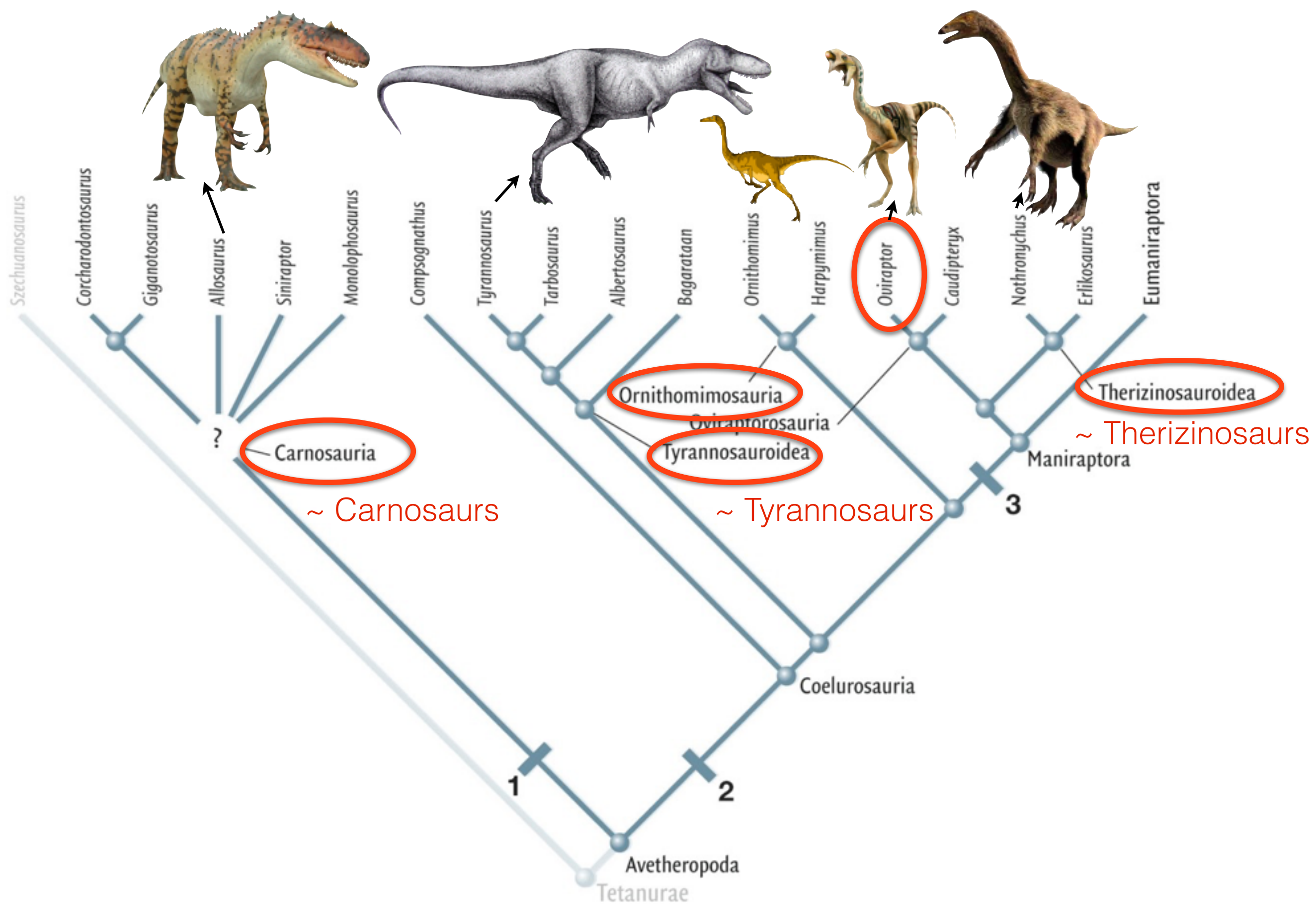
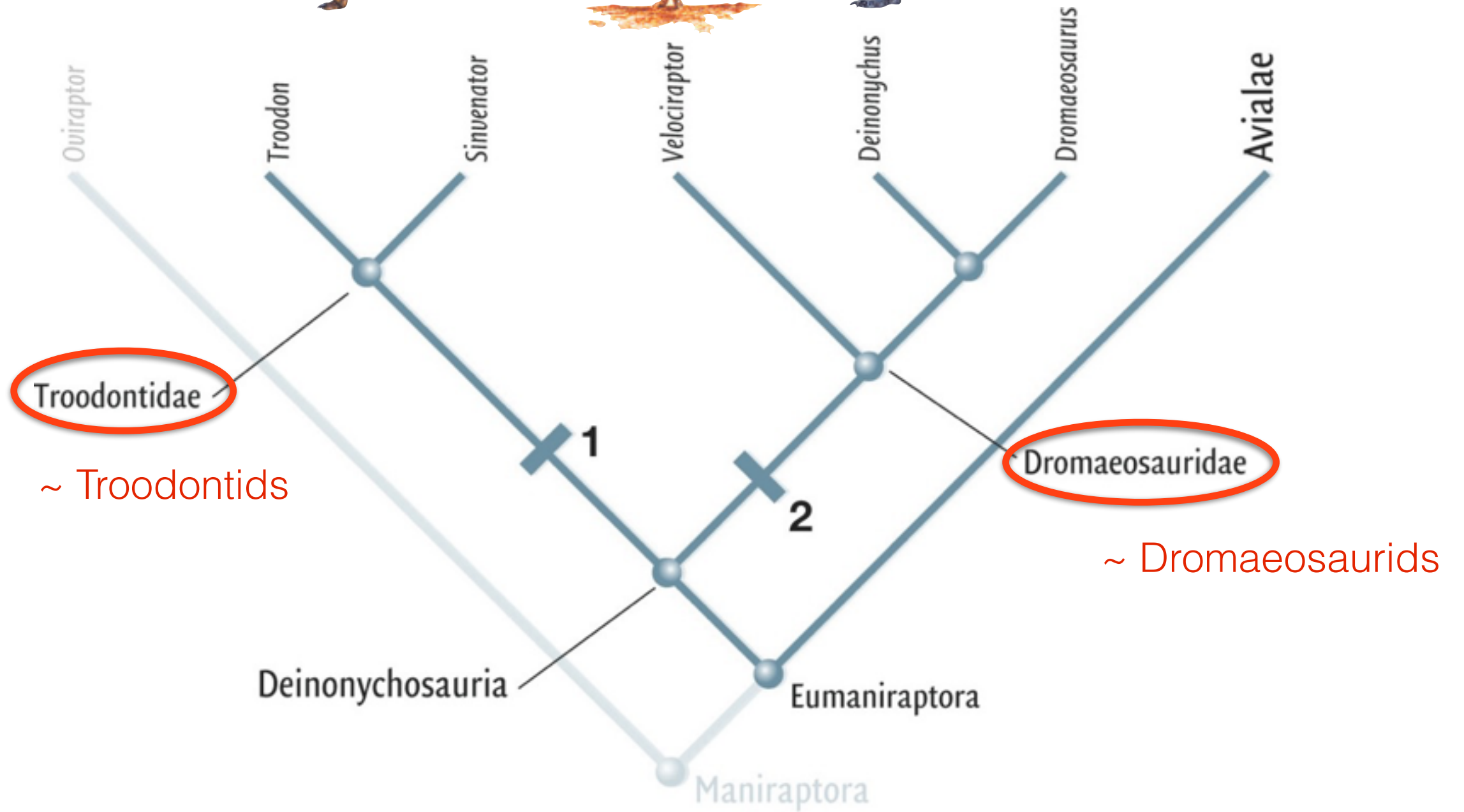


