
FAILURE
"oh well"
IS JUST SUCCESS
ROUNDED DOWN

EXAM 2 ON WEDNESDAY

BRING:

GREEN SCANTRON

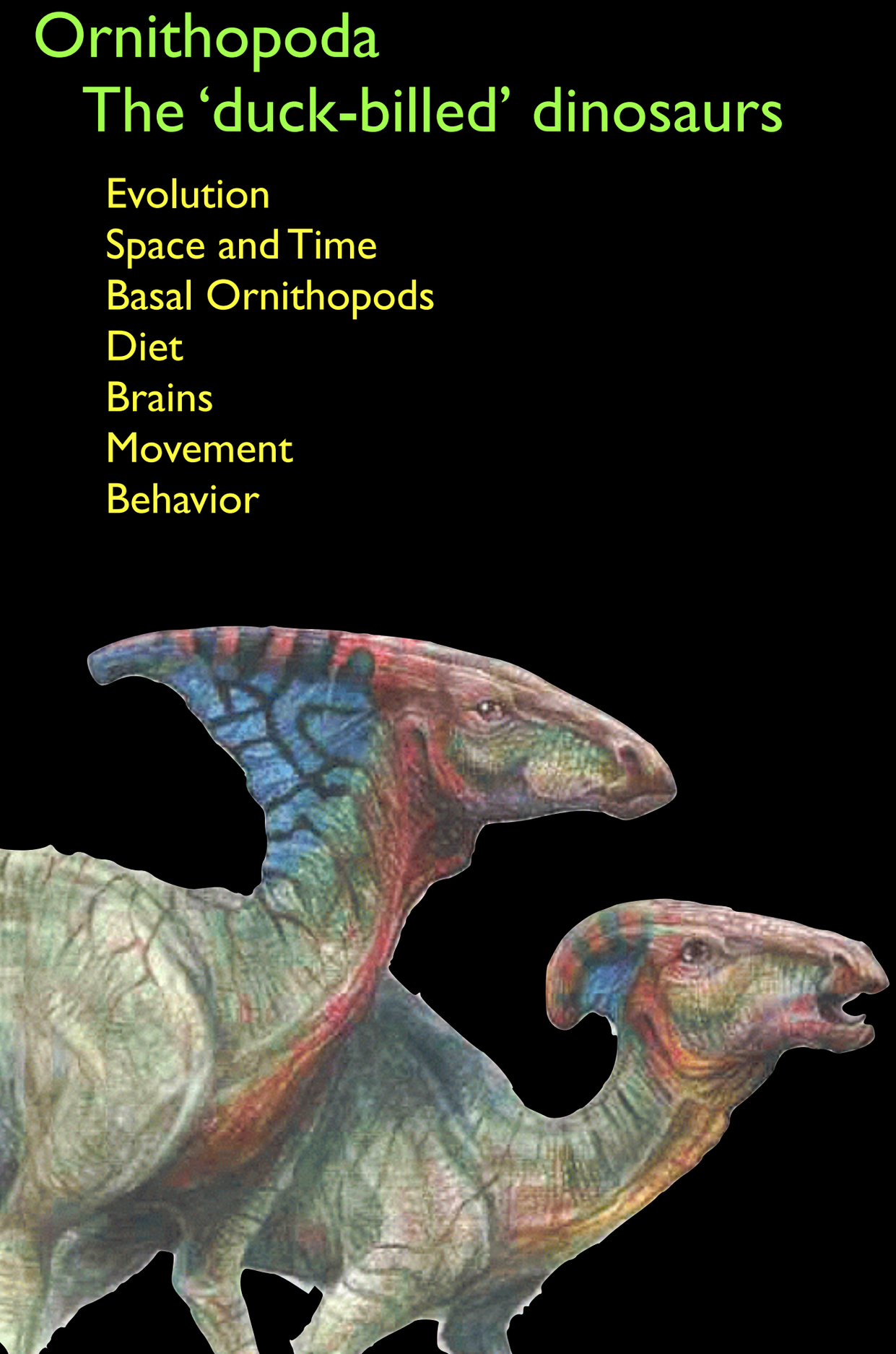
YOUR BRAINS

SECTION THIS WEEK:

Instead of a physical discussion section, we will have a homework assignment.

Ornithopoda
The ‘duck-billed’ dinosaurs

- Evolution
- Space and Time
- Basal Ornithopods
- Diet
- Brains
- Movement
- Behavior

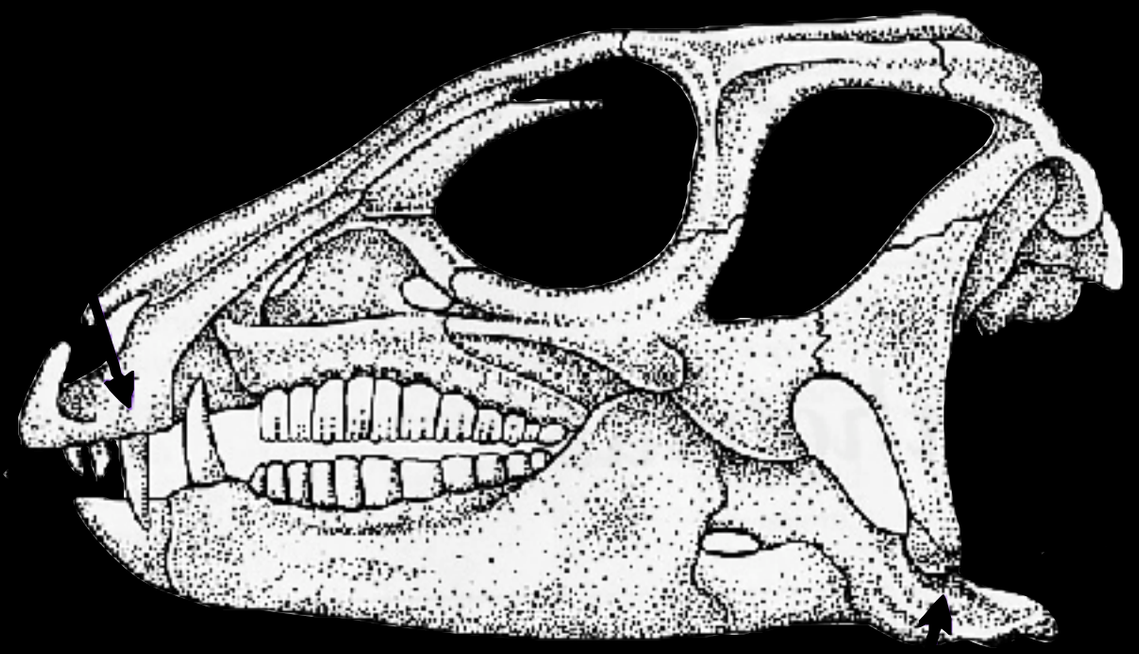


Genosauria
Cerapoda
Marginocephalia
Pachycephalosauria
Ceatopsia
Ornithopoda: 'bird feet'

Iguanodon

Edmontosaurus

Primitive Characteristics: basal Ornithopods are 'typical' Ornithischians
Opisthopubic condition
No fenestra in mandible

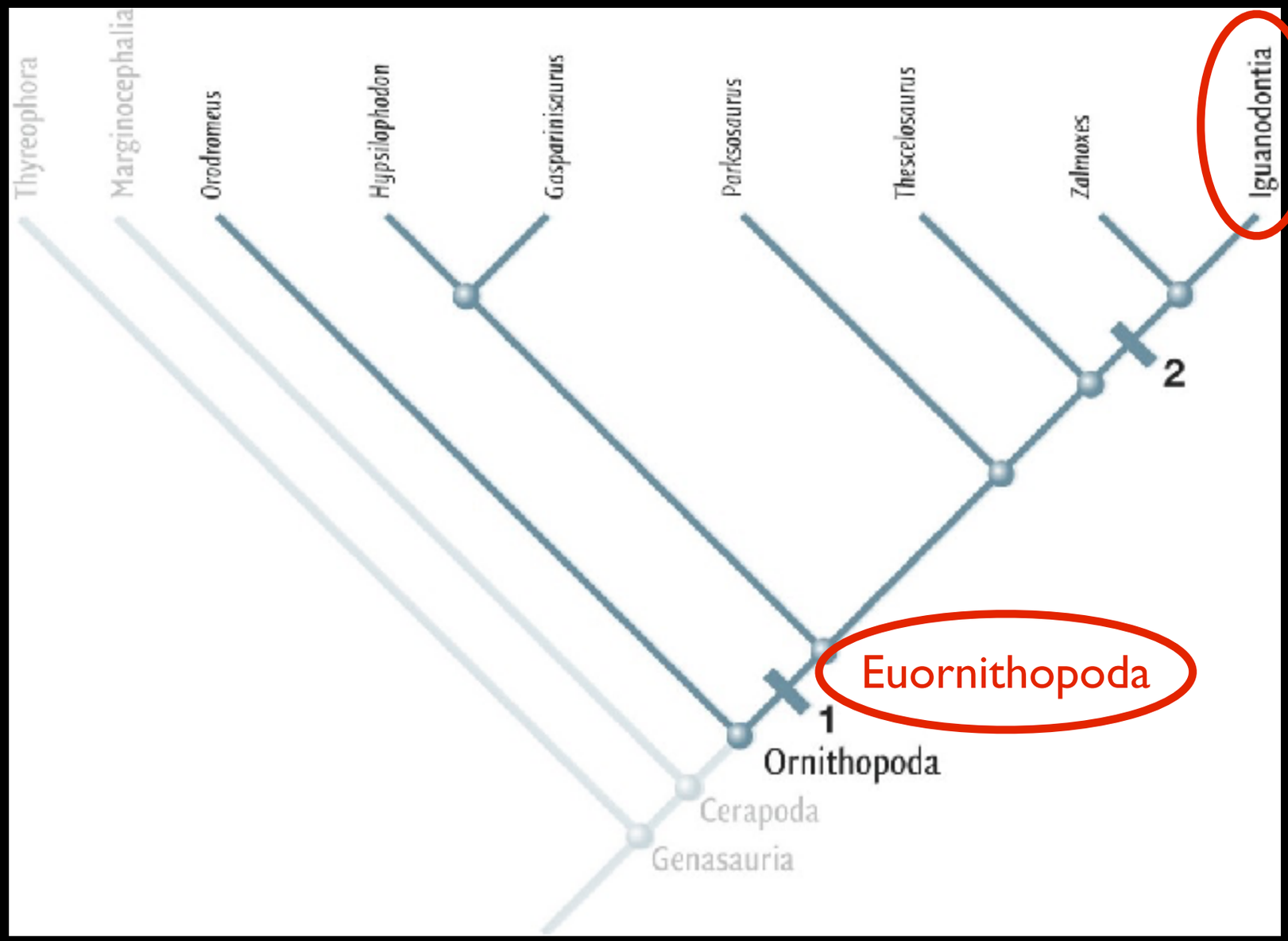


Derived Characteristics:

- Ventrally offset premaxillae
- Very low jaw joint

Small, bipedal

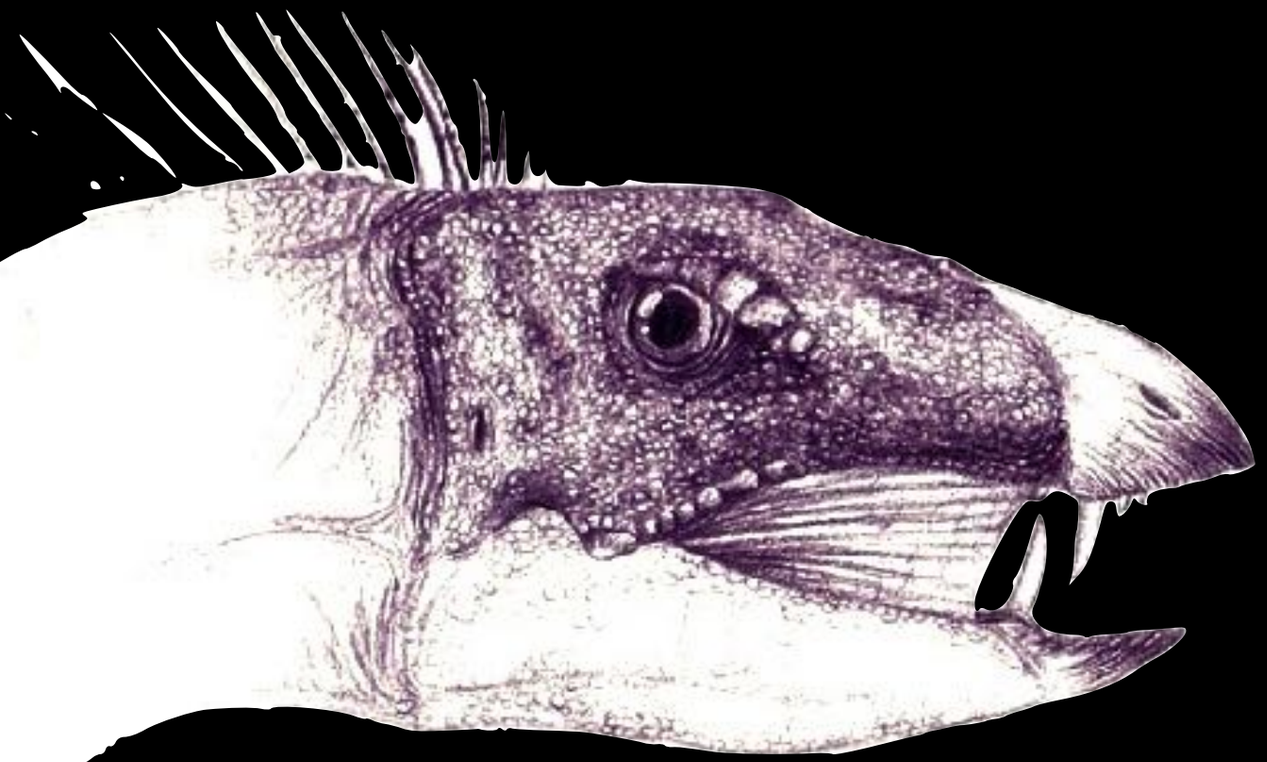
Derived: Larger, mainly quadrupedal

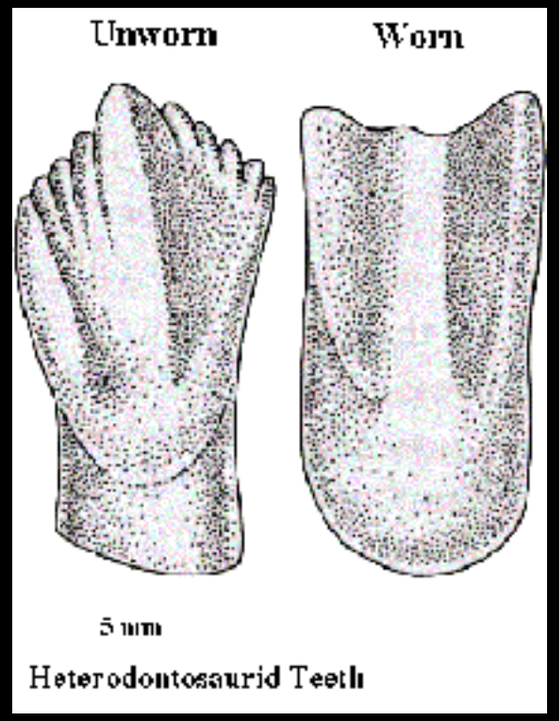


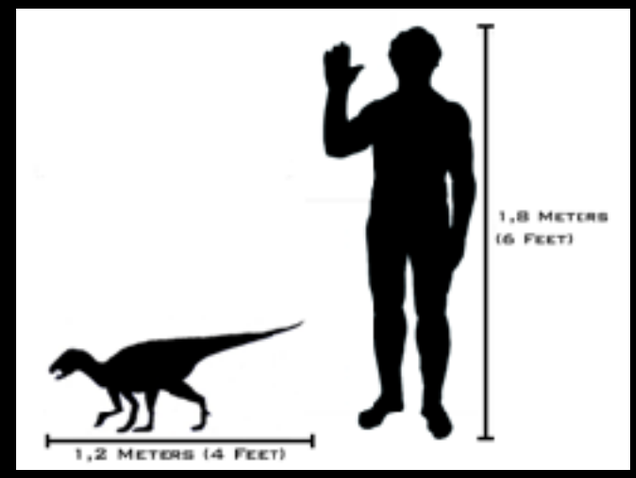
Early Ornithopods & Euornithopods

Small, bipedal

Heterodontosaurids may have been basal Ornithopods (or basal Ornithischians, depending on who you ask)

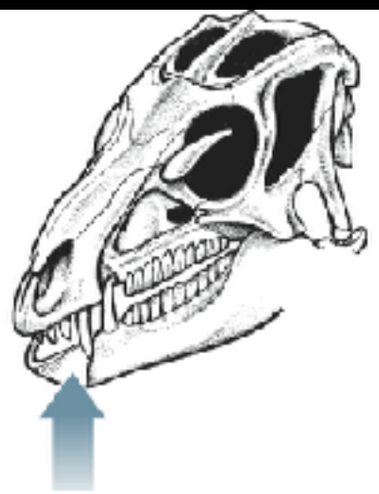






Heterodontosaurids: Not Primitive...
unique chewing.

Three kinds of teeth
Anterior: Snipping/Cropping
Posterior: Chewing
Tusks/Caniforms: Potentially display/courtship



