

A Battering Ram?

All evidence suggests that Pachycephalosaur skulls were built to withstand extreme forces

9 inches of solid bone

Bone organized in a radial arrangement- structural support

Articulation btw back of skull and vertebrae oriented to transfer forces linearly

Articulation btw back of skull and vertebral column built to withstand sideways forces

Vertebral column has tongue and groove articulations

Spinal column is an S-shaped shock absorber

BUT

There is no 'locking' mechanism on skull to keep battering heads aligned

Some Pachycephalosaurs have imprinted blood vessels on dome

These factors suggests that head-butting may not be likely



Intraspecies Competition (typically male-male)

Females are typically choosy

Why?

Because they have more to lose



Common rule in biology: Females are expensive to lose, males are cheap (e.g. deer hunting)
Females choose the male most likely to provide the most successful offspring

Males compete with each other for access to female vs. female chooses the strongest male

Choosey females // Strong males have more offspring => SEXUAL selection

Many ways to do this...

But: In general, maximize competition and minimize accidental deaths (= no fitness)



<http://www.youtube.com/watch?v=PontCxFgs0M>



http://www.metacafe.com/watch/1941236/giraffe_fight/

<http://www.youtube.com/watch?v=DYDxIy38vGw>





They dont show you this on the TV



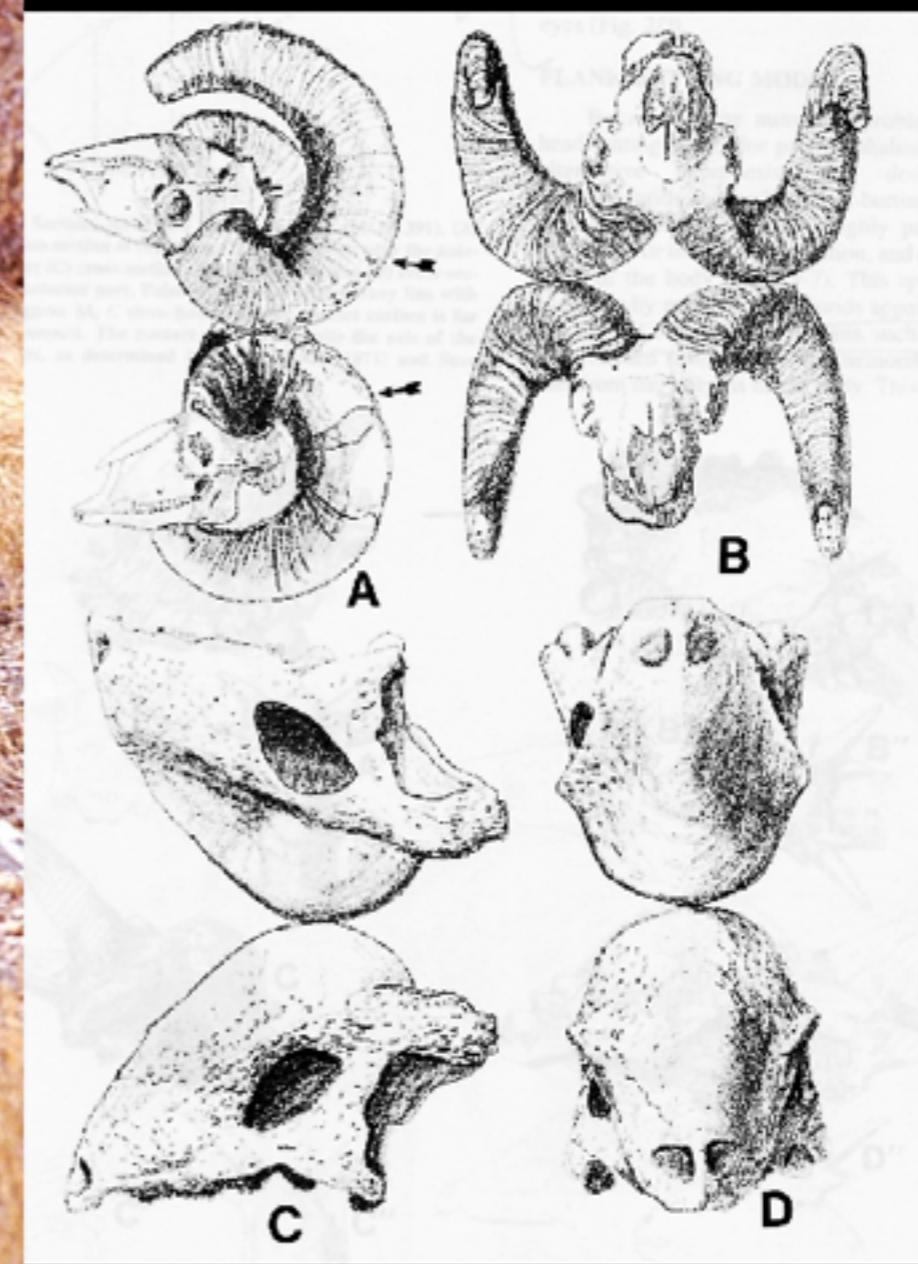
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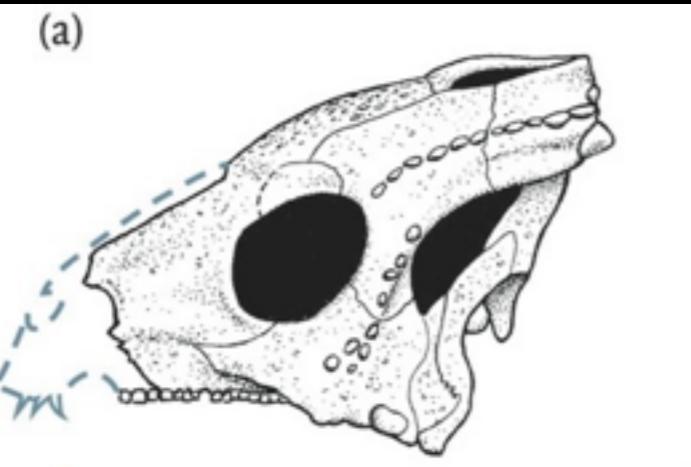


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