Basal Theropods

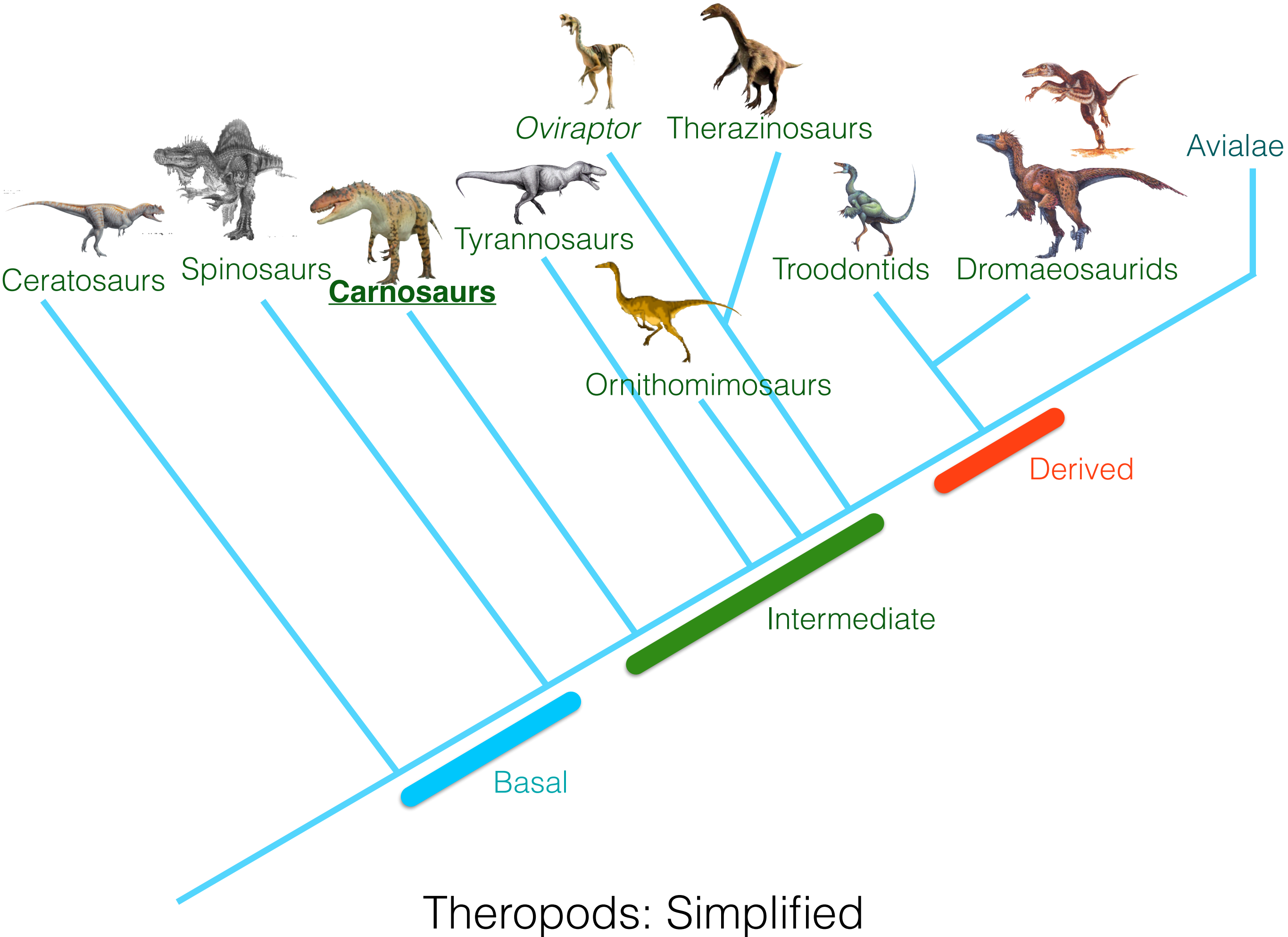


Intermediate Theropods



## Derived Theropods







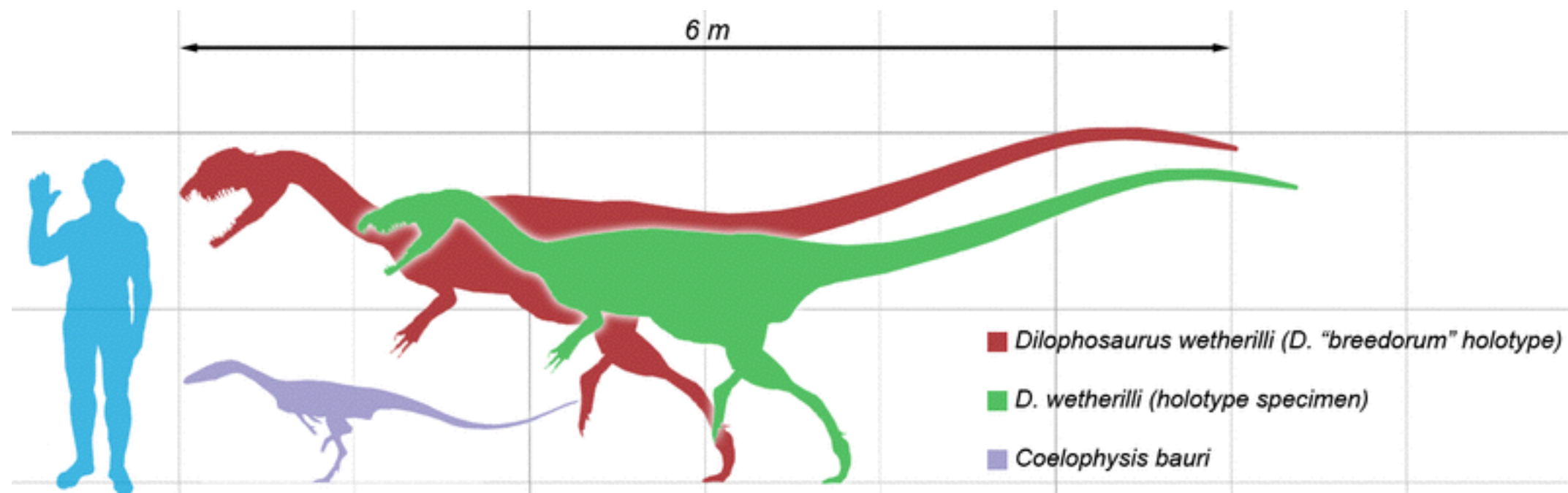