Heterodontosaurids: Kinetic LOWER JAW

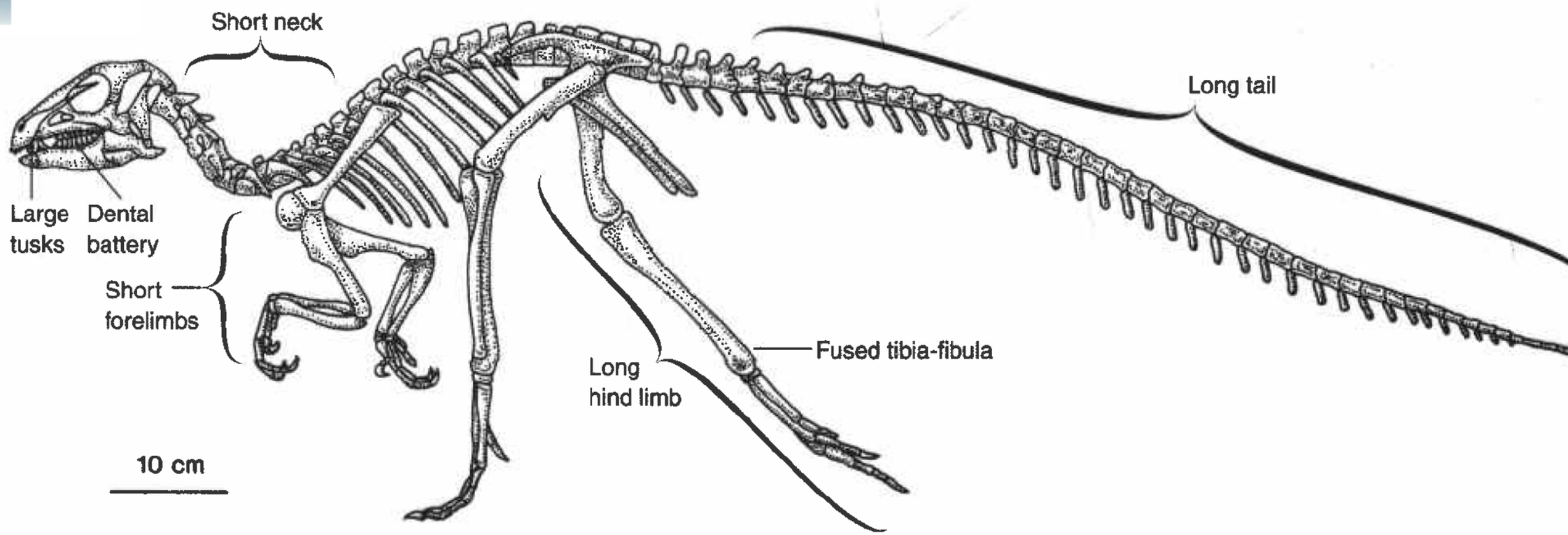


FIGURE 7.4

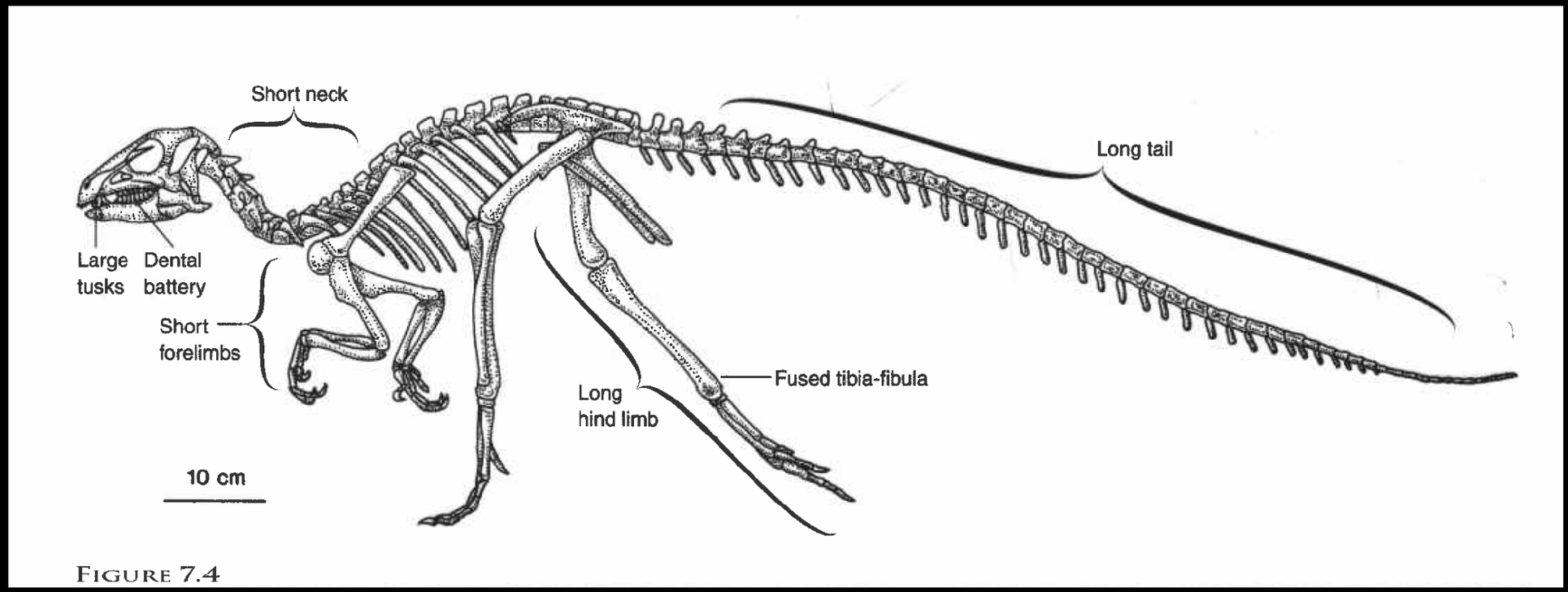
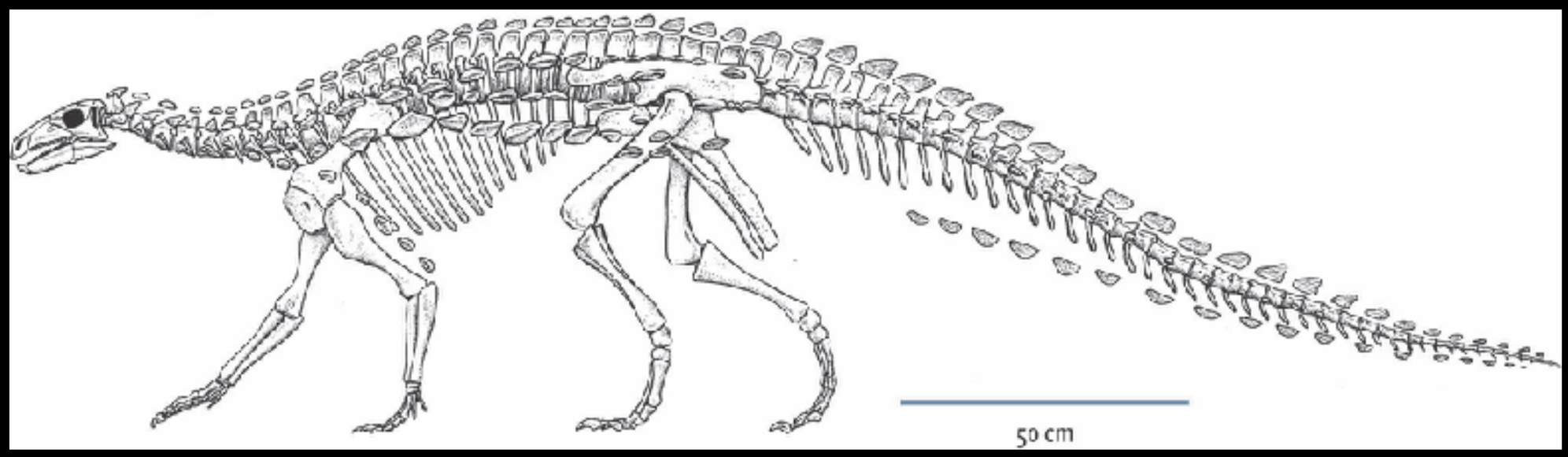


FIGURE 7.4

Heterodontosaurus: Short femur; Long tibia/fibula = fast

vs.



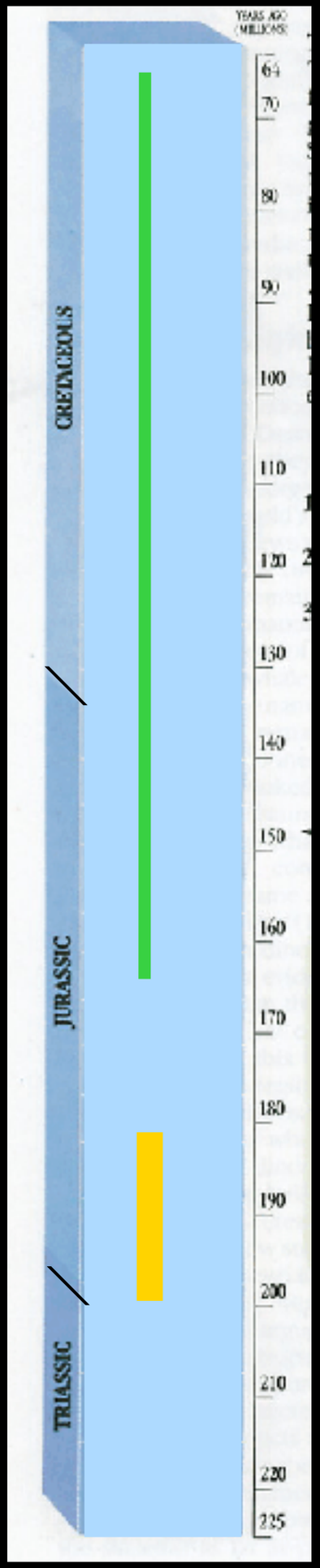
Scelidosaurus (basal Thyreophoran): Long femur; Short tibia/fibula = slow

We will explore this concept more with Theropod dinosaurs

Cretaceous

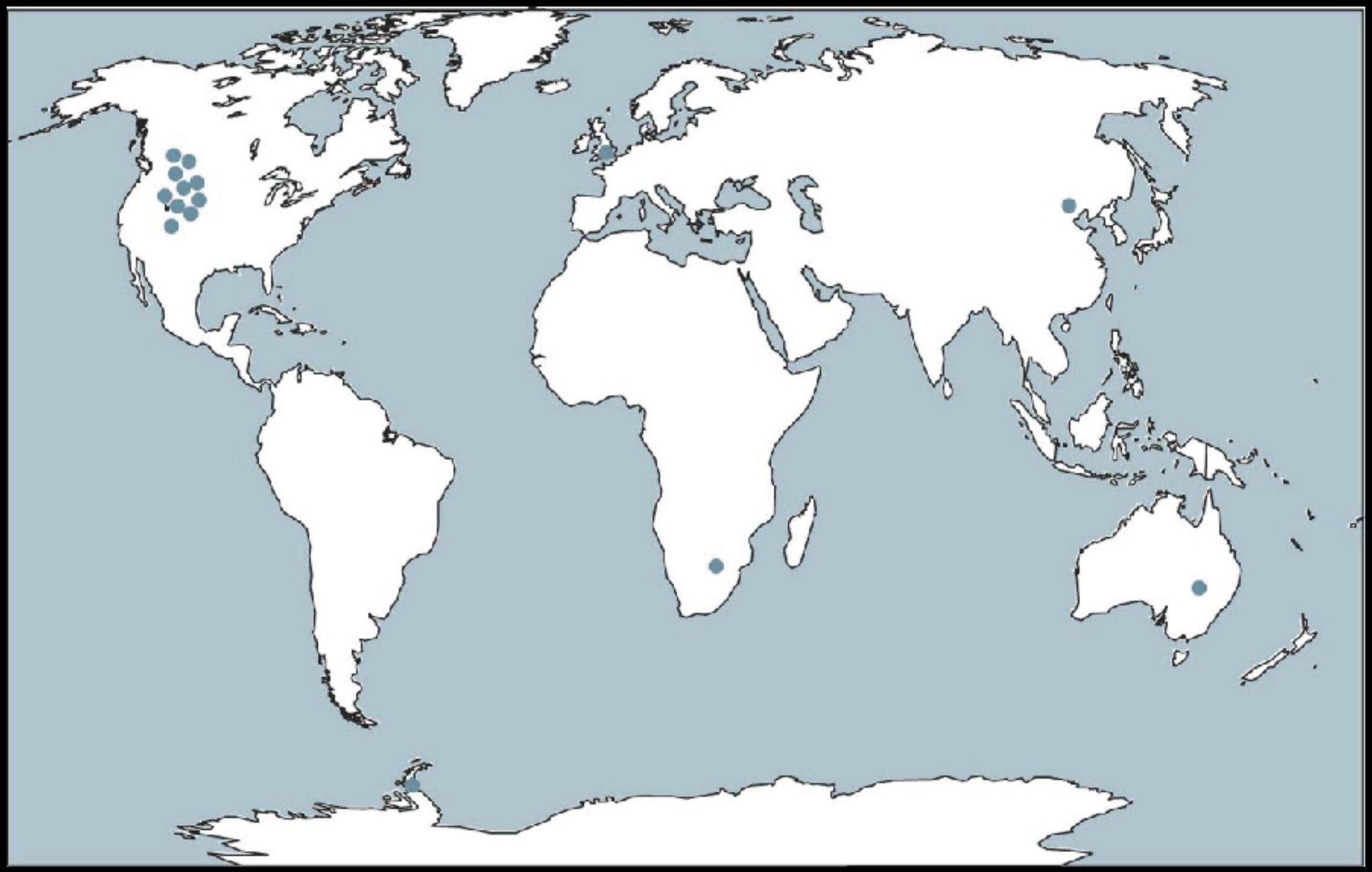
Jurassic

Triassic

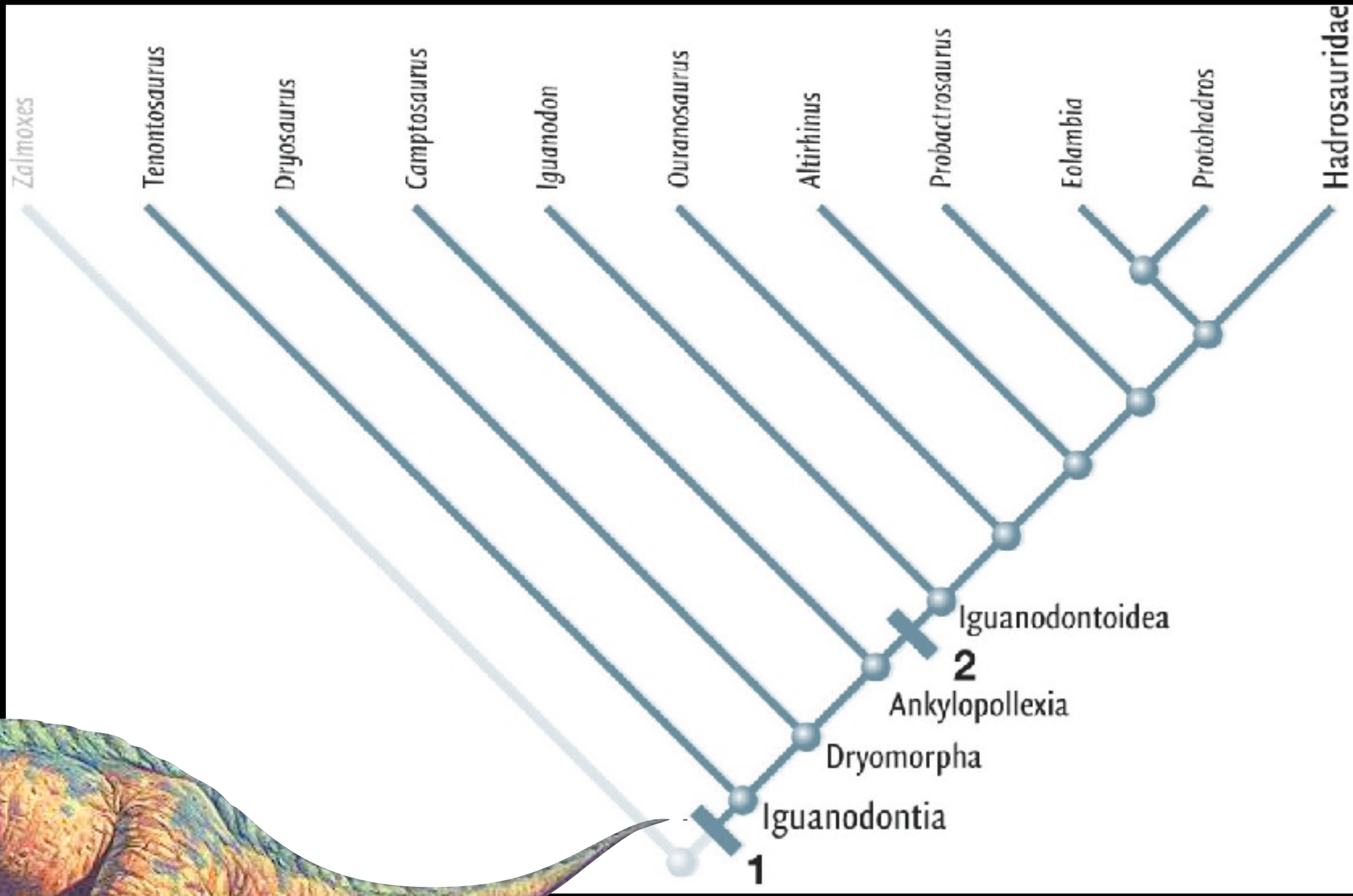


Basal euornithopod time range

Heterodontosaurid time range



Tenontosaurus



Iguanodontia: the most diverse clade

- Toothless premaxilla
- Smooth, rounded predentary
- Generally larger
- Derived forms (Ankylopollexia): Expanded dental batteries & spiked thumb

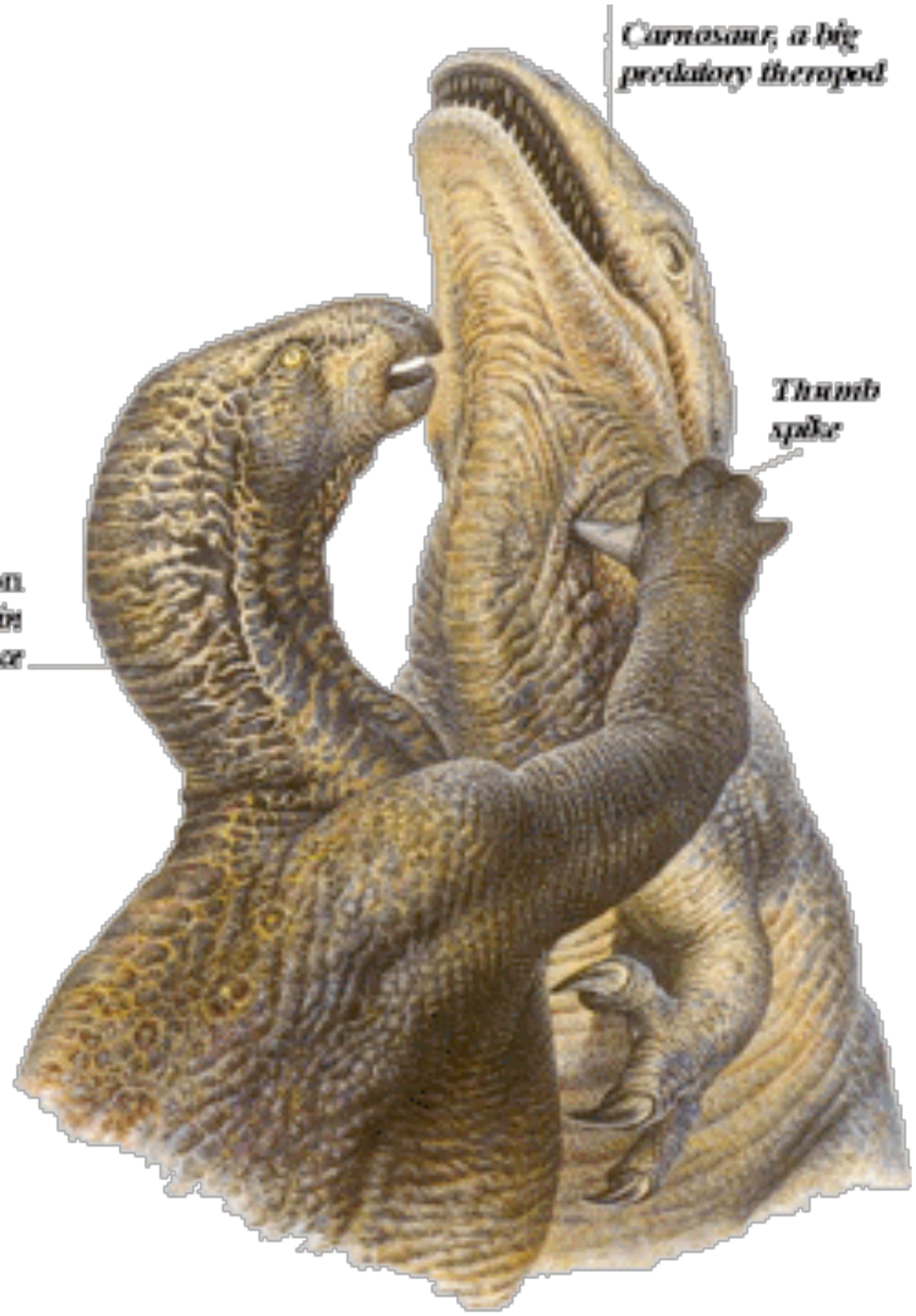
everted pmx

no pmx teeth

broad predentary

many teeth in dental battery

Thumb spike

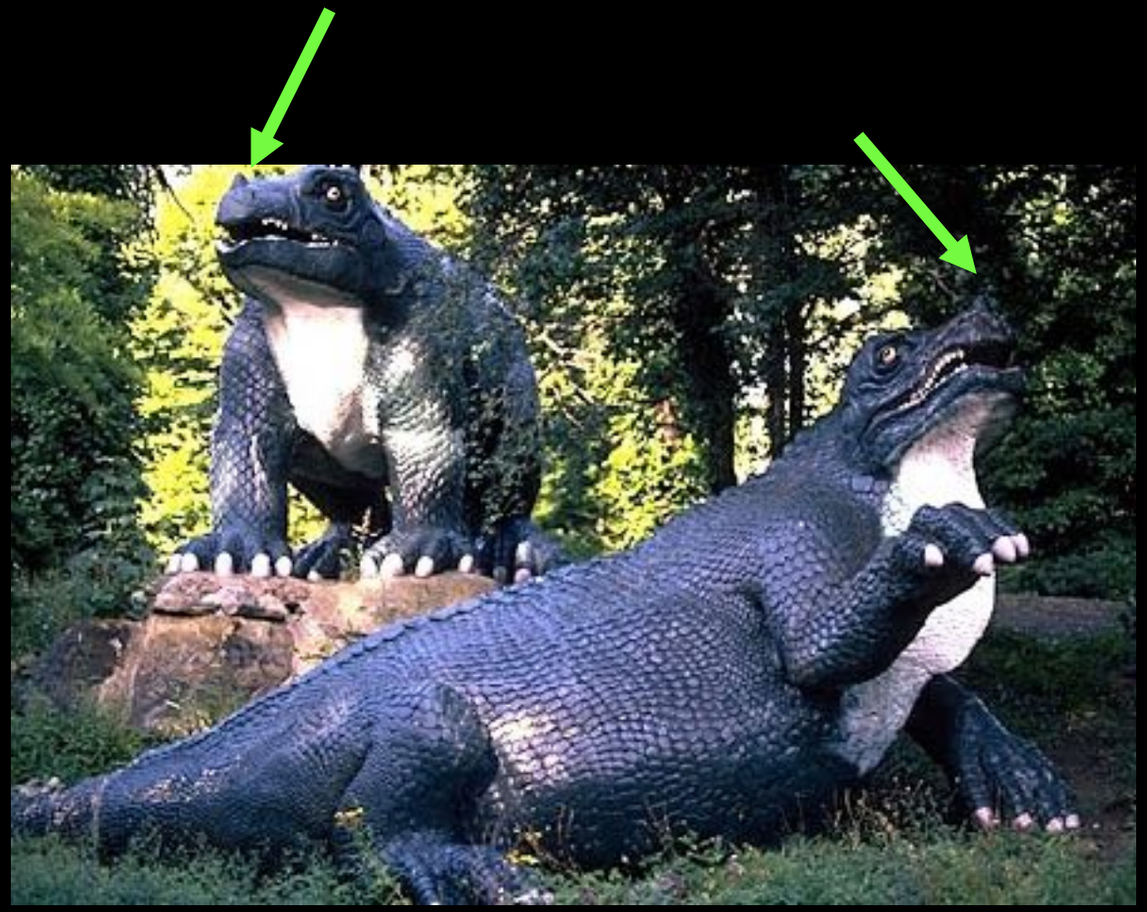


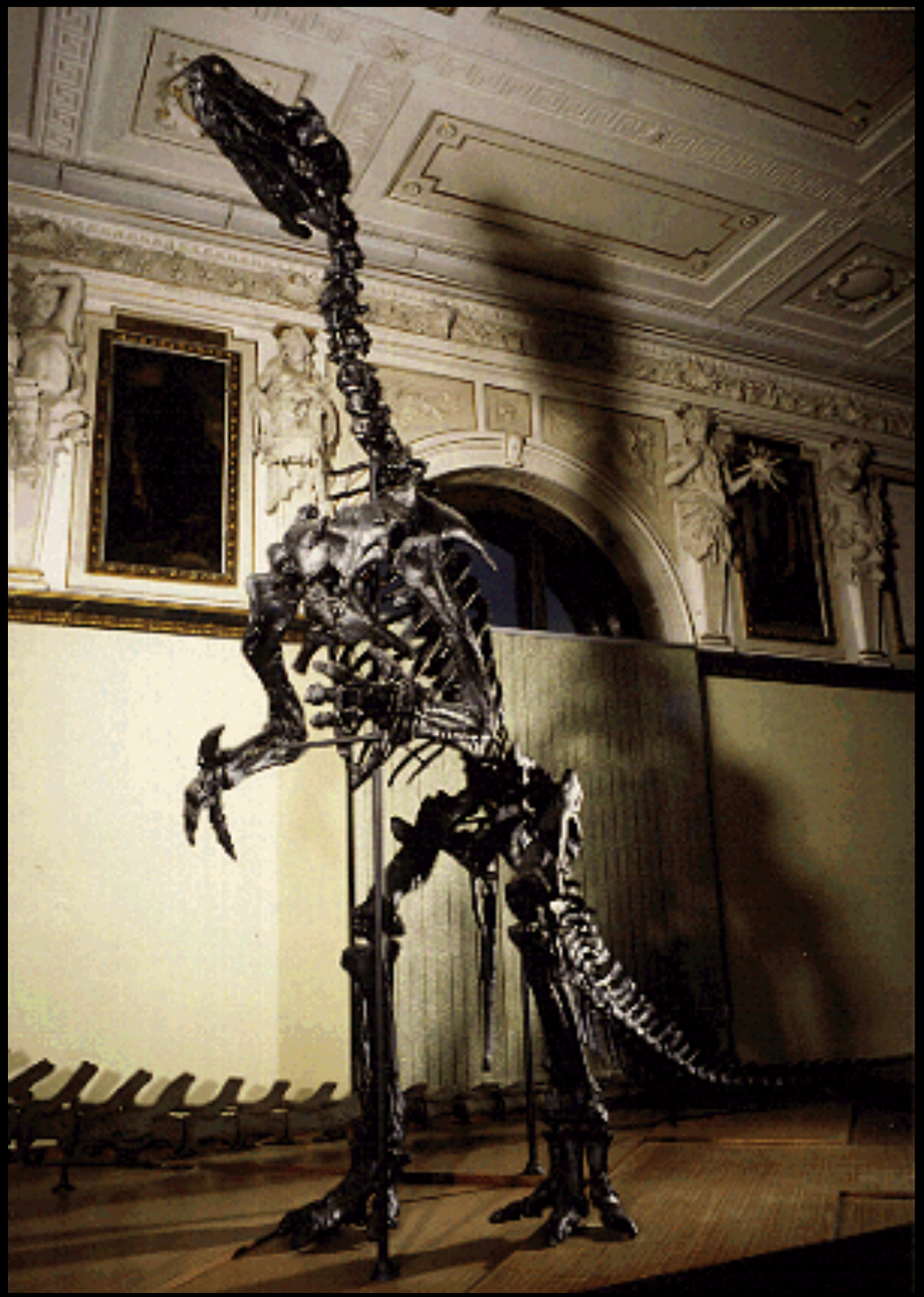
SPIKED THUMB

If attacked by a large, sharp-toothed, sharp-clawed theropod, *Iguanodon* might have reared up on its hind limbs and counterattacked with its spiked thumb. Strong, bony, and stiletto-like, this thumb could have penetrated the attacker's scaly hide or inflicted wounds on the throat, eyes, or belly.

