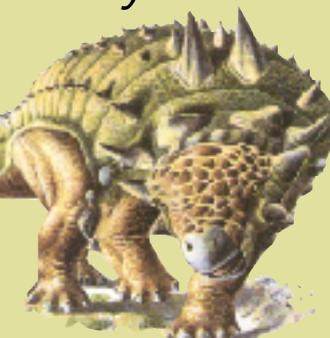
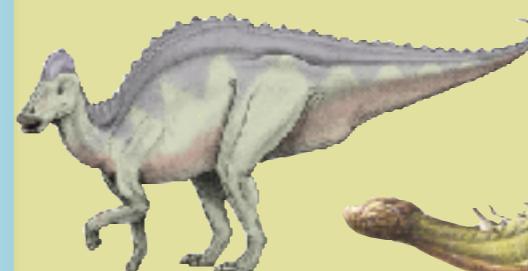
Lambeosaurus

Corythosaurus



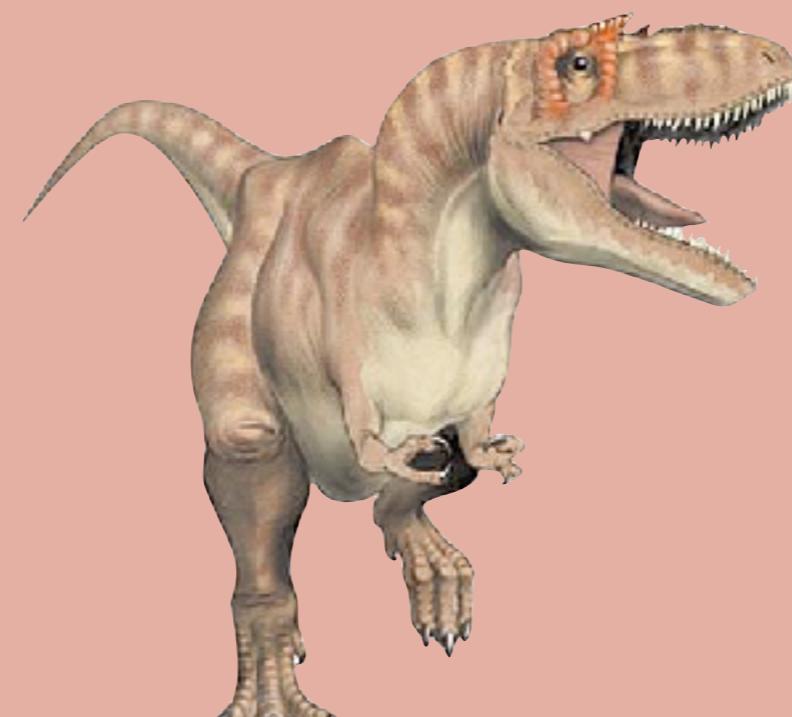
Devil's Coulee  
Rain shadow

Drier on a seasonal basis



Hypacrosaurus

No difference in  
carnivore assemblage



Gorgosaurus



Saurornitholestes



Troodon



赵闯 耿进华 绘图

Reconstructed by Zhao Chuang & Xing Lida