# Theropods: Specializations

## Cranial Ornamentation

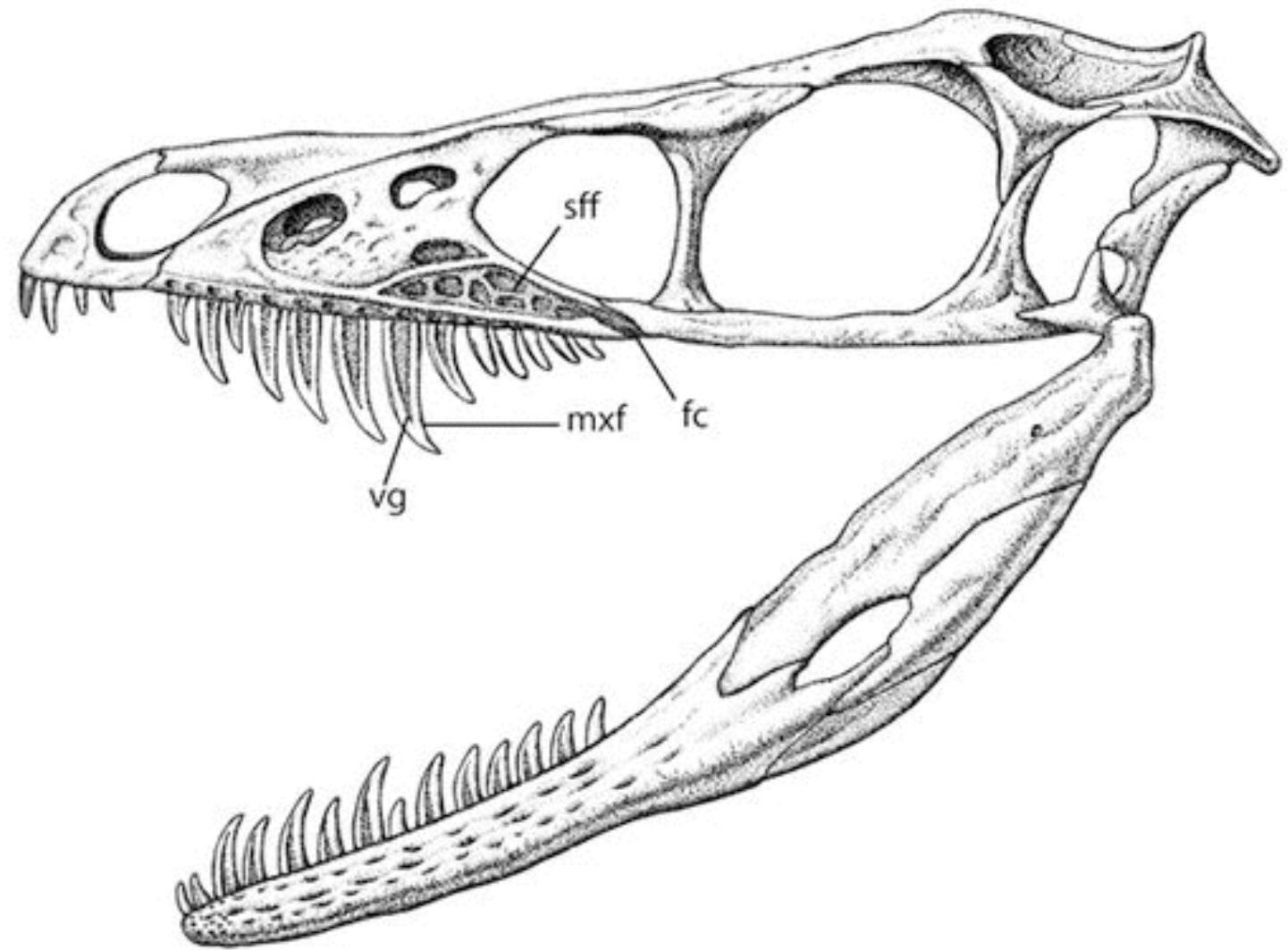
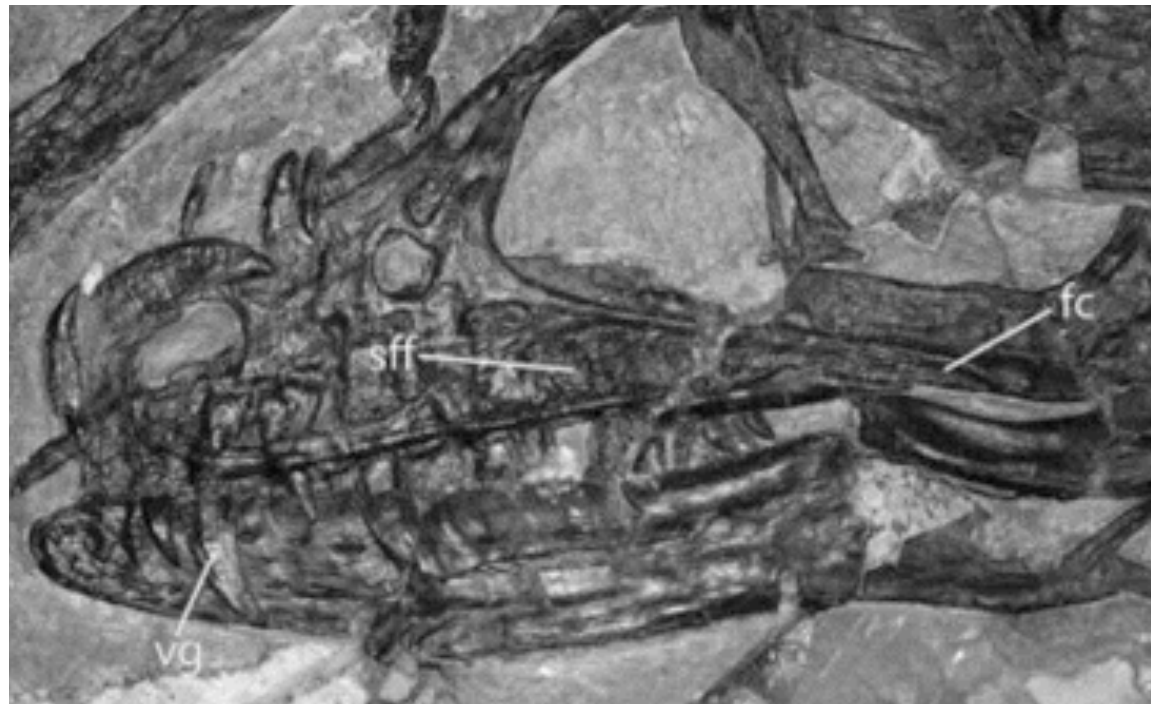
*No evidence for frill  
or venom glands*