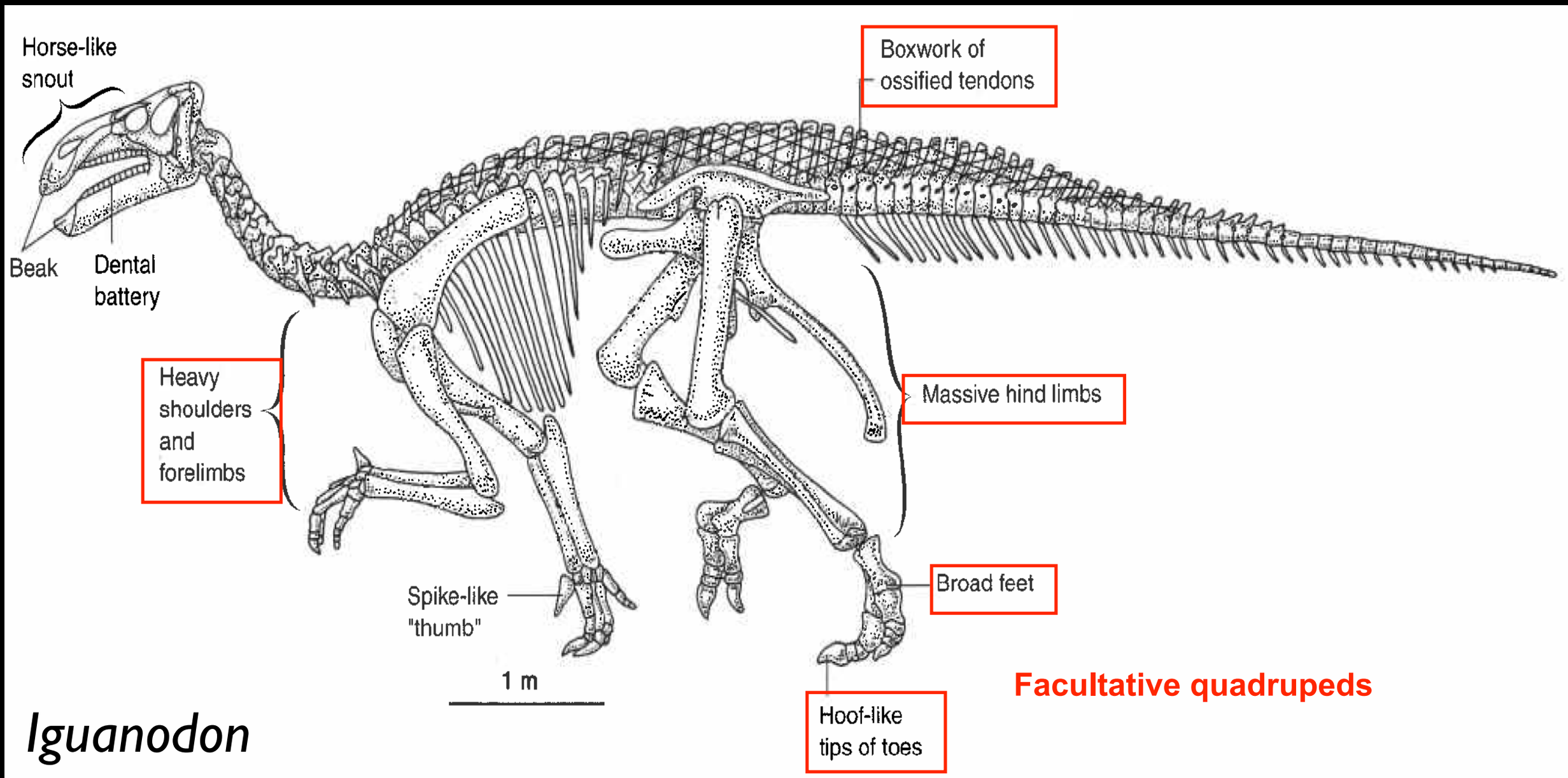
Defense? Comp

Thumb spike placement





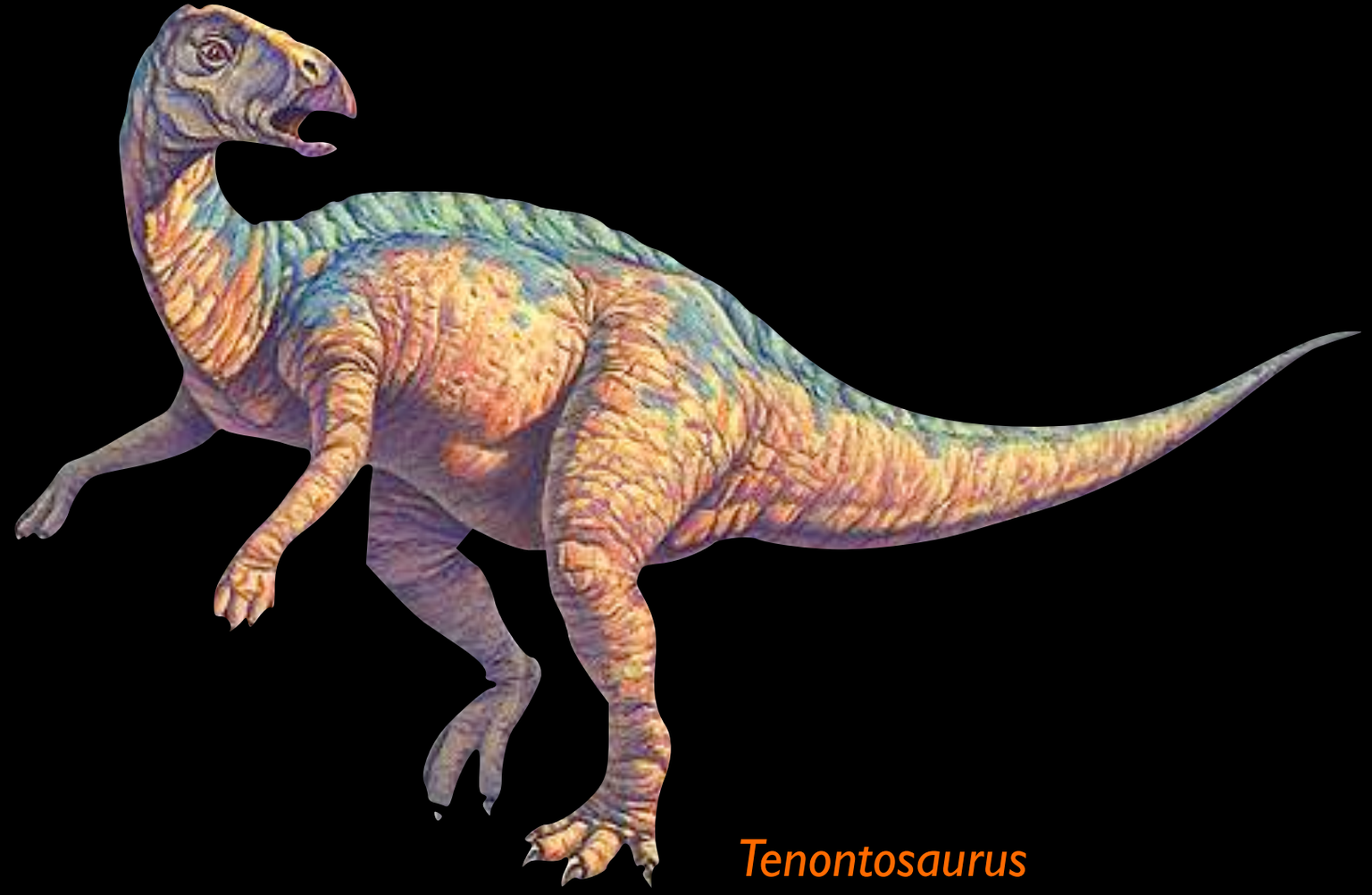
***Big**, with appropriate modifications.*



Iguanodon

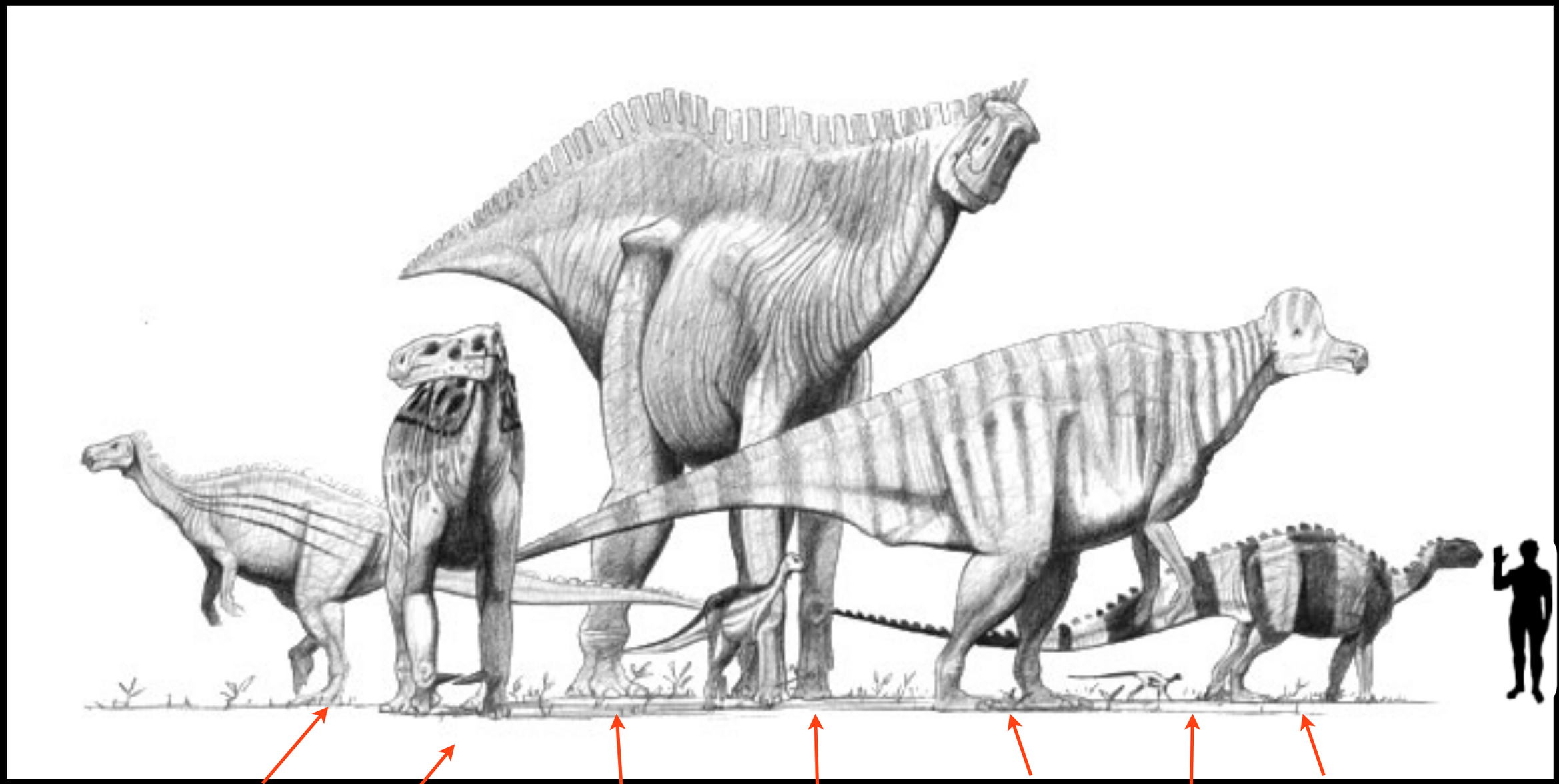
Facultative quadrupeds

Obligate Bipedal
Facultative Bipedal

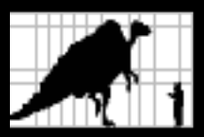


Tenontosaurus

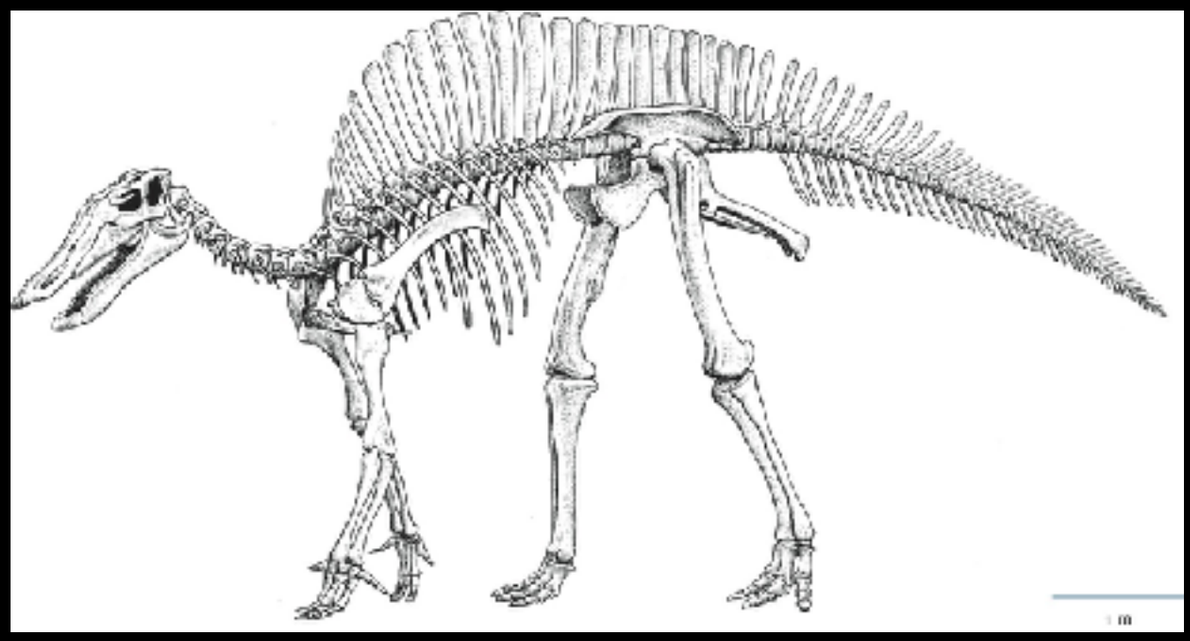
Scales: Ornithopods, great and small



Dryosaurus: one of the smallest; 2.4 - 4.3 m long; 200 lbs
Shantungosaurus: one of the largest; skull 1.6 m (5 ft); length: 15 m (50 ft); 16 tonnes = 35,274 lbs



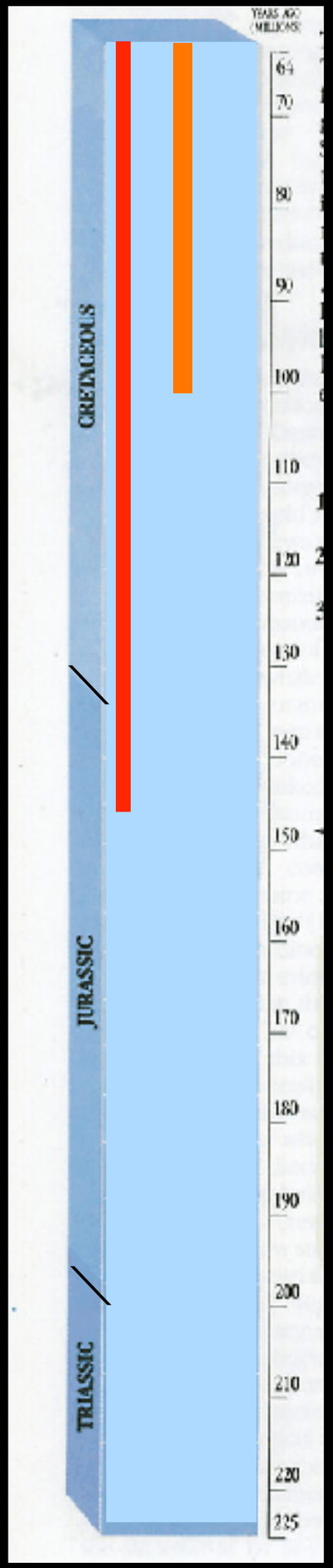
Ouranosaurus
(Niger)