*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

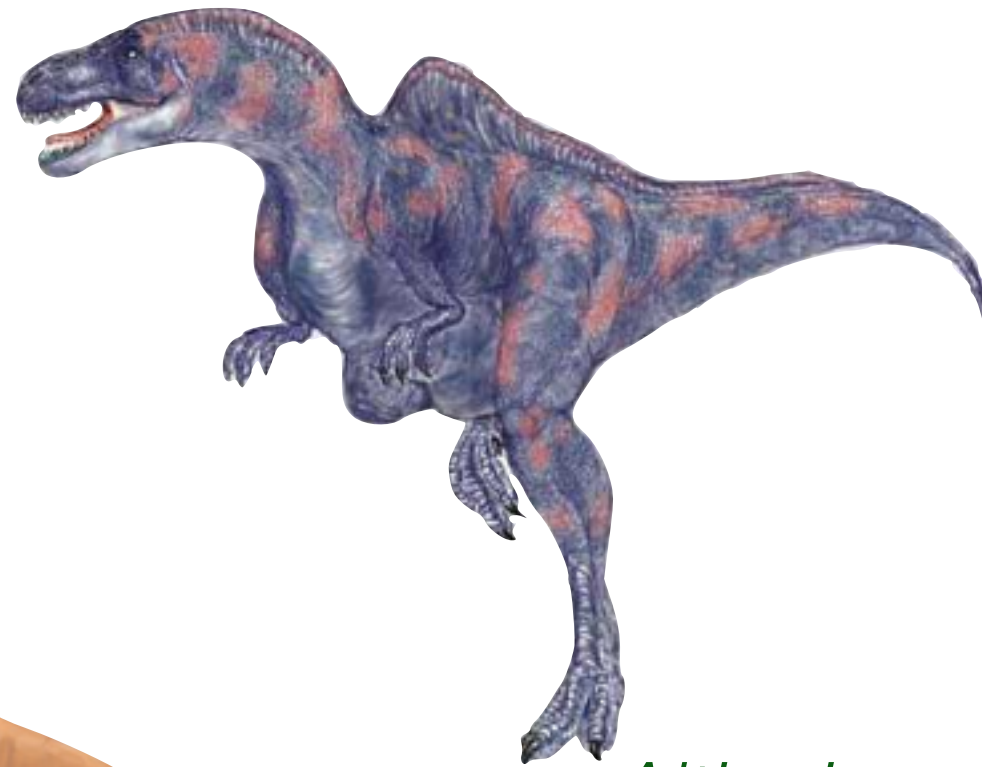
Only known for *Syntarsus* and *Coelophysis*  
(both Coelophysids, or basal theropods)





# Theropods: Specializations

## Vertebral Spines



*Altispinax*



*Spinosaurus*

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



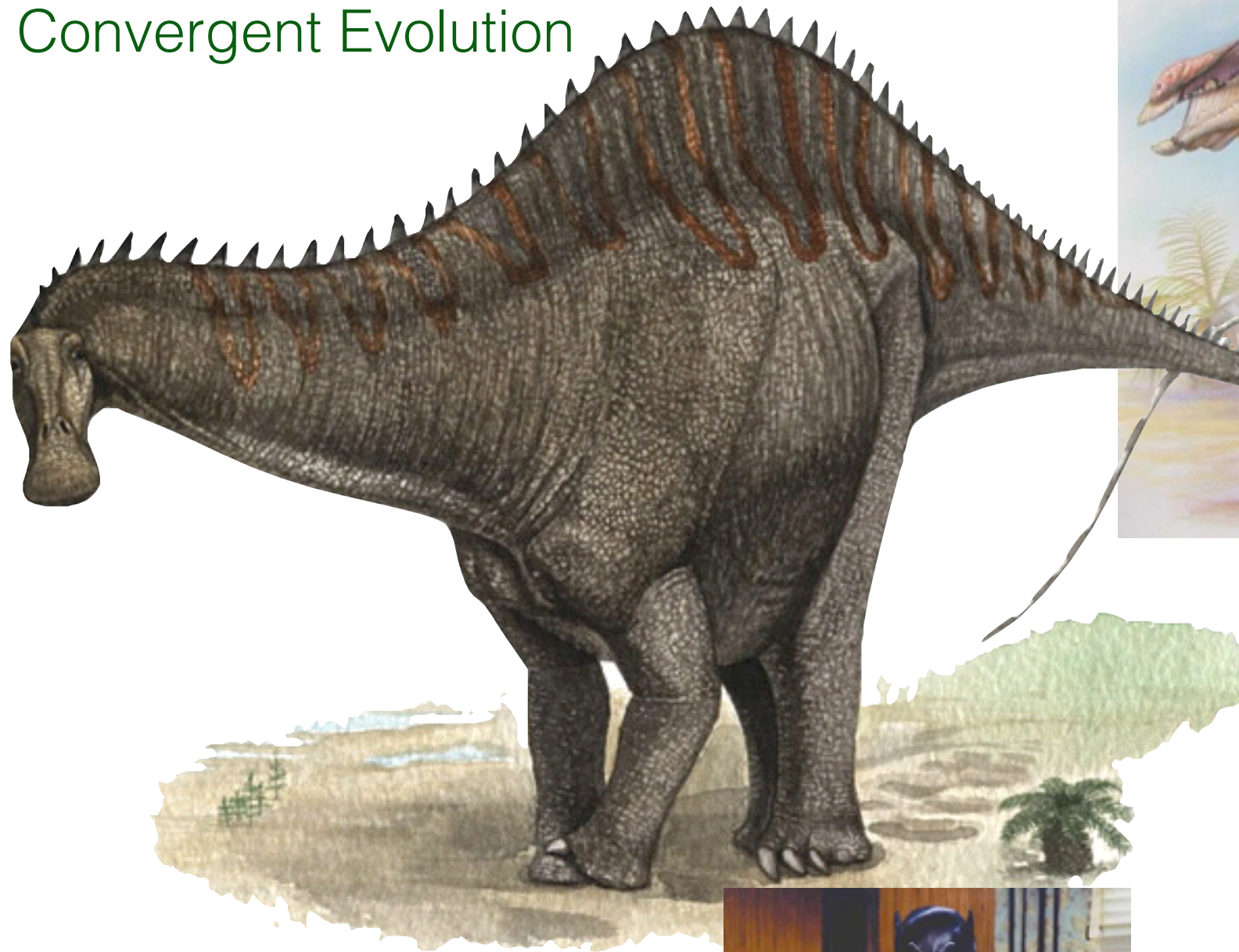
*Acrocanthosaurus*



# 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

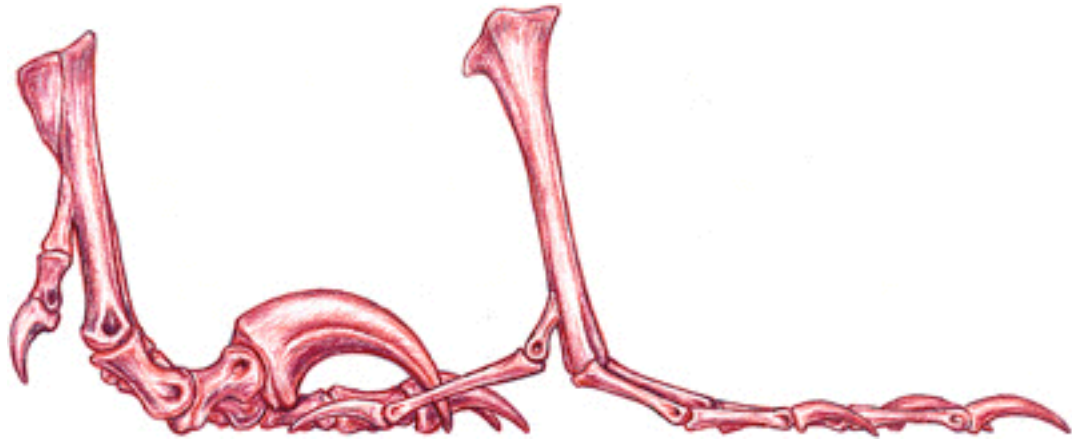


*Troodon*

# Dromaeosaurids







*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

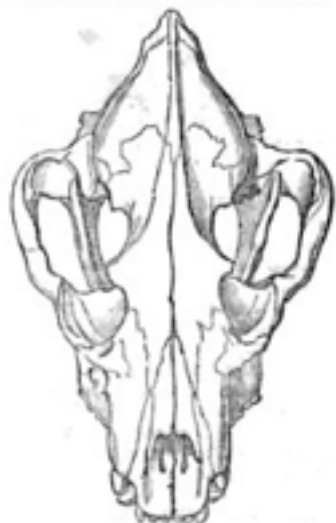
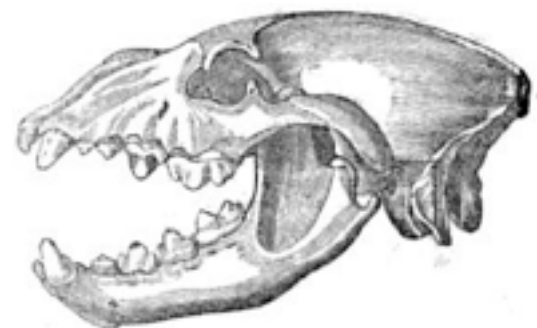
Direct Evidence