Cretaceous

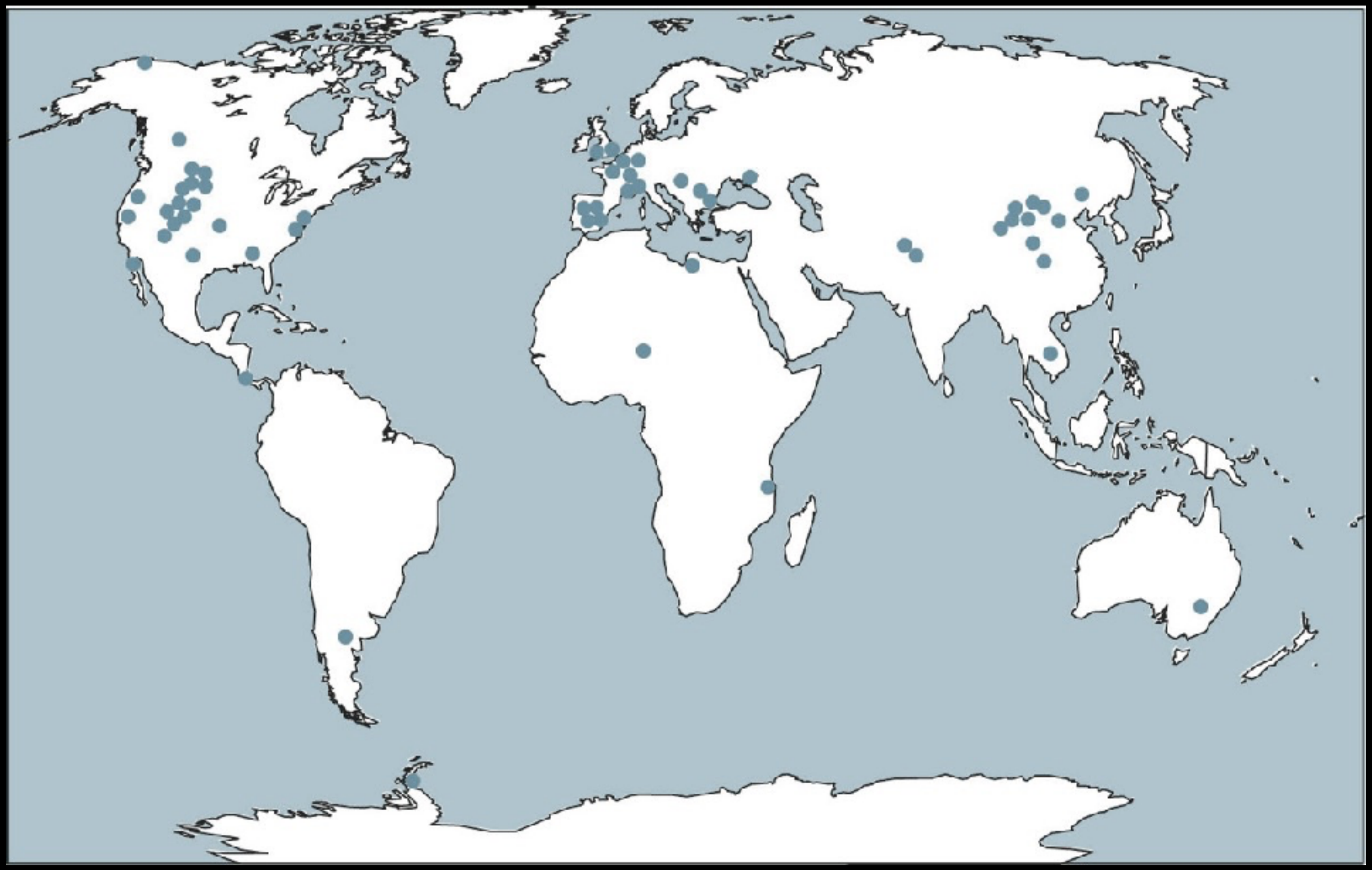
Jurassic

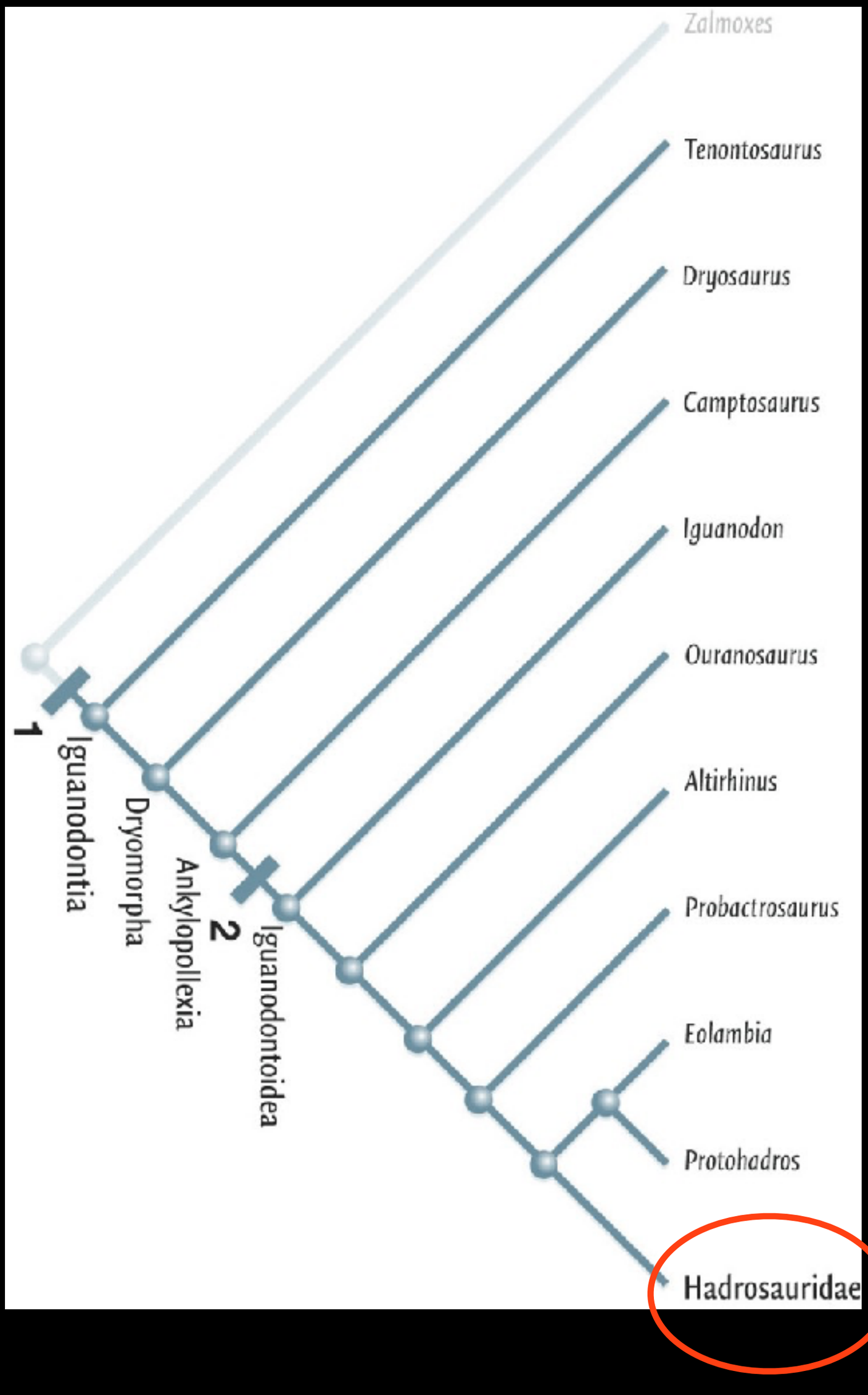
Triassic



Hadrosaurid time range

Non-hadrosaurid iguanodontian time range

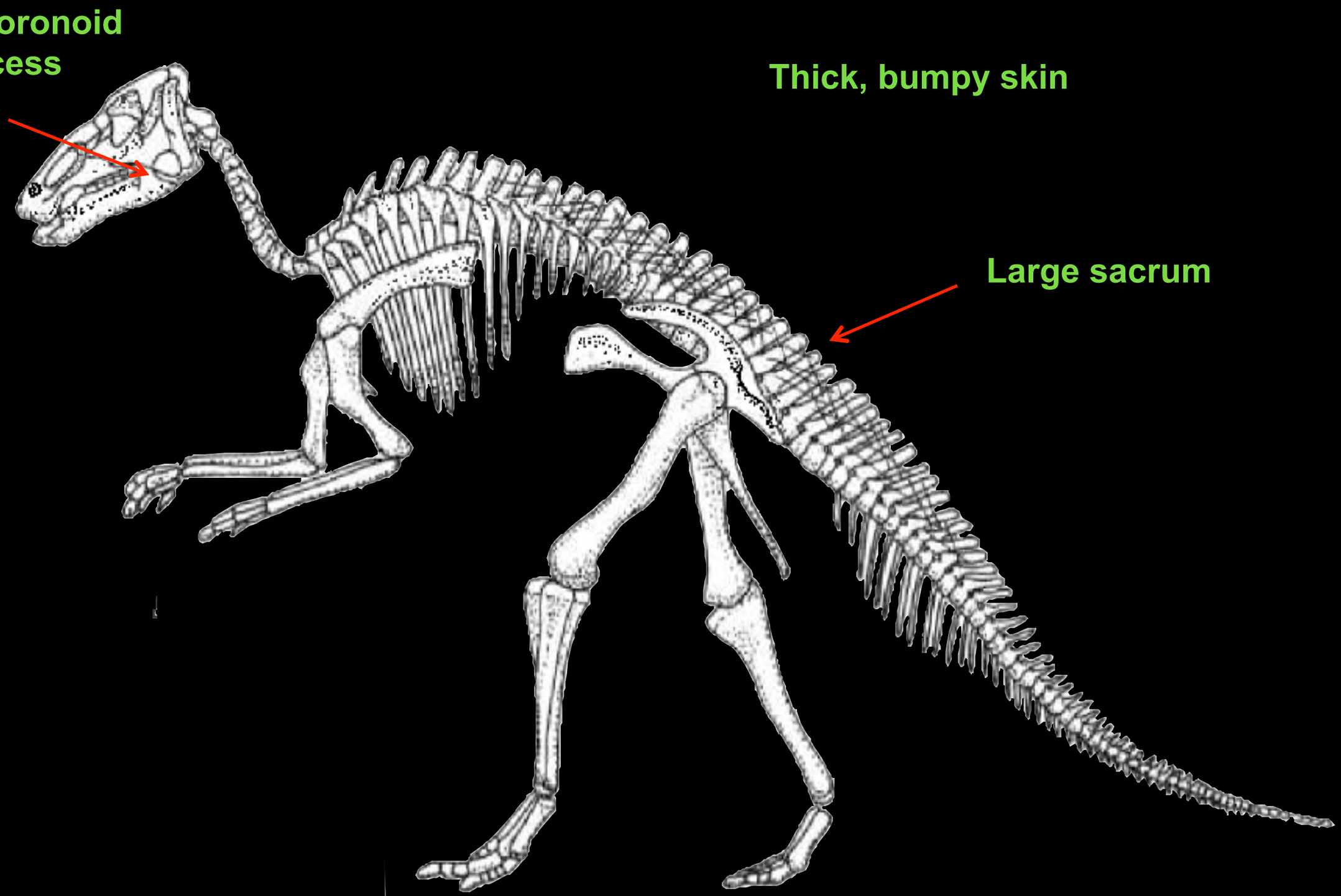



Zalmoxes
Tenontosaurus
Dryosaurus
Camptosaurus
Iguanodon
Ouranosaurus
Altirhinus
Probactrosaurus
Eolambia
Protohadros
Hadrosauridae
1
Iguanodontia
Dryomorpha
2
Ankylopollexia
Iguanodontoidea

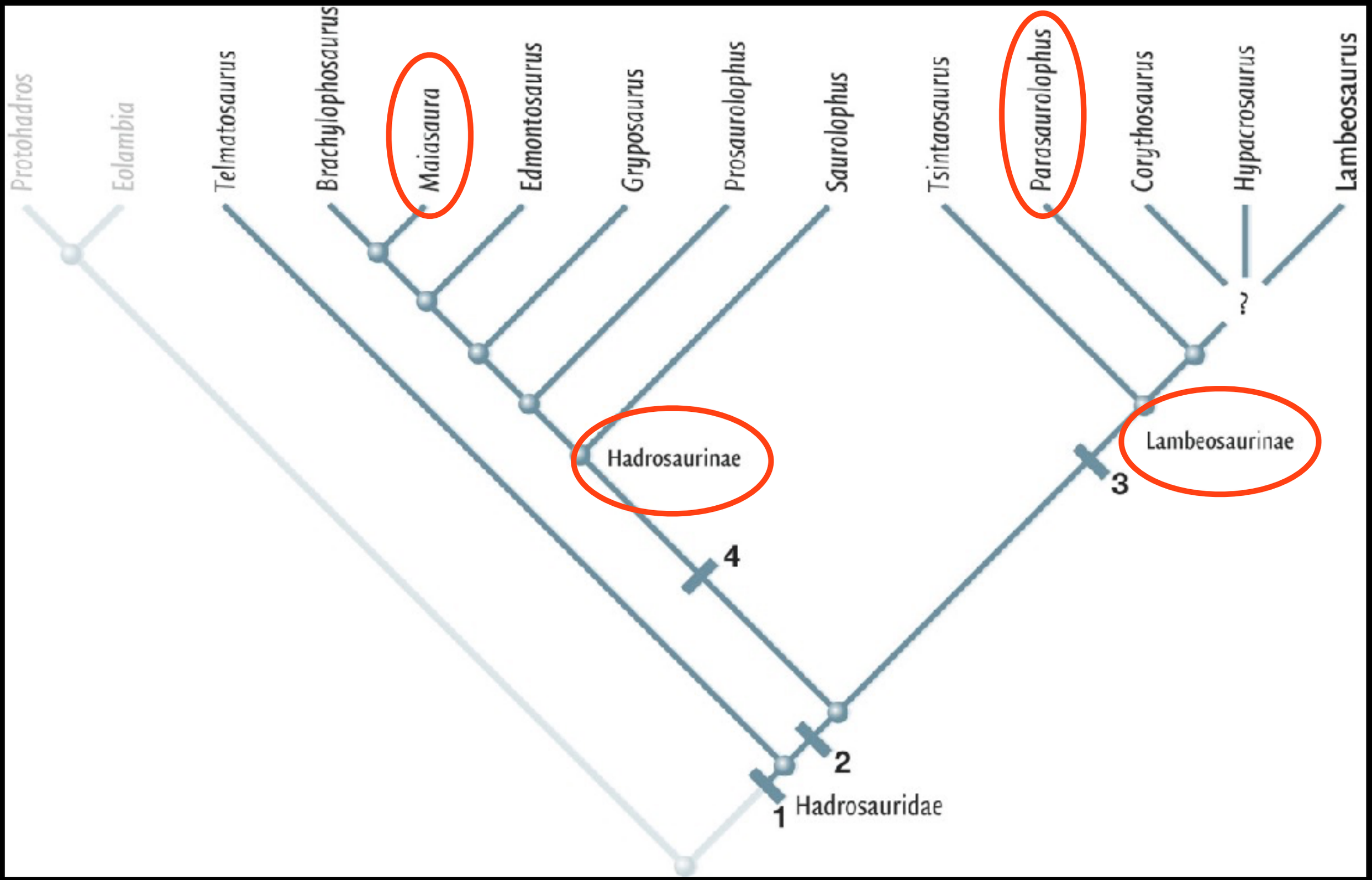
Hadrosaurids

Well developed dental battery

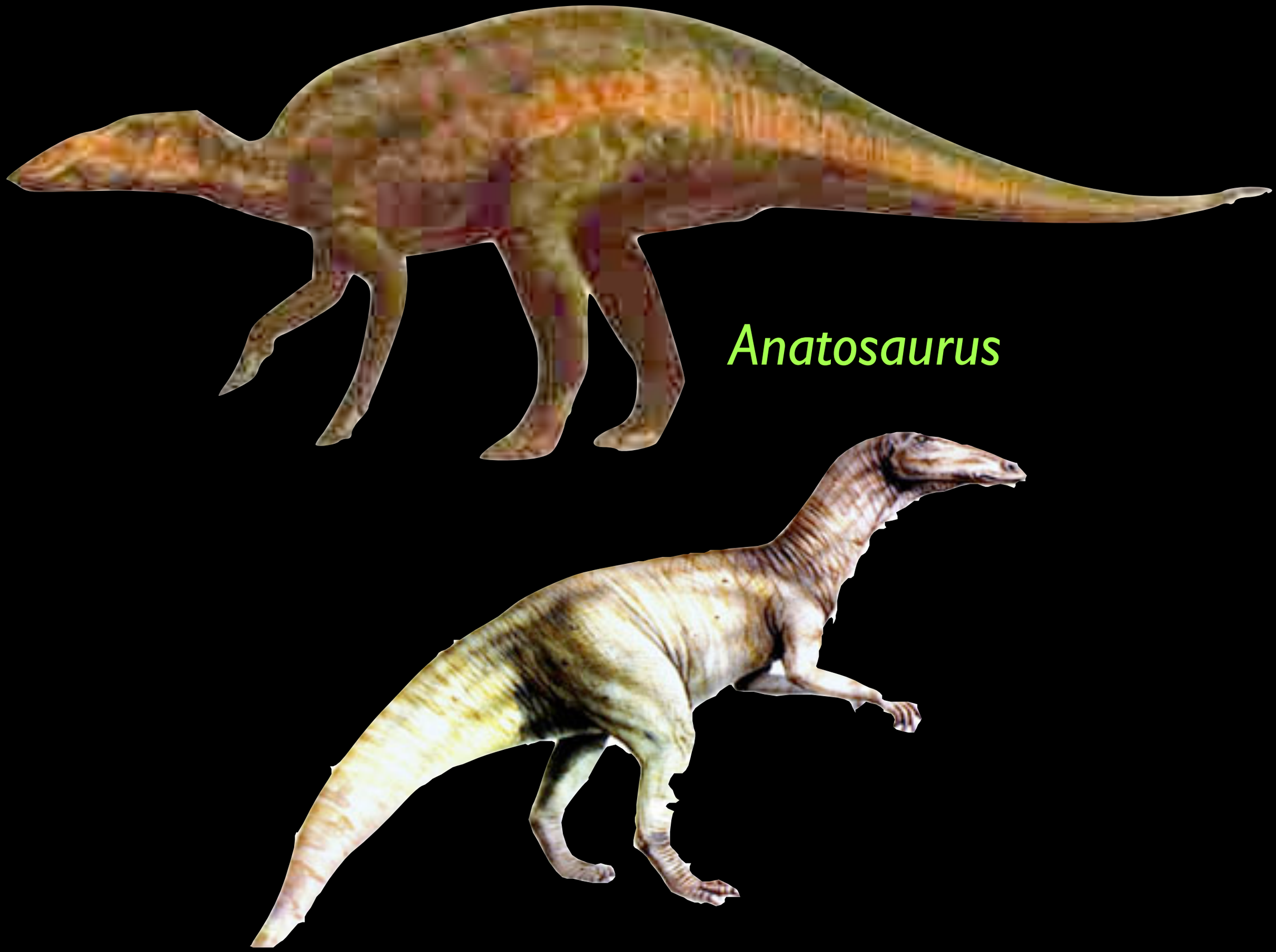
Modifications to skull and mandible to enhance chewing efficiency



Hadrosaur front foot
Anatotitan


Protohadros
Eolambia
Telmatosaurus
Brachylophosaurus
Maiasaura
Edmontosaurus
Gryposaurus
Prosaurolophus
Saurolophus
Hadrosaurinae
4
Tsintaosaurus
Parasaurolophus
Corythosaurus
Hypacrosaurus
Lambeosaurus
?
Lambeosaurinae
3
2
1
Hadrosauridae

Meet the Hadrosaurines (wide snouts)