## Scavengers

Rounded teeth

Small arms

Large olfactory lobes in brain



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

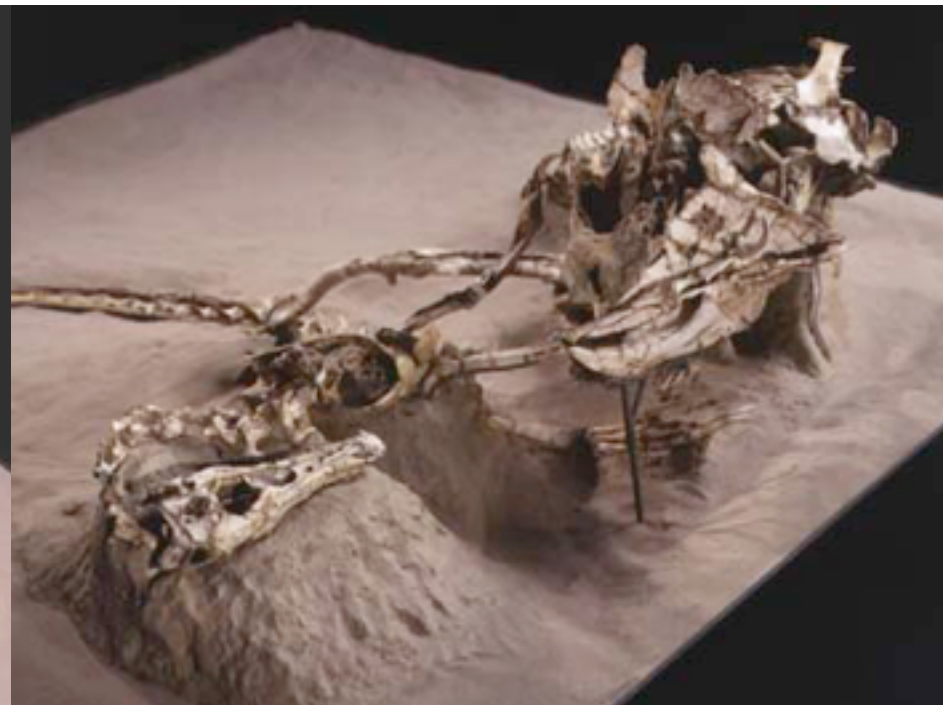


# What is the tangible evidence for Dinosaur predation?

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



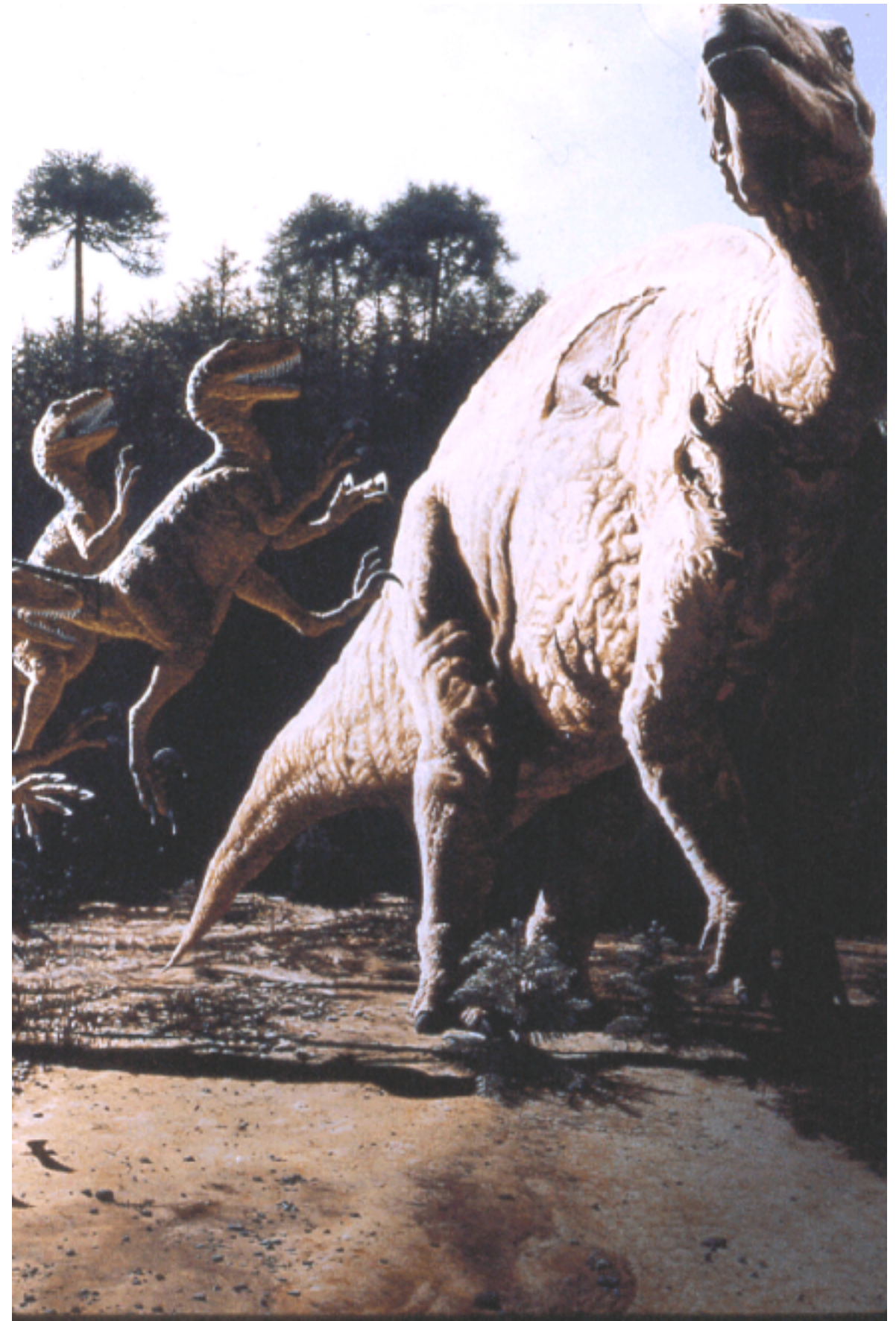




# *What is the tangible evidence for Dinosaur predation?*

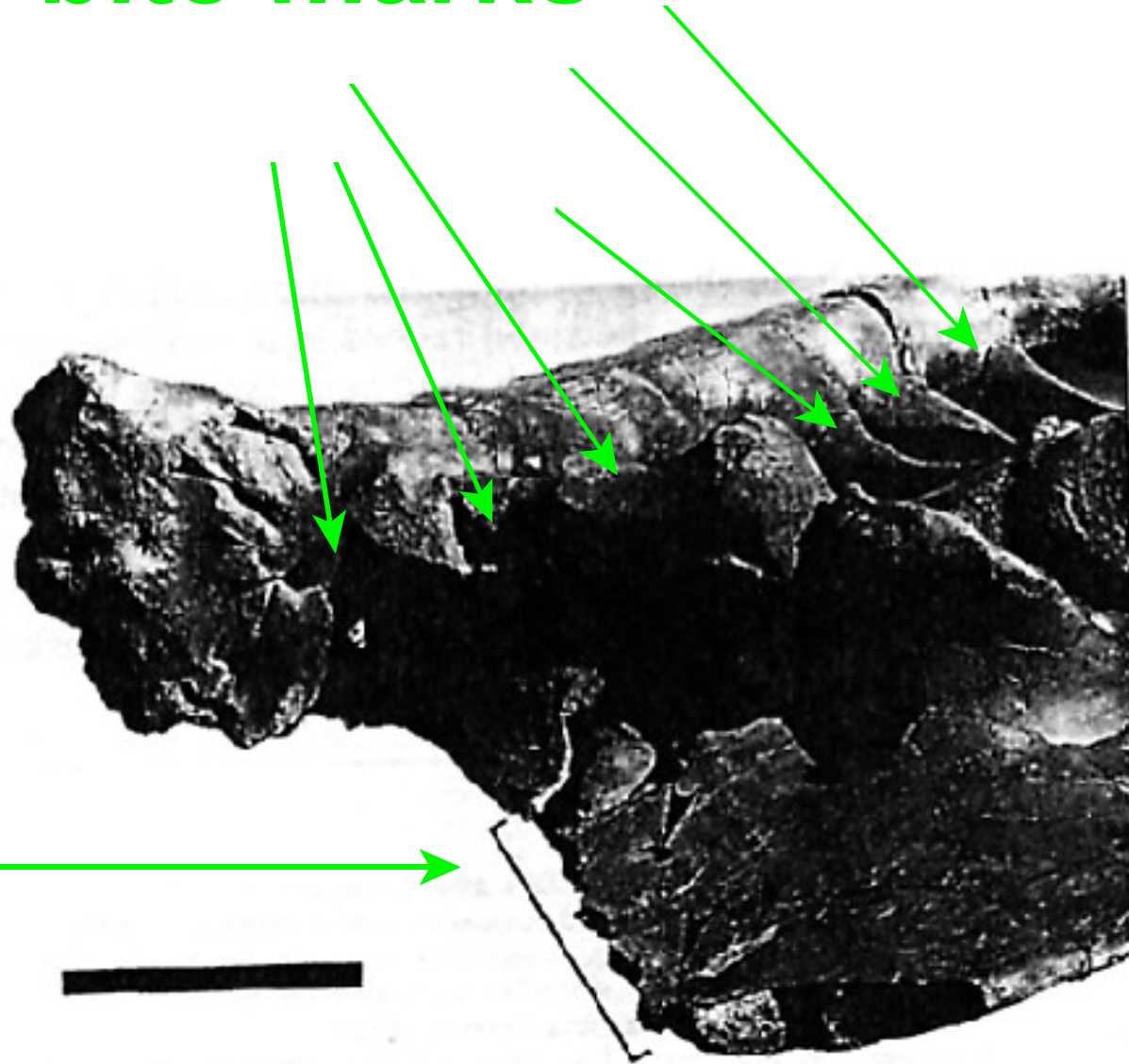
3) Three *Deinonychus* found underneath a *Tenontosaurus* ornithomimid that had apparently been predated upon by other *Deinonychus* dinos