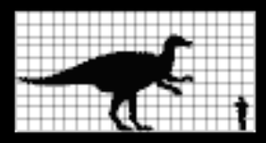


Anatosaurus

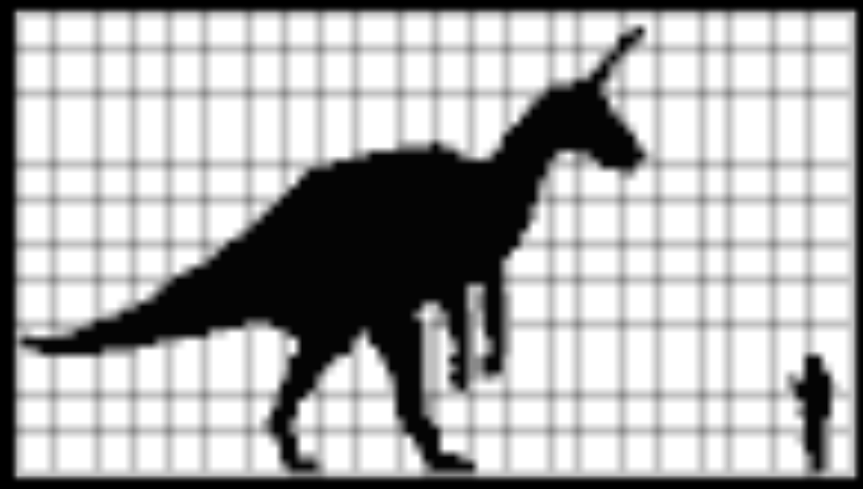
Edmontosaurus

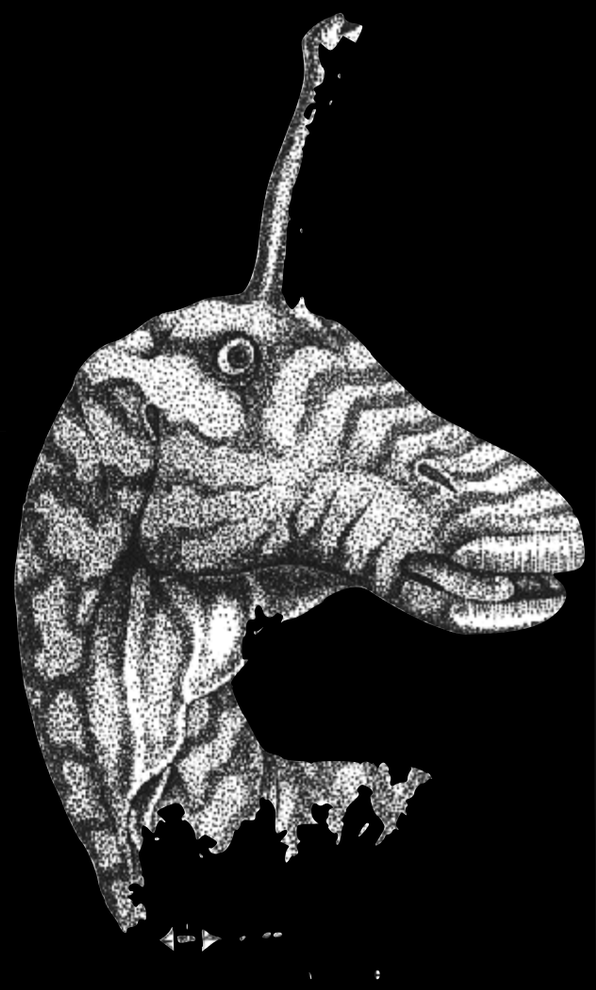
Maiasaura

Saurolophus

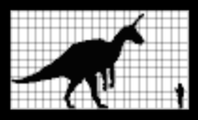


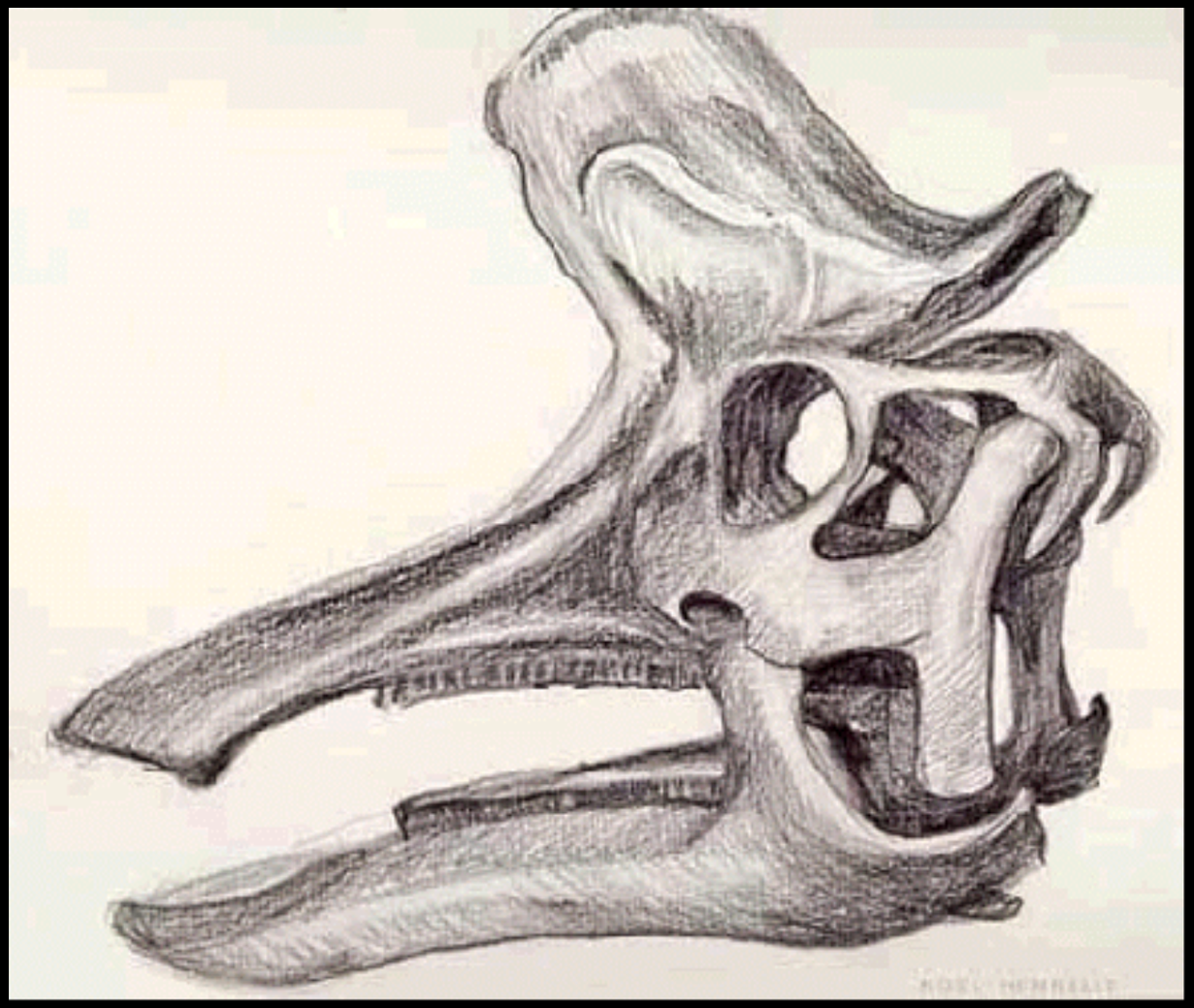
Meet the Lambeosaurines



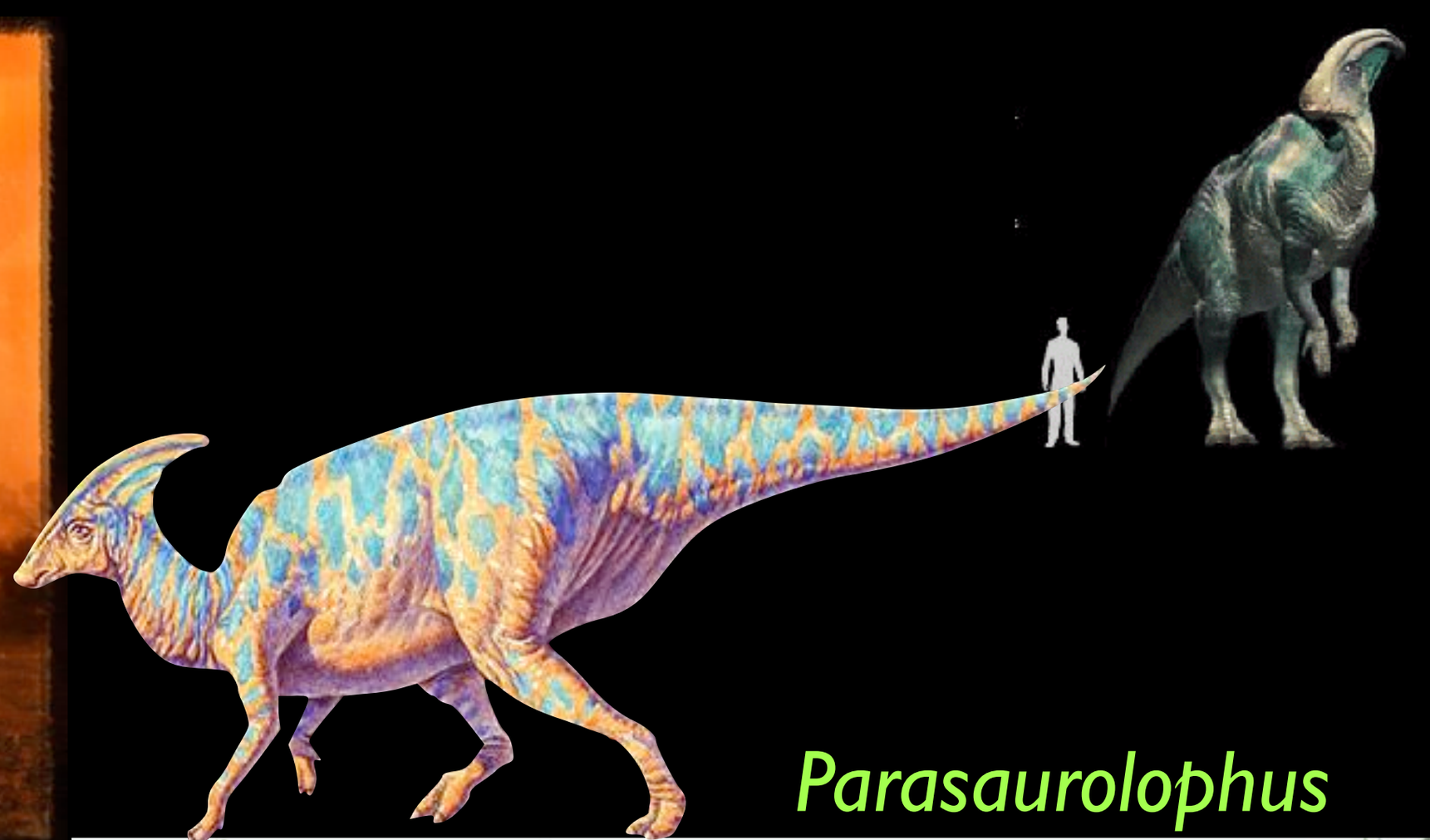


Tsintaosaurus

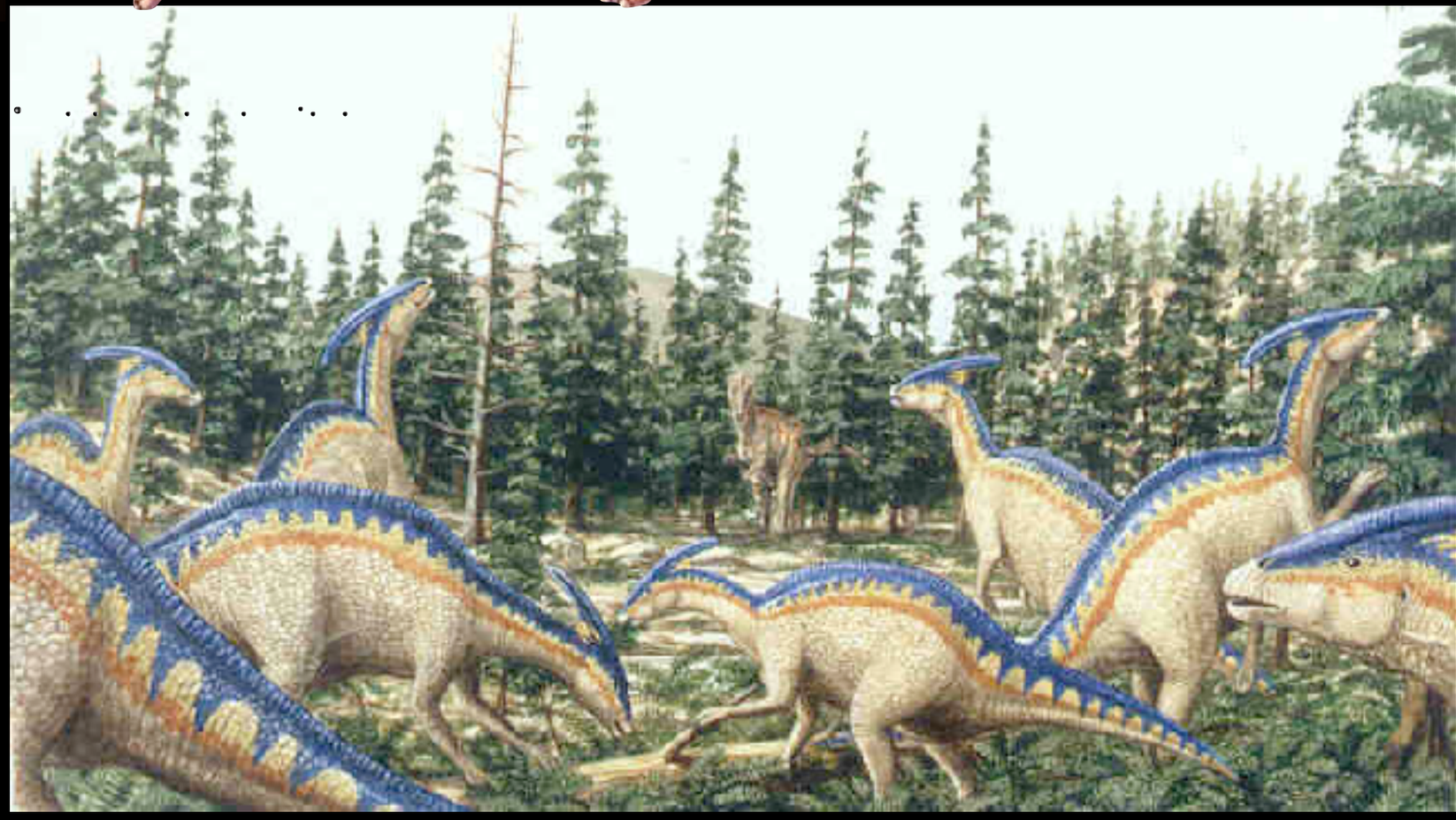


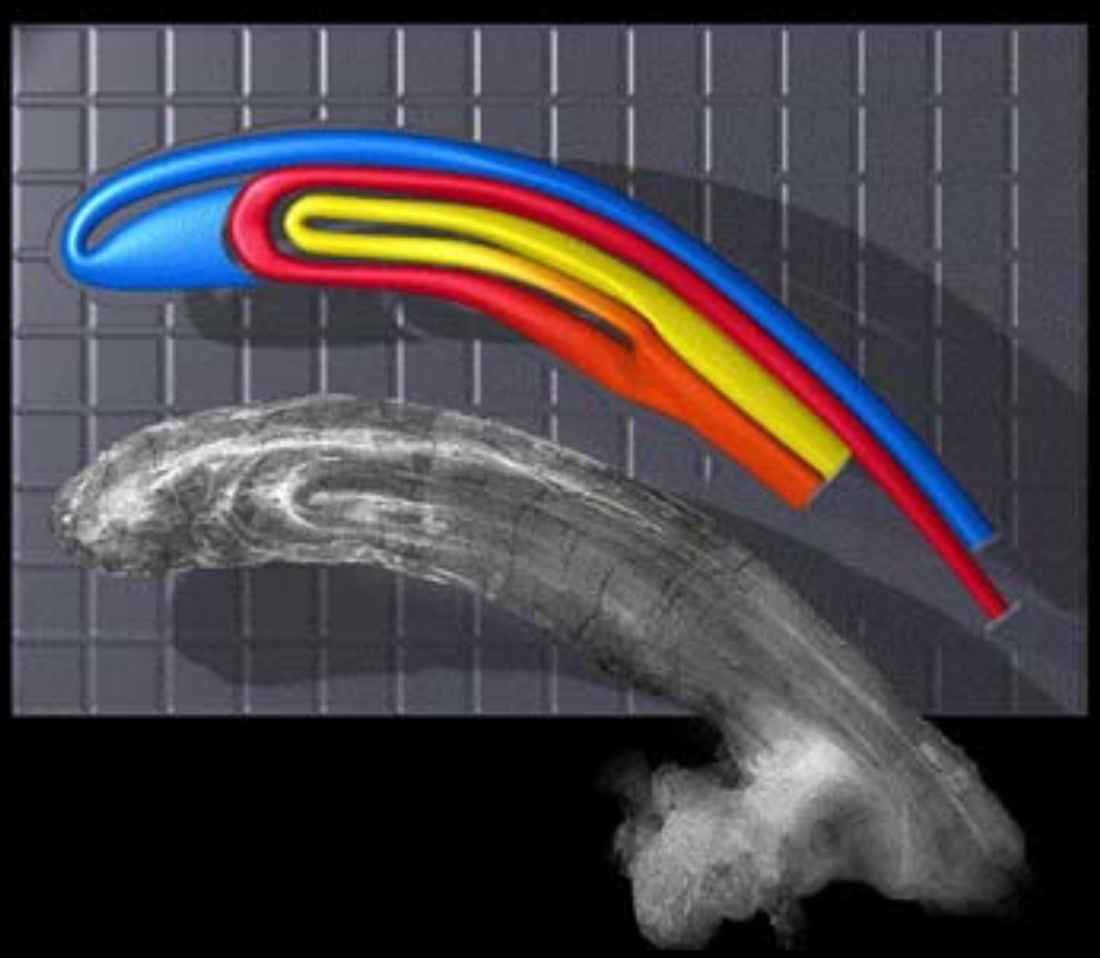


Lambeosaurus

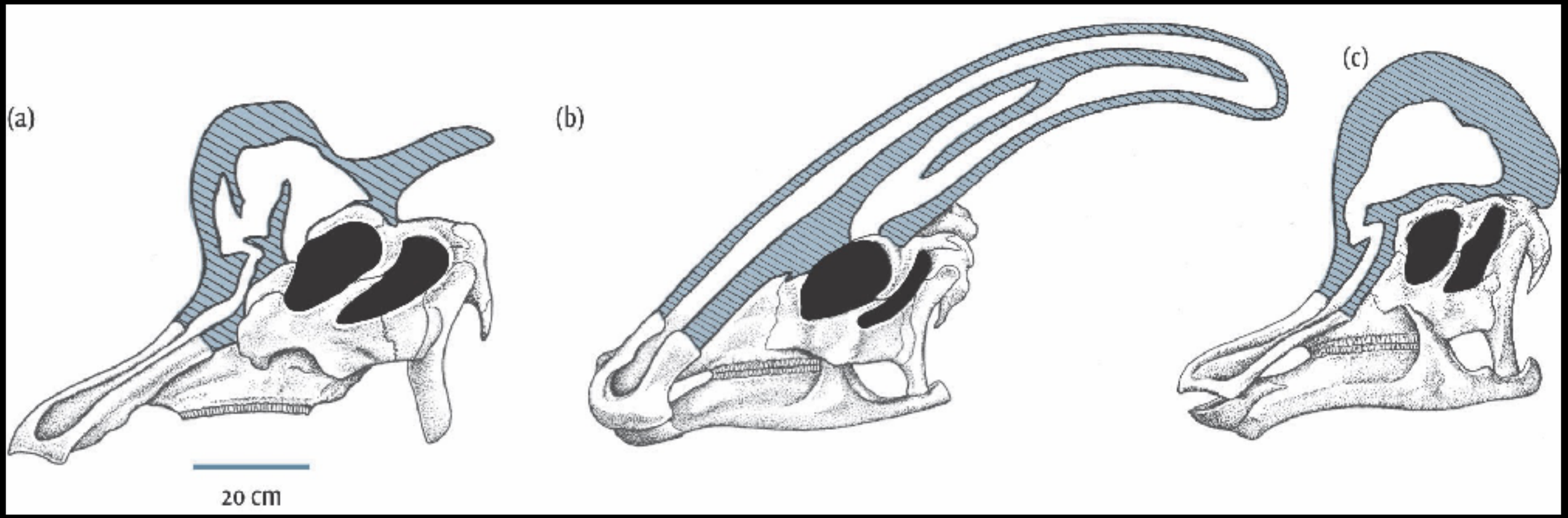


Parasaurolophus





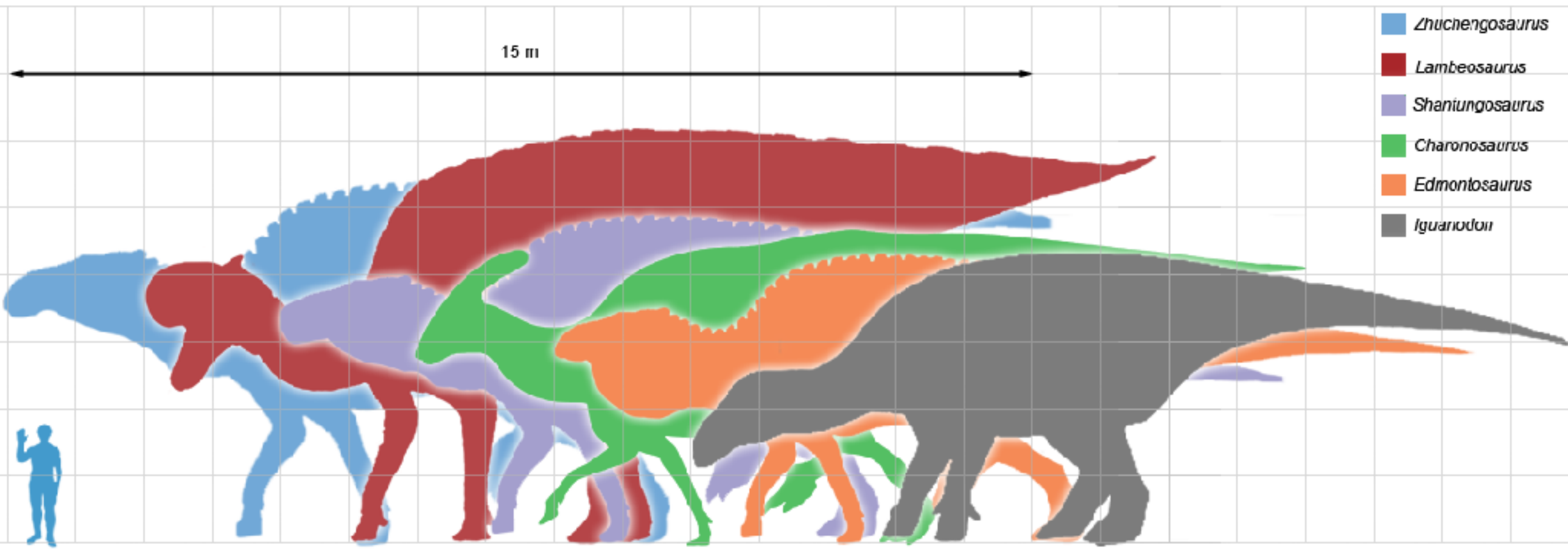
Snorkel?

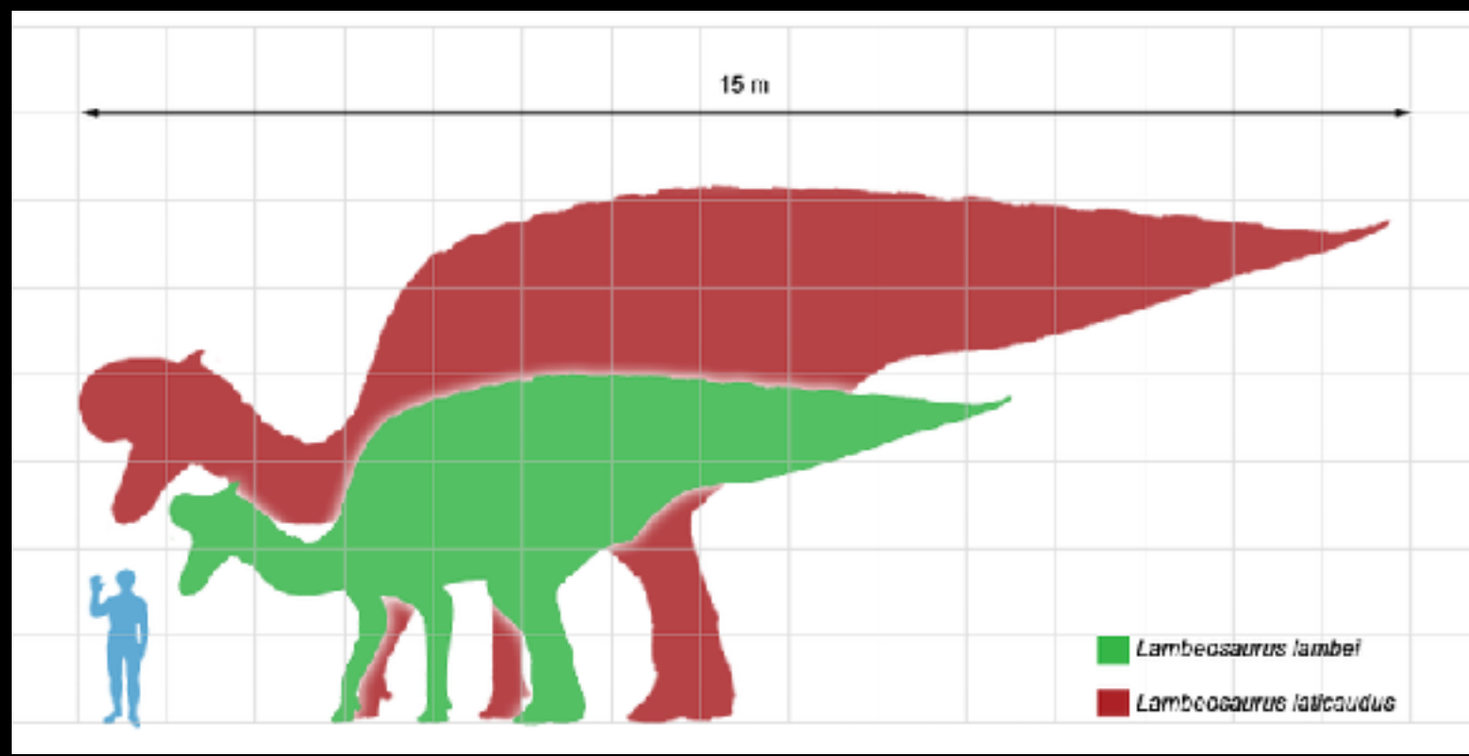


Lambeosaurus *Parasaurolophus* *Corythosaurus*

Hadrosaur skin

Scales: the largest Hadrosaurids

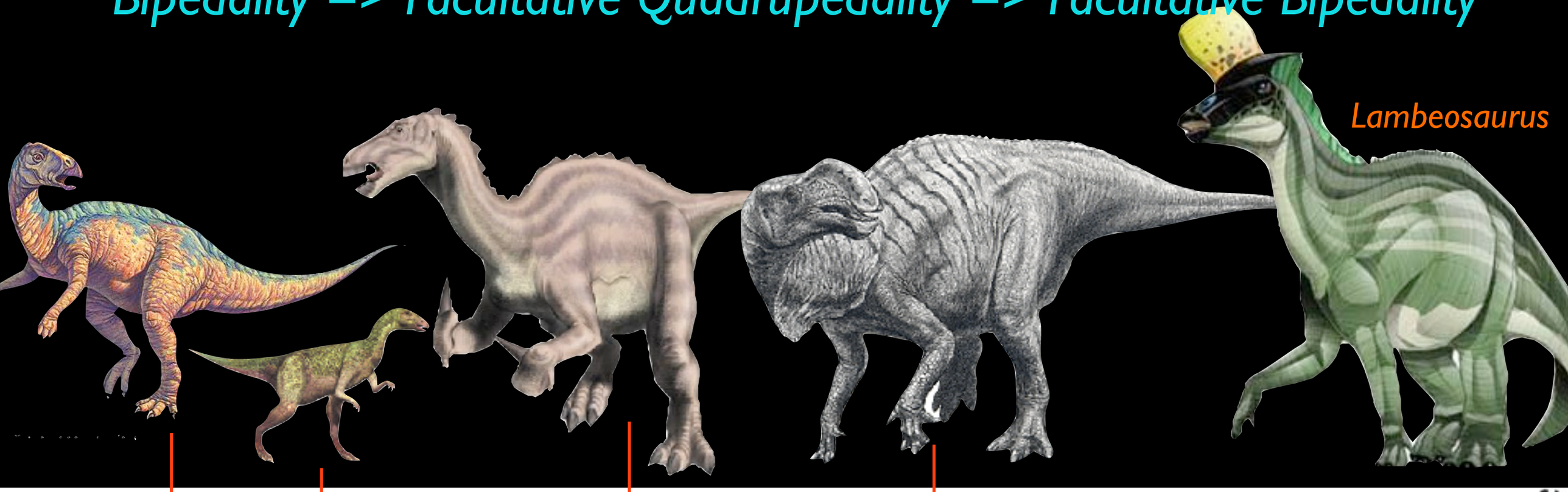


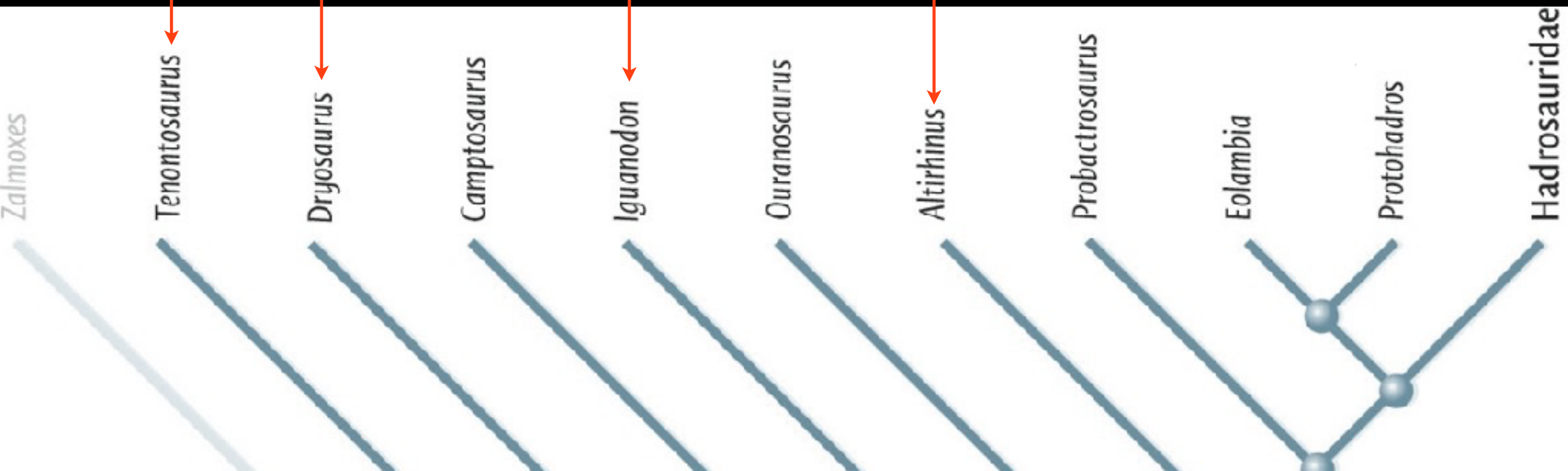


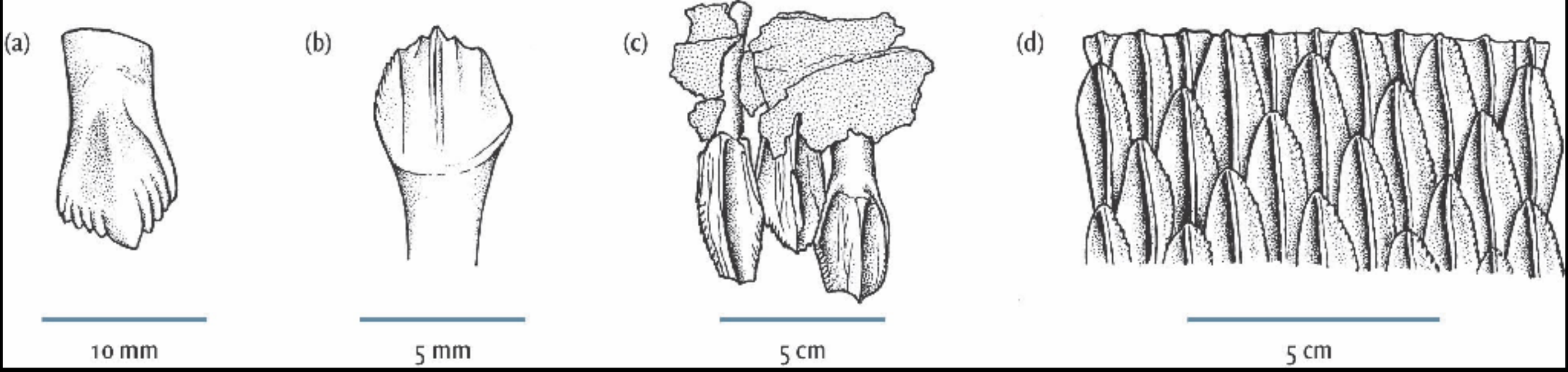
Major Evolutionary Trends

1. *Efficient, robust dental battery*
2. *Larger body size*

Bipedality => Facultative Quadrupedality => Facultative Bipedality

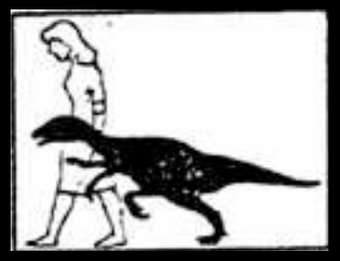




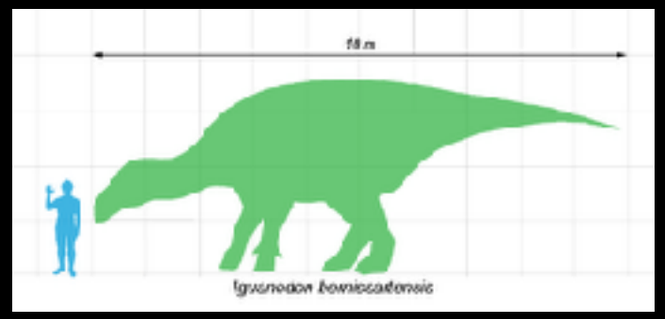


Lycorhinus (Heterodontosaurid)

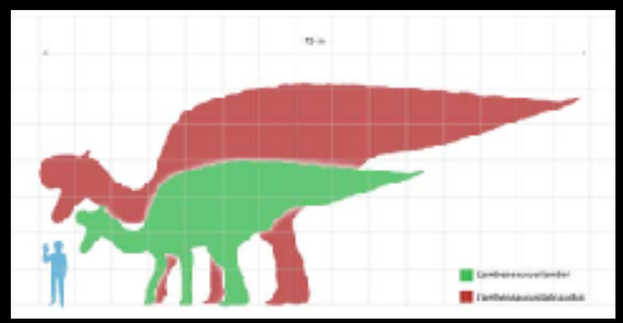
Hypsilophodon



Iguanodon



Lambeosaurus



TRENDS

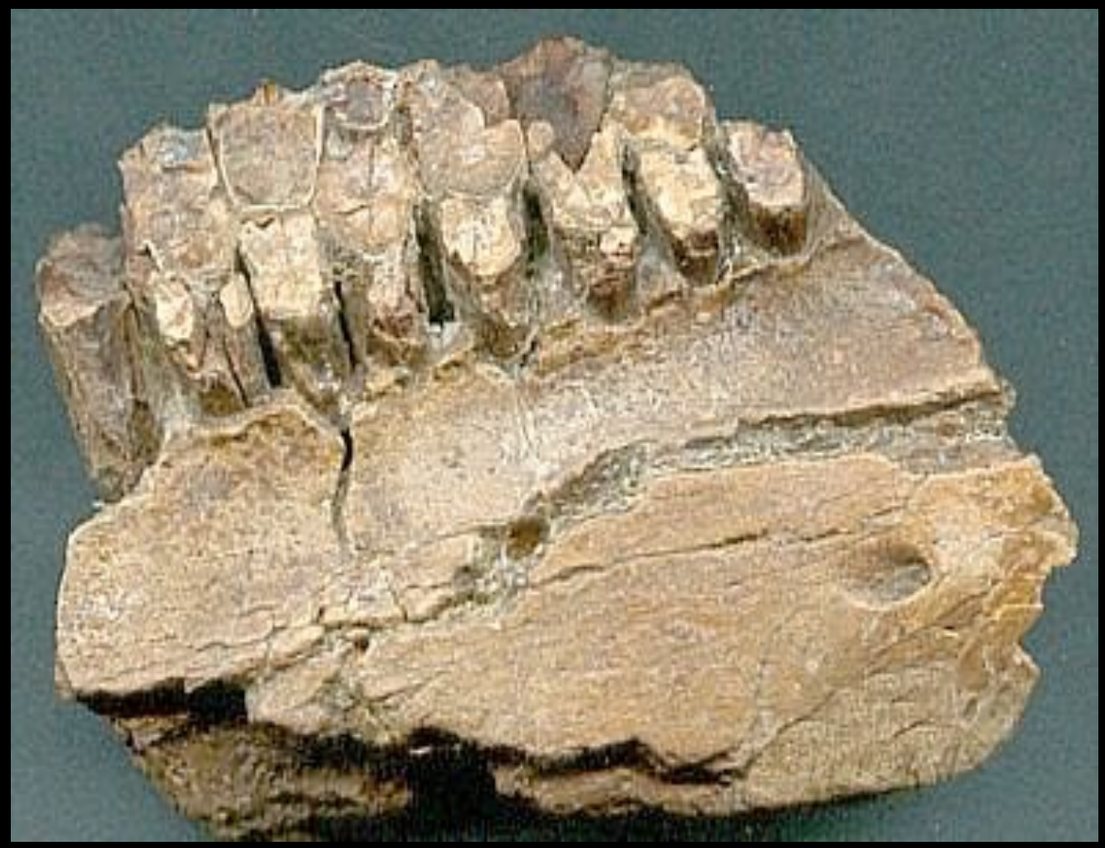
1. Efficient, robust dental battery

2. Larger body size

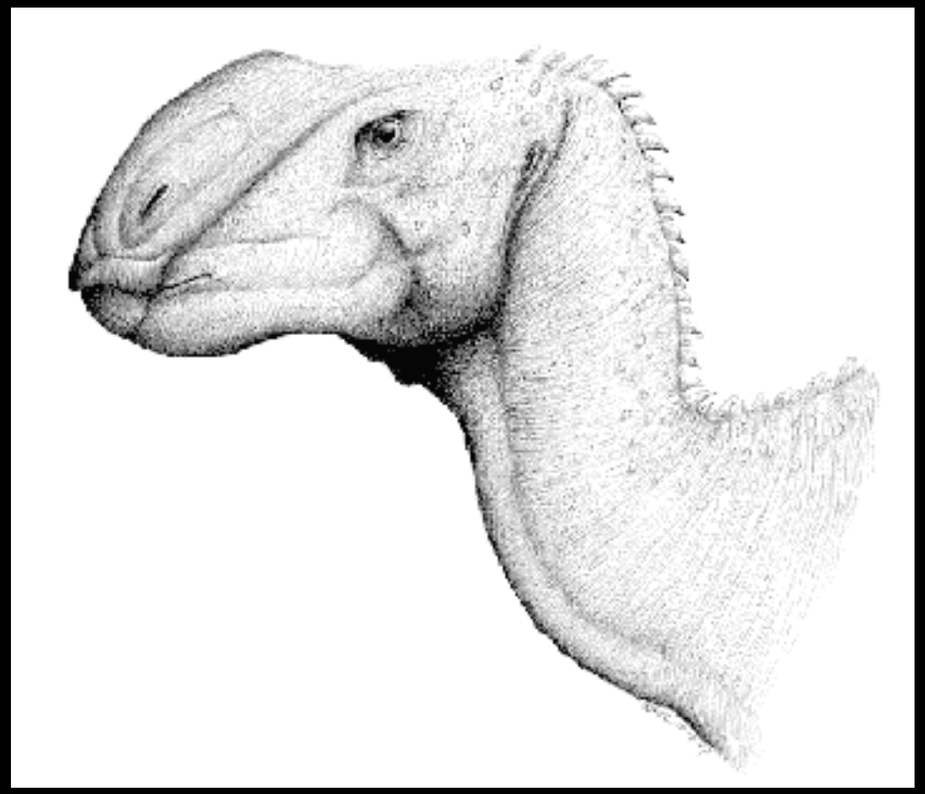
Gastroliths

Large, robust coronoid process

Deep, inset tooth row

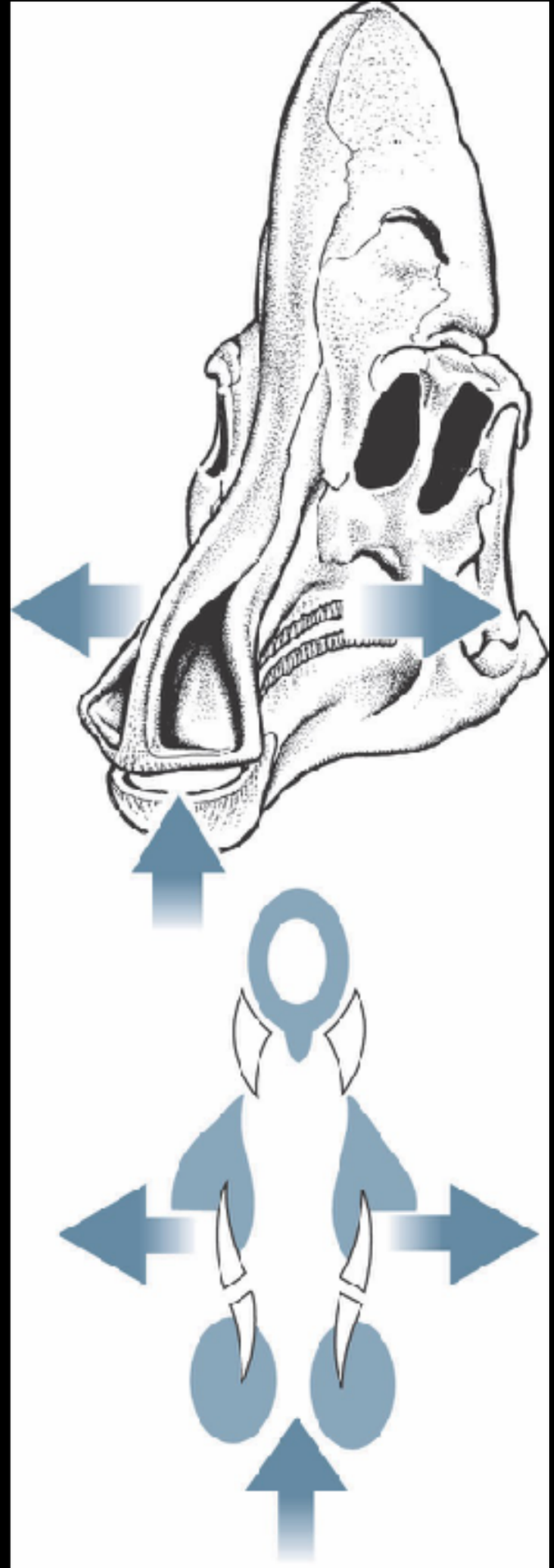


Brachylophosaurus



A new type of chewing (Euornithopoda)
Pleurokinesis
Lateral mobility of UPPER jaws

http://www.youtube.com/watch?v=6Sr5is7-wdk

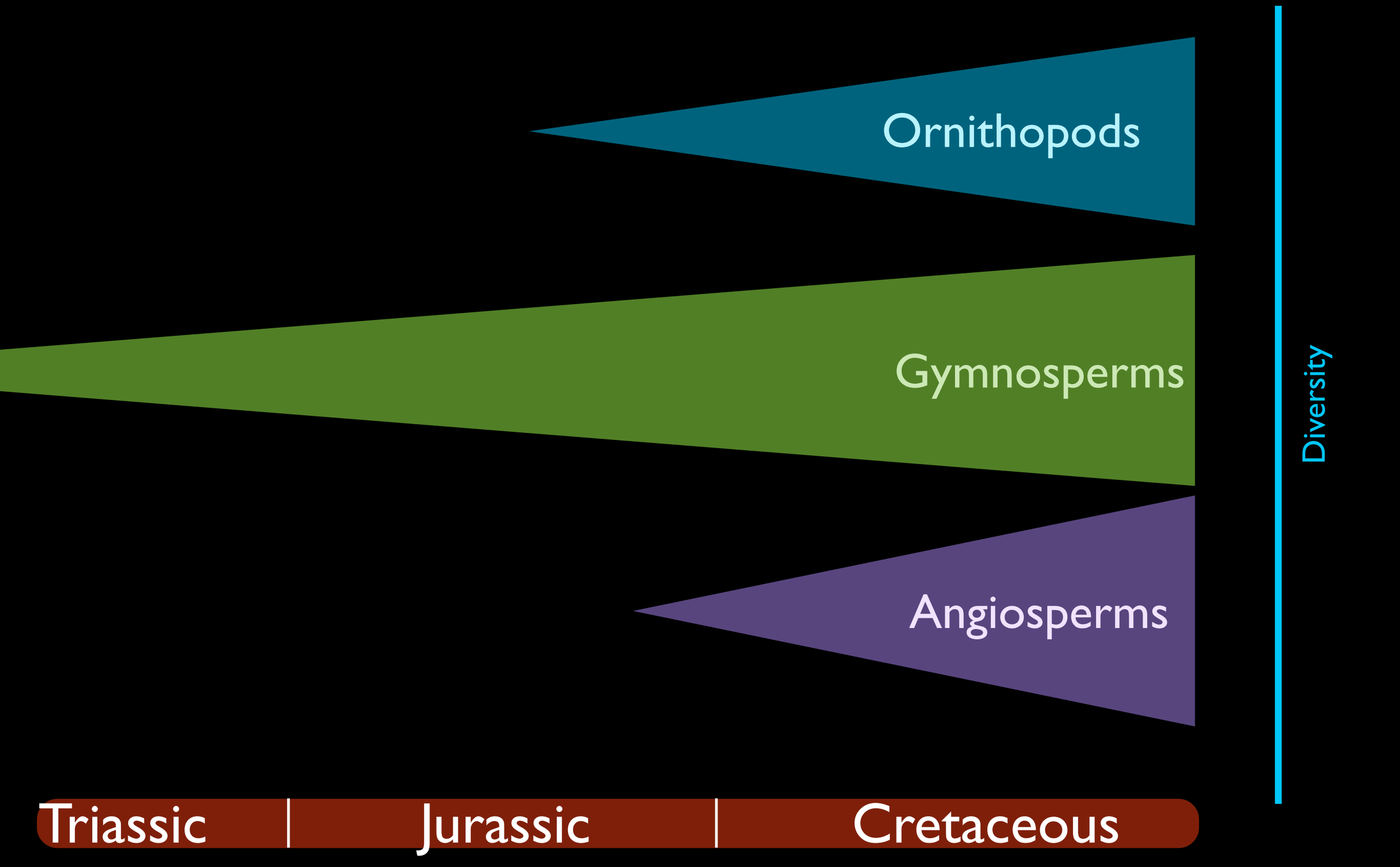


Visualizing the Pleurokinetic Model for Mastication in an Undescribed Hadrosauroid Dinosaur

So what did they eat?