- Suggests not only predation
- But **PACK HUNTING**



# *What is the tangible evidence for Dinosaur predation?*

**bite marks**



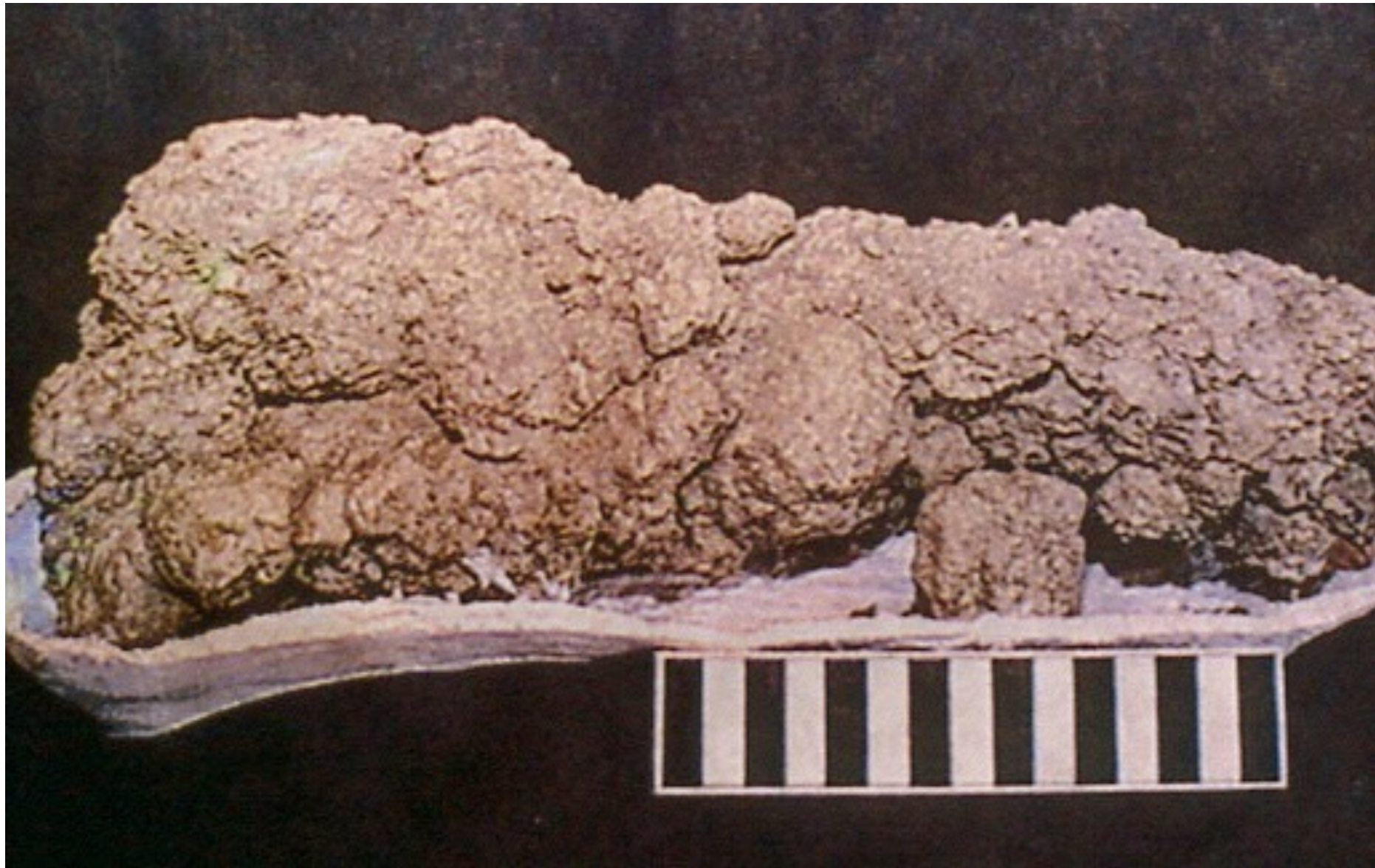
**damage  
suggests bite  
force of up to  
13,000 N  
(equivalent to  
an alligator)**

**~1/6 of ilium  
bitten off**

**Damaged Triceratops sp. pelvis  
(Erickson et al., 1996)**



*What is the tangible evidence for Dinosaur predation?*



*Bone-filled coprolites*



# What is the tangible evidence for Dinosaur predation?

## Trackways

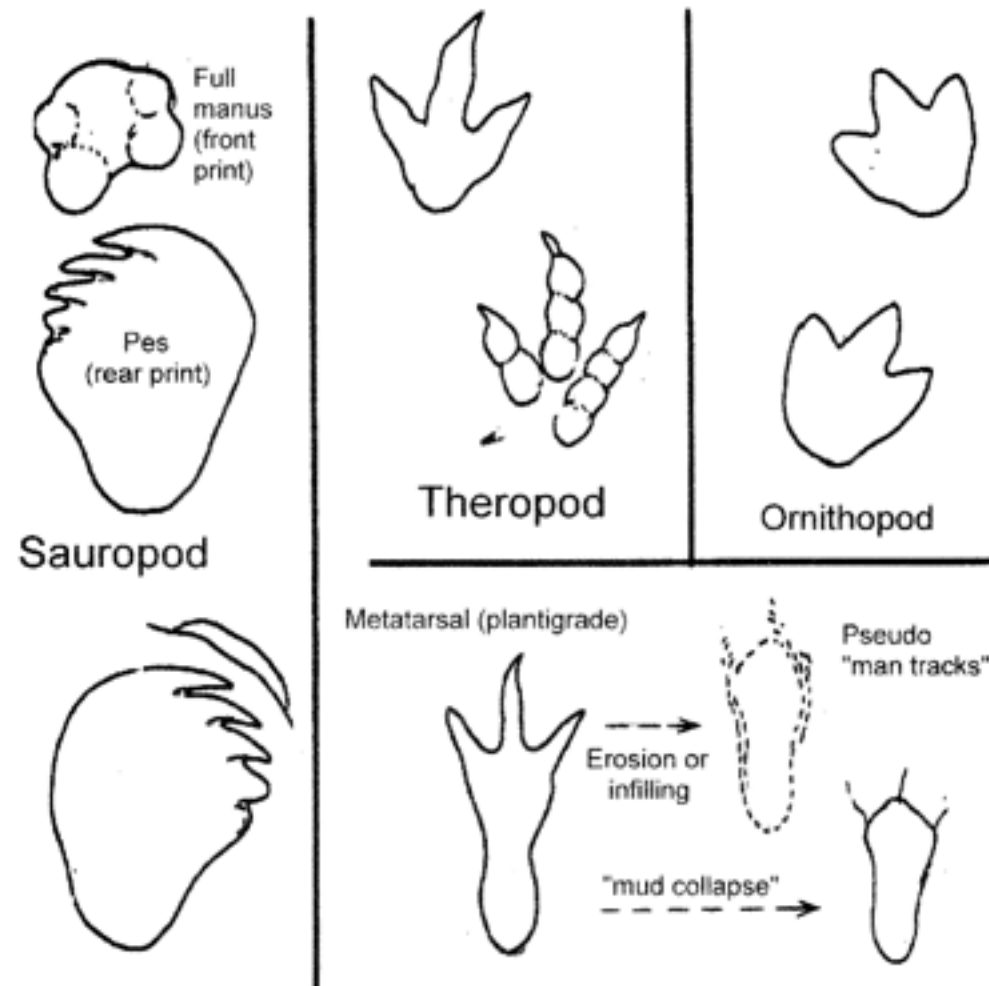
### Major Types of Dinosaur Tracks in Texas