Twigs, fruits, berries
Ground cover
Lower level foliage from conifers
Newly evolving Angiosperms
Limited to 1-2 meters off the ground; larger animals, up to 4 meters (13 ft)

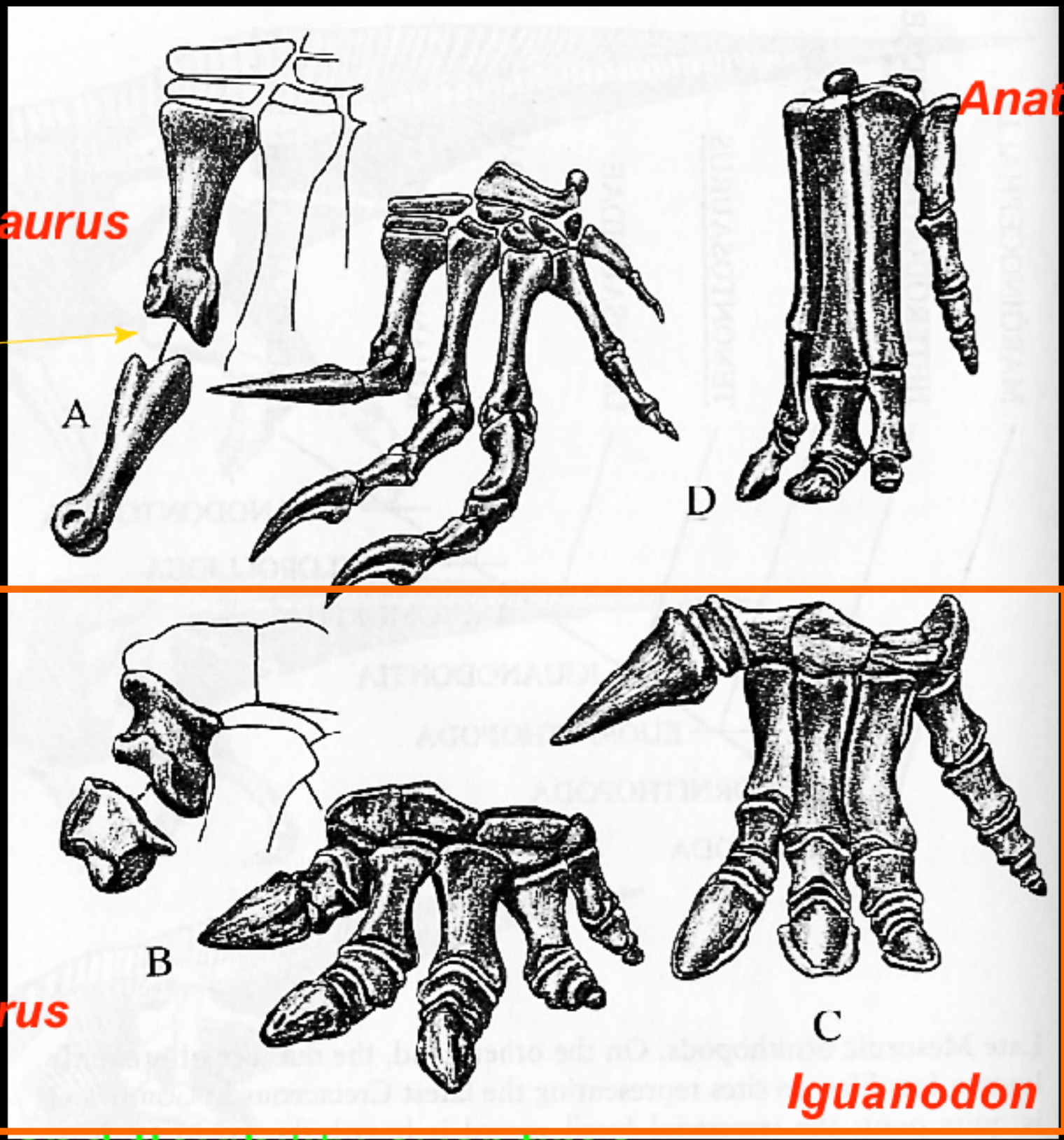
Evolutionary Trends
Ornithopod diversity and plant diversity




14
LUNCH BREAK!

Heterodontosaurus

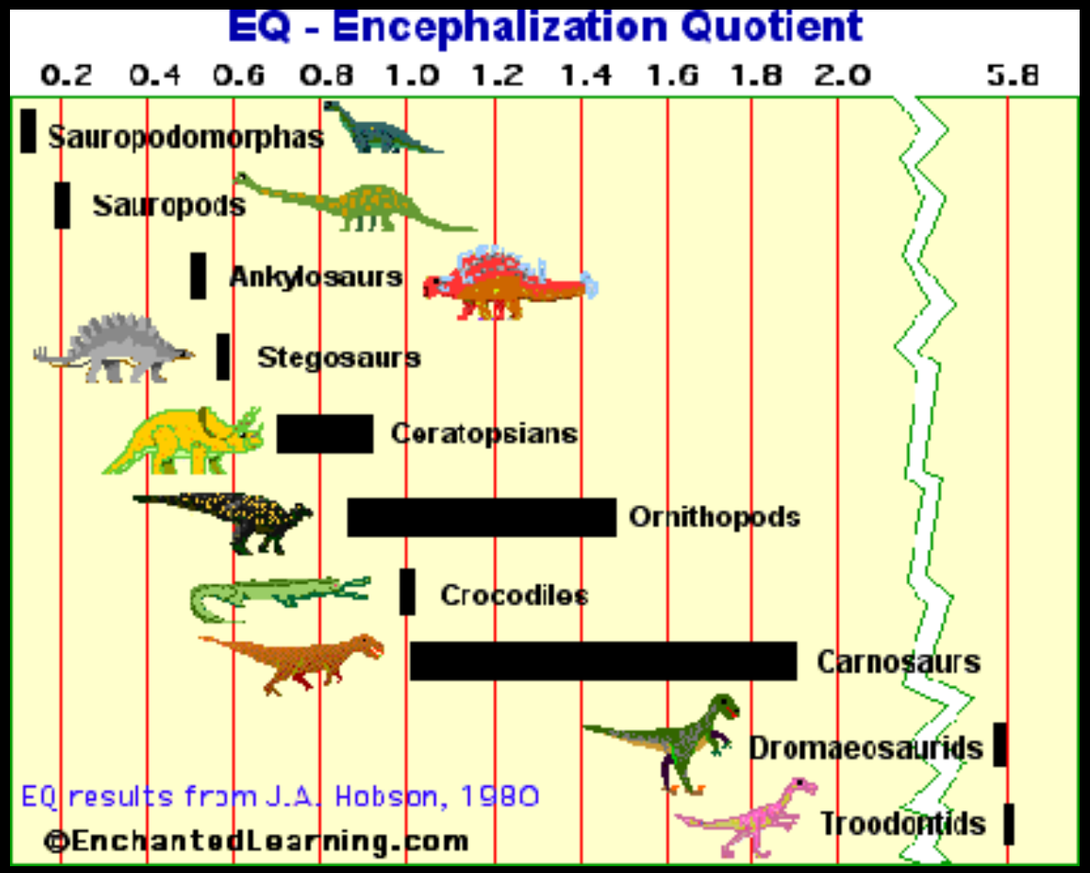
Basal Ornithopod



Closely related non-Hadrosaur Iguanodontians

Loss of hand flexibility over time

Brains



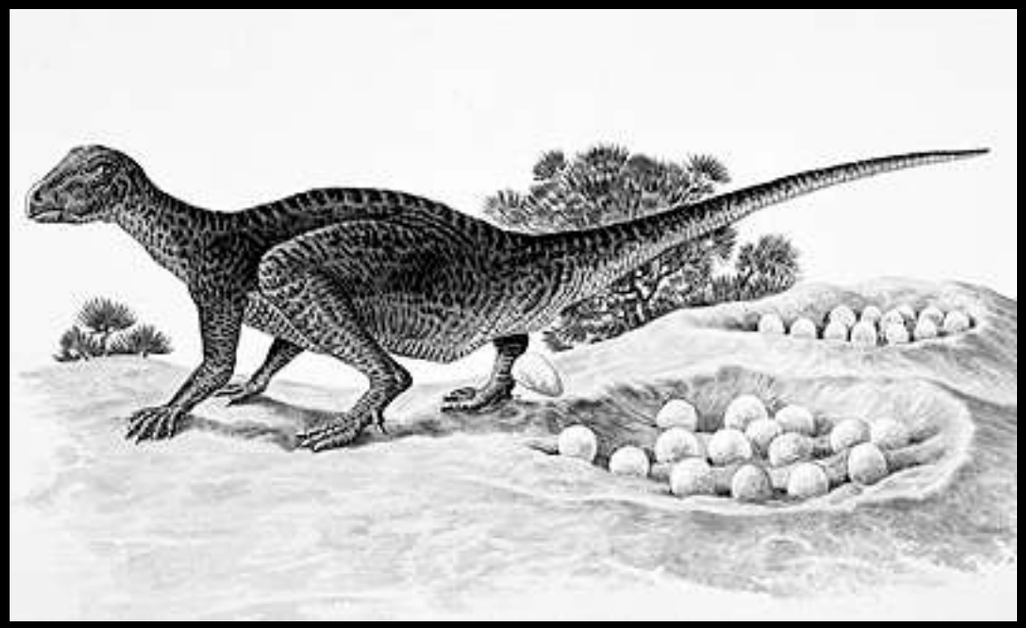
+ fossil evidence==> “sophisticated” social behavior

Behavior!

1) Hadrosaur head gear

2) Herding

3) Reproductive Behavior



Hadrosaurinae
w/o hollowed crests/horns

Behavior!

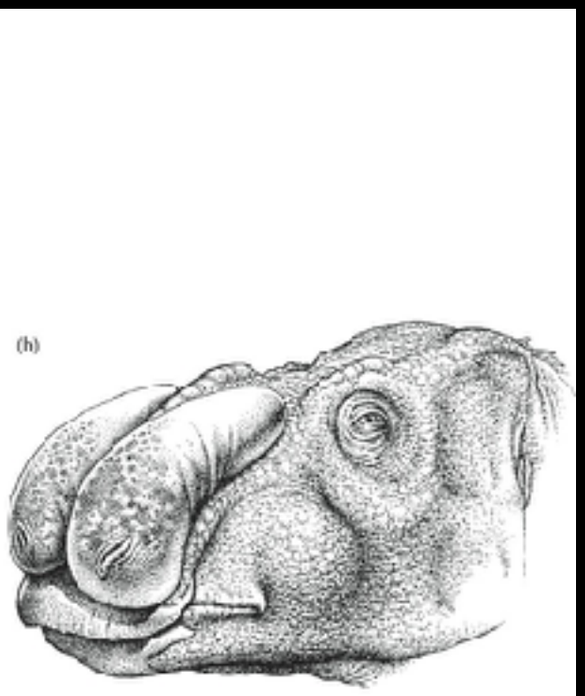
1) Hadrosaur head gear

Vocal adaptations

Air sacs?

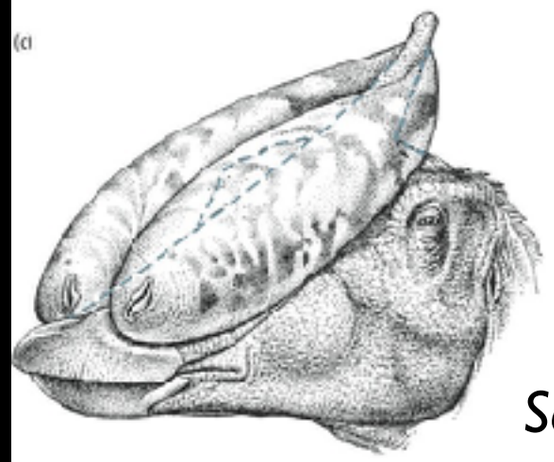
Visual adaptations

Gryposaurus



Gryposaurus

Saurolophus



Saurolophus

Species specific (recognition)

Male-male competition (competition for mating)

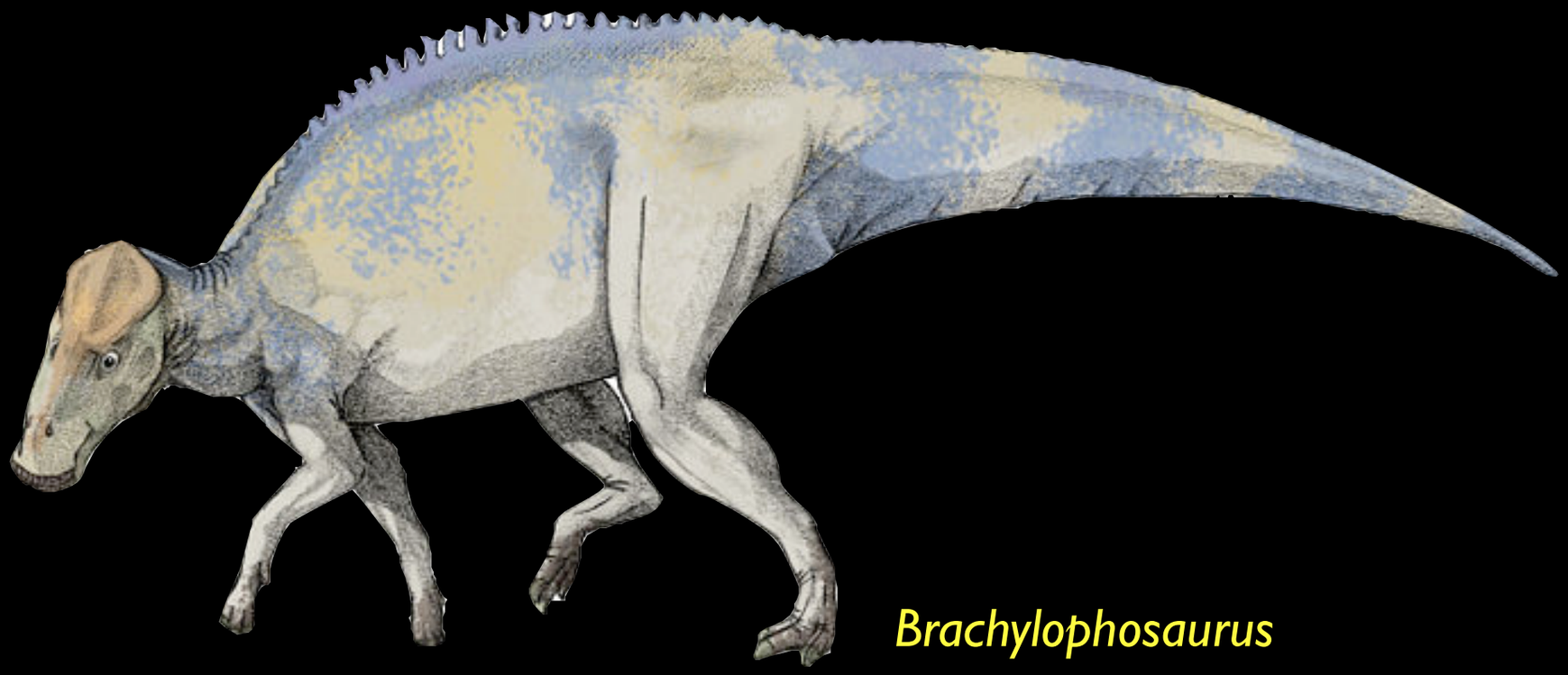
Intimidation

Physical head-butting?

Attract females (competition for mating)

Altirhinus

Edmontosaurus



Brachylophosaurus

Altirhinus

Behavior!

1) Hadrosaur head gear

Proof?

Such sexual selective traits would suggest certain evidence would be present

a) Hadrosaurs should have good hearing / eyesight ✓

b) Outside structure of the 'horns', headgear, should be divorced from the internal workings (indicating the outside is being used as a visual stimulus) ✓

c) Crests should be species specific ✓

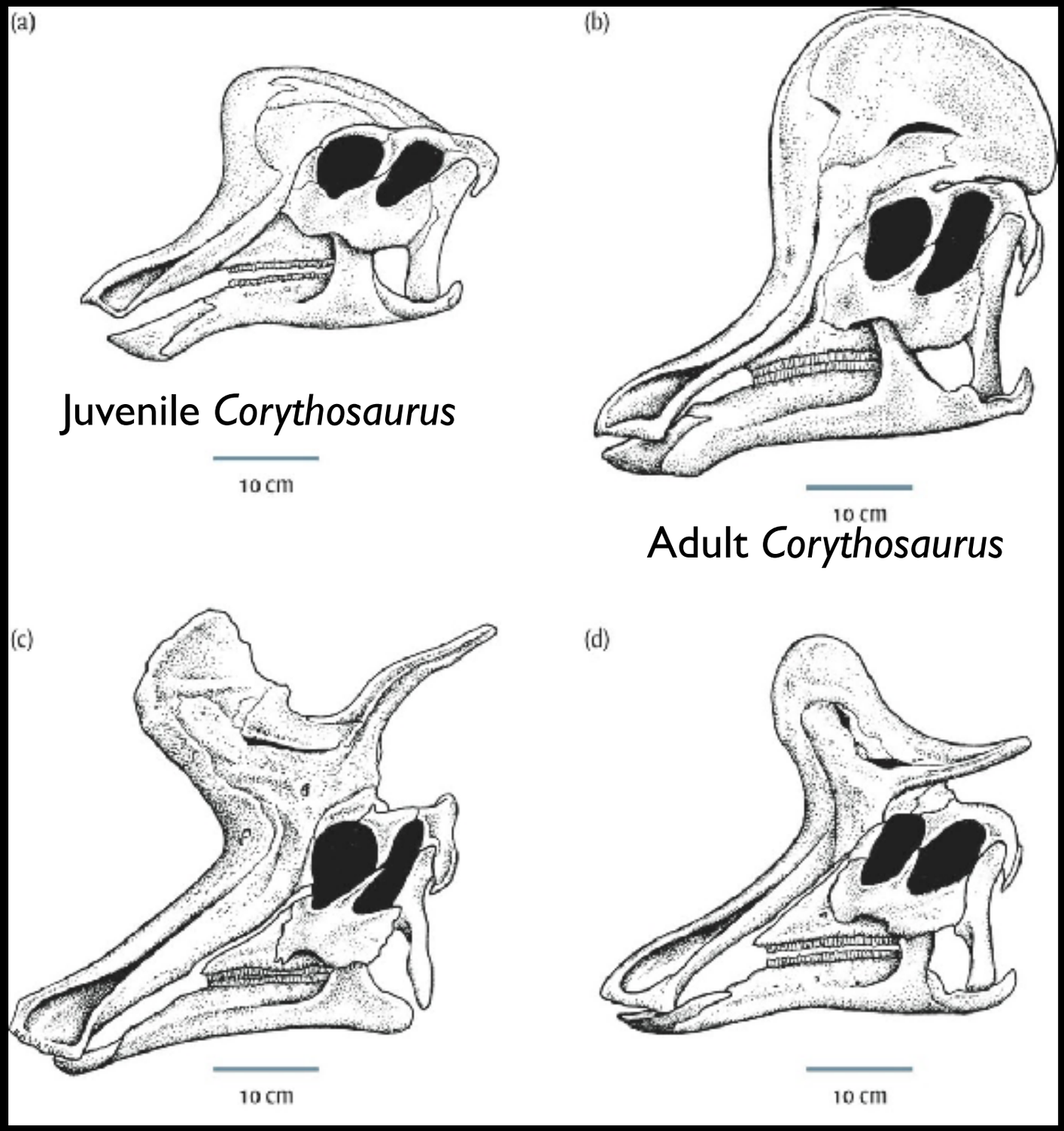
d) When multiple species co-occur, differences between species should be more exaggerated ✓

e) Differences between dimorphic crests should increase through time ✗

Behavior!

1) Hadrosaur head gear

Growth and Sexual Dimorphism



Juvenile *Corythosaurus*

Adult *Corythosaurus*

Male? *Lambeosaurus*

Female? *Lambeosaurus*

Behavior!

2) Bonebeds

Bonebeds found for:

Dryosaurus

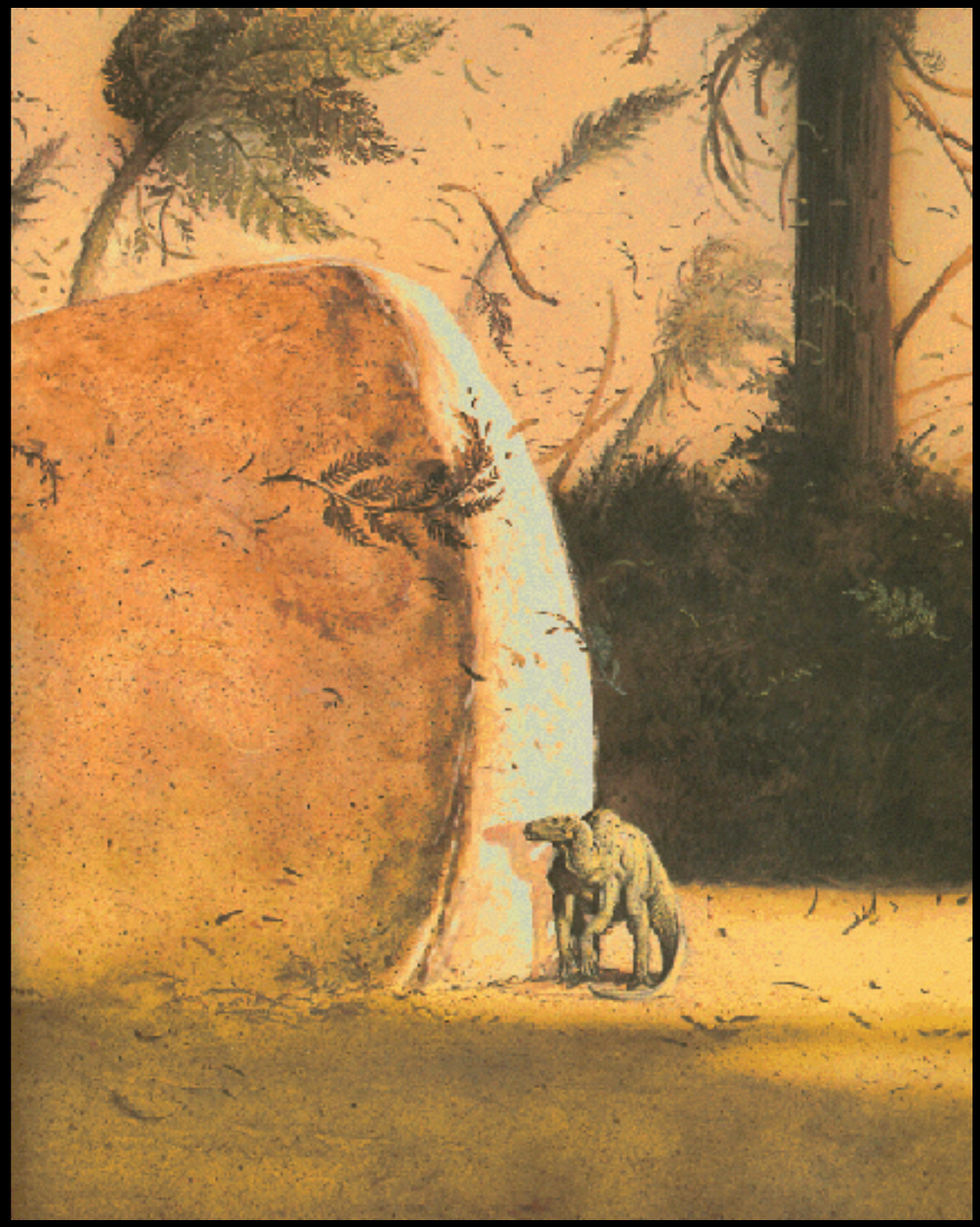
Iguanodon

Maiasaura

Hypacrosaurus

Herds?

Migratory behavior?



Behavior!

3) Reproductive Behavior

"R-selected" "K-selected"

Behavior!

3) Reproductive Behavior

"R-selected

Orodromeus

K-selected"

Maiasaura

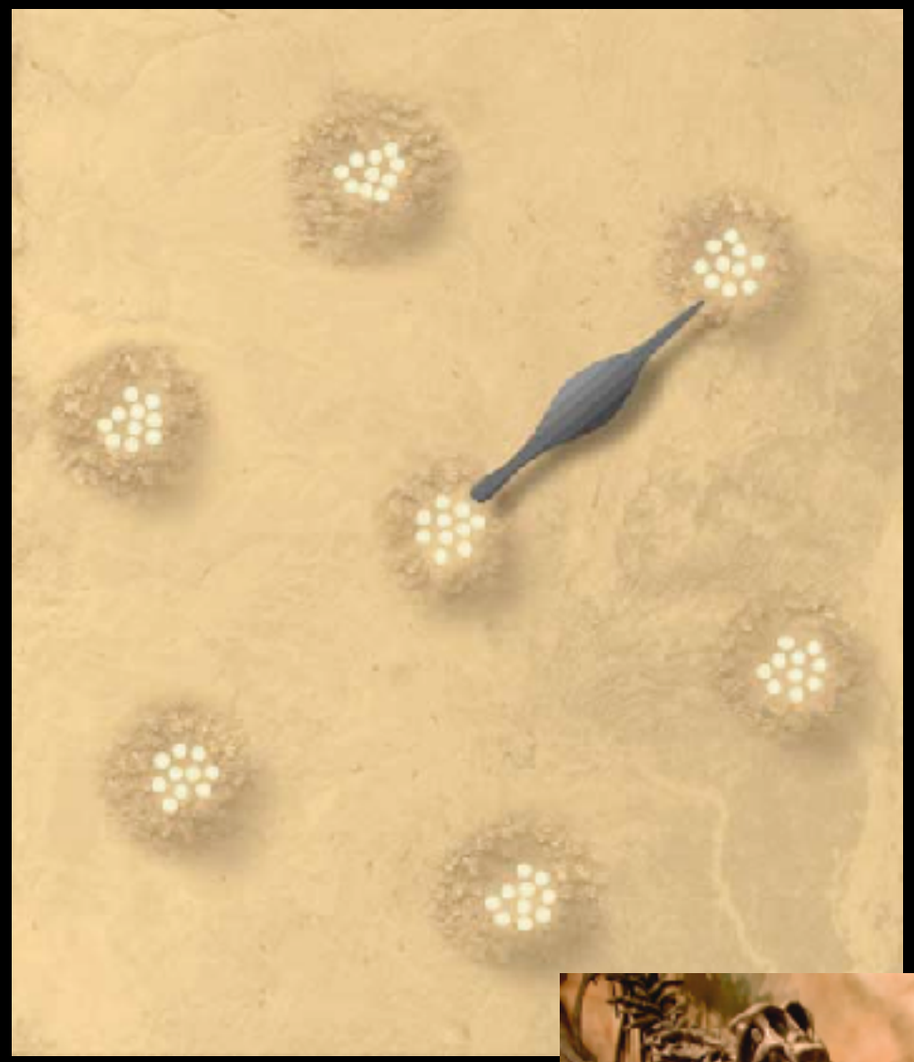
Hatchlings have well-developed limb bones
Fully formed joint surfaces
Parental care assumed to be minimal
But still groups
= Precocial

Nested in colonies
Usually 17 (30 max) eggs in each nest
Hatchlings have poorly developed limbs; likely needed constant parental care for 8-9 months after birth
= Altricial

Maiasaura Nesting Sites

Maiasuara: 30 ft long

LARGE HERDS: up to 10,000 individuals!



Nests

Eggs packed tightly together, like modern seabirds

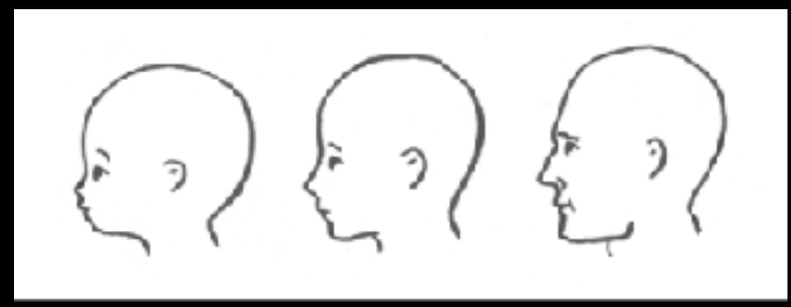
Ostrich egg size

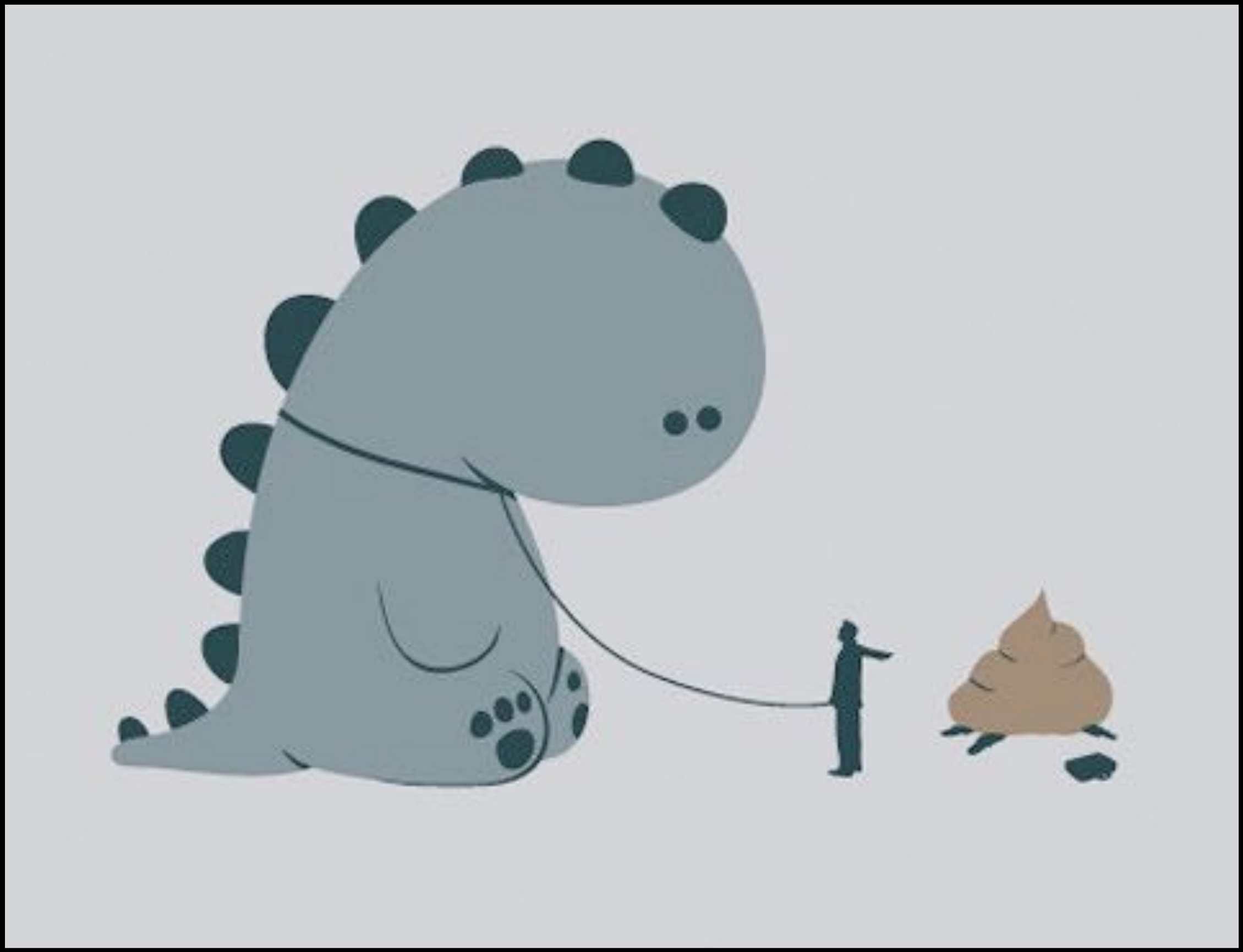
Rotten vegetation helped incubate the nests (no sitting)

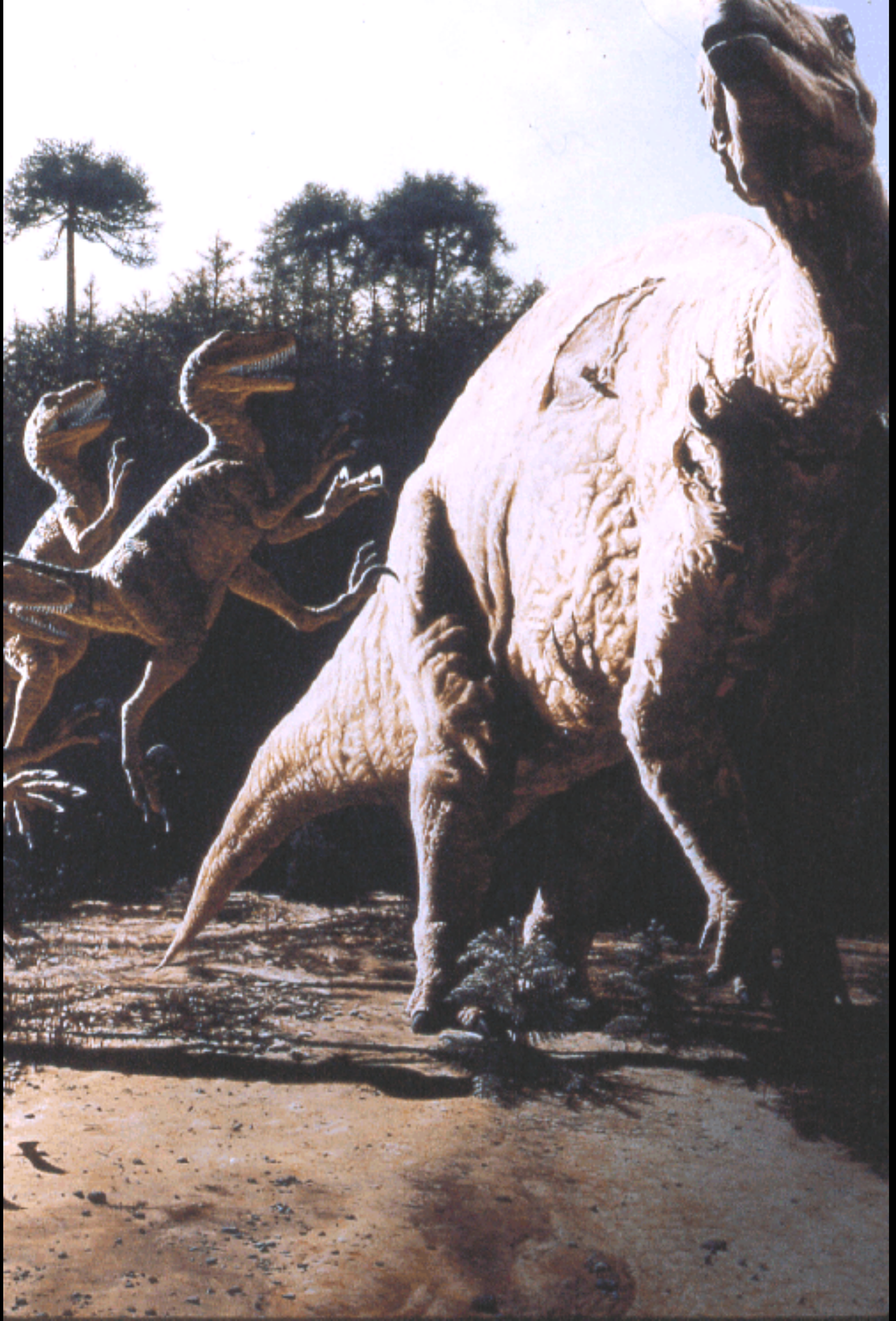
Hatchlings incapable of walking

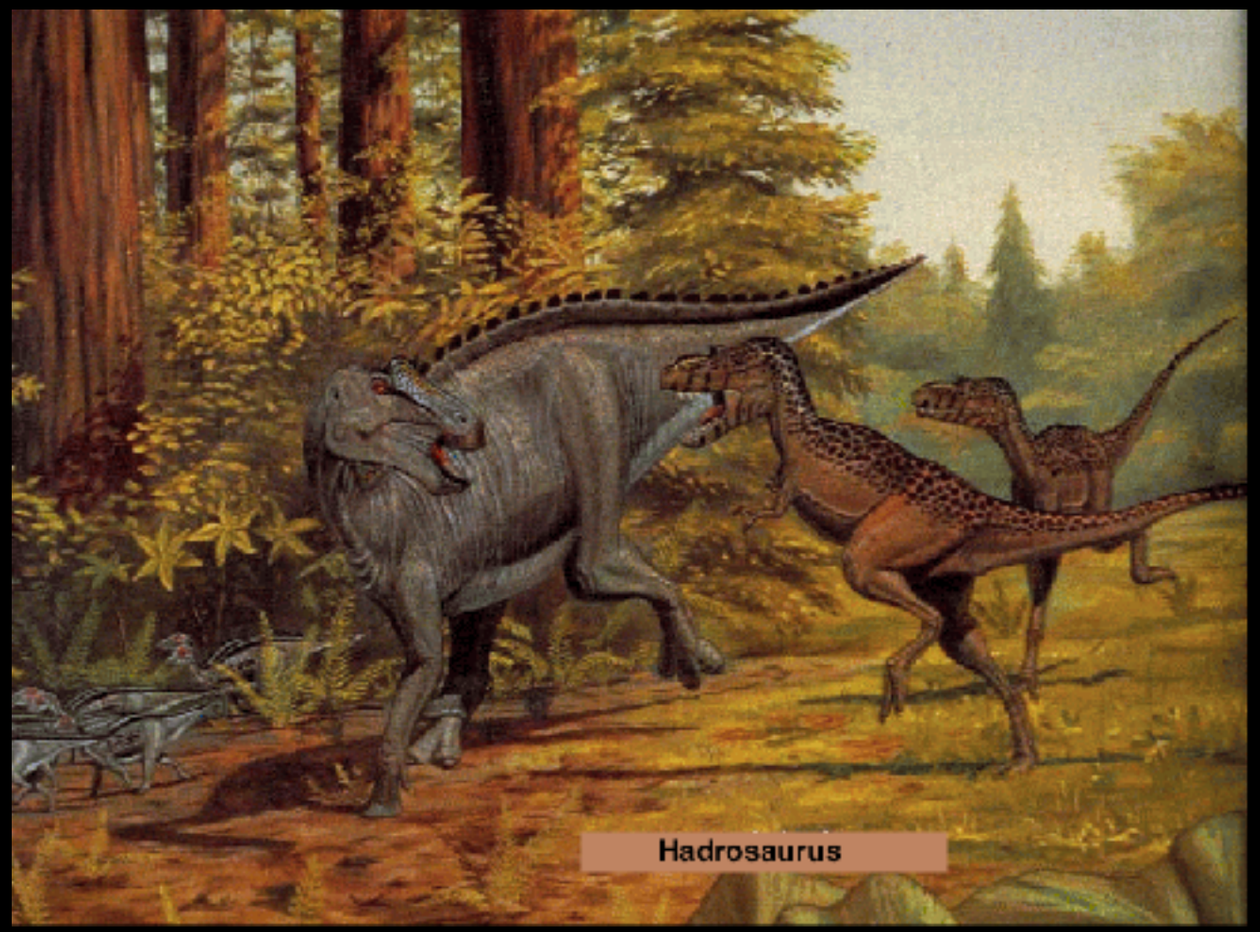
Hatchling rate of growth thought to be extremely high: warm-bloodedness?

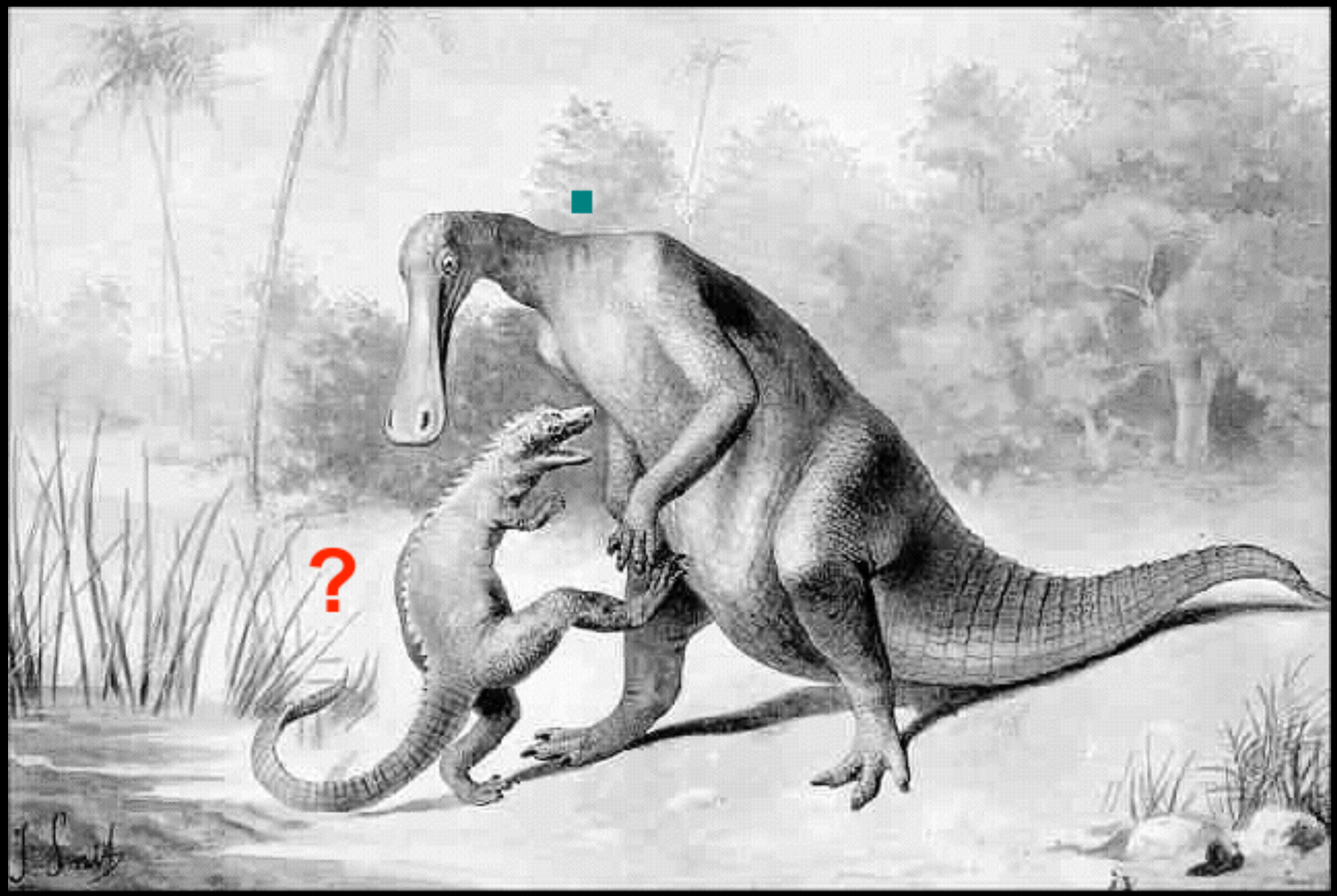
Hatchlings were 'cute': a common feature among altricial young








Hadrosaurus



Hadrosaurus

Walking with DINOSAURS: Spirits of the Ice Forest

The Ornithopod Players:

Leaellynasaura

Hypsilophodont (basal euornithopod) Ornithopod
Enlarged eyes (adaptation for low light conditions?)

Muttaburrasaurus

Iguanodontine Ornithopod

Enlarged eyes (adaptation for low light conditions?)

Some things to look out for:

- Assumed sociality of *Leaellynasaura*
  - Here they've modeled them after Meerkats
- Herding behavior in *Muttaburrasaurus*
- Migration
- Nasal air sacs
- Group defense
- Bipedality vs. Quadrupedality within *Muttaburrasaurus*
  - *Middle digits of front foot => hoof-like pad*