**Sauropod ("brontosaurus")**  
Trackname: *Brontopodus birdi*  
Trackmaker: *Paluxysaurus*

**Theropod** (bipedal meat-eater)  
Trackname: *Eubrontes*  
Trackmaker: *Acrocanthosaurus*

**Ornithopod** (bipedal plant-eater)  
Trackname: *Amblydactylus* (?)  
Trackmaker: *Iguanodont*?





# 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*







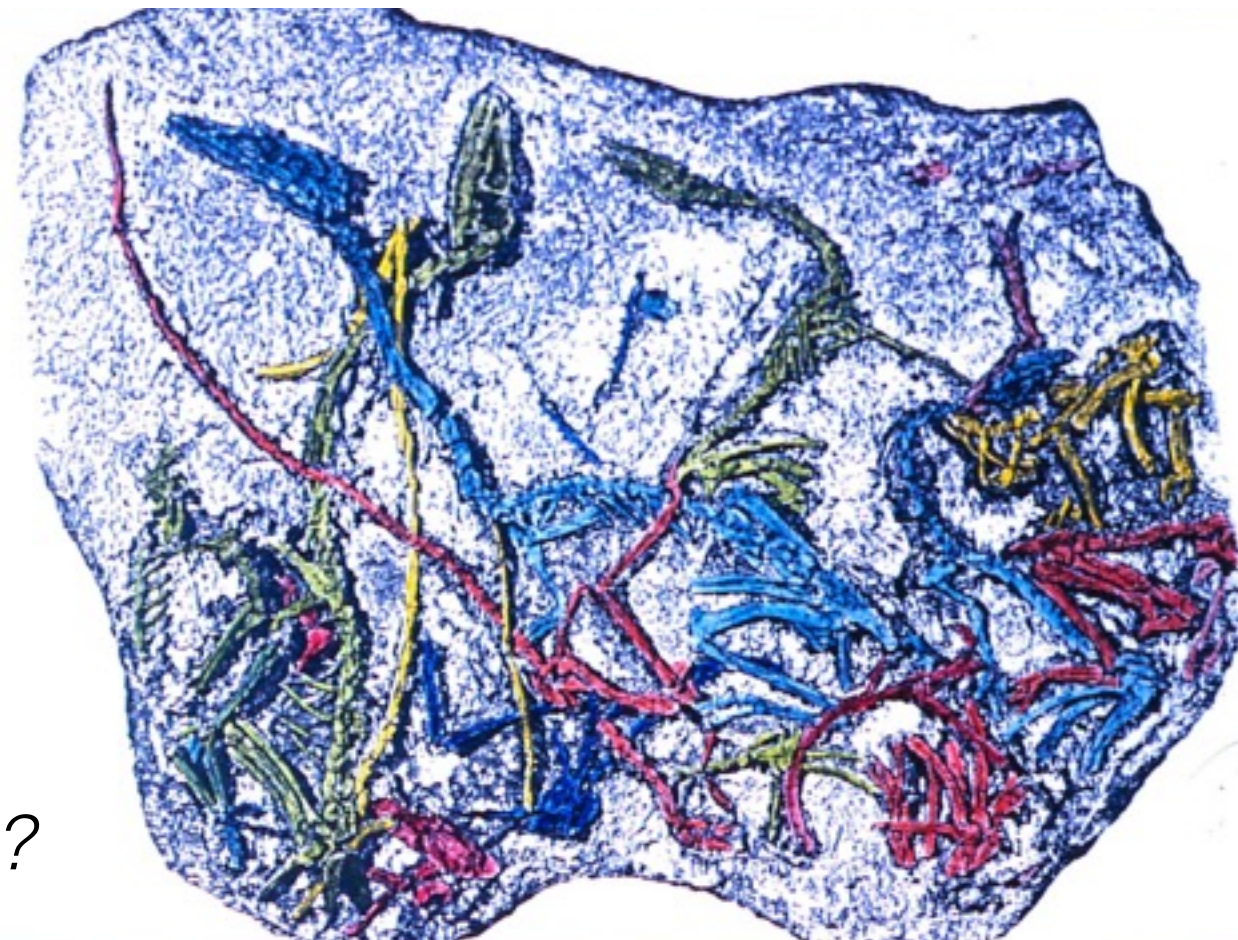
**FIGURE 3.6**  
This map shows some of the scattered bones at the Cleveland-Lloyd dinosaur quarry in Utah, where the remains of at least 44 individuals of *Allosaurus* were collected. The bones apparently accumulated in an ancient lake deposit, but the cause of this "predator trap" remains unknown.

44+  
*Allosaurus*  
skeletons



*Cleveland-Lloyd Dinosaur Quarry,  
Utah*

*Evidence of gregariousness?  
A predator Pit?*





# 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



Devil's Coulee  
Rain shadow

Drier on a seasonal basis



Lambeosaurus

Corythosaurus



Hypacrosaurus

Ankylosaurs



No difference in  
carnivore assemblage



Gorgosaurus



Saurornitholestes



Troodon





Reconstructed by Zhao Chuang & Xing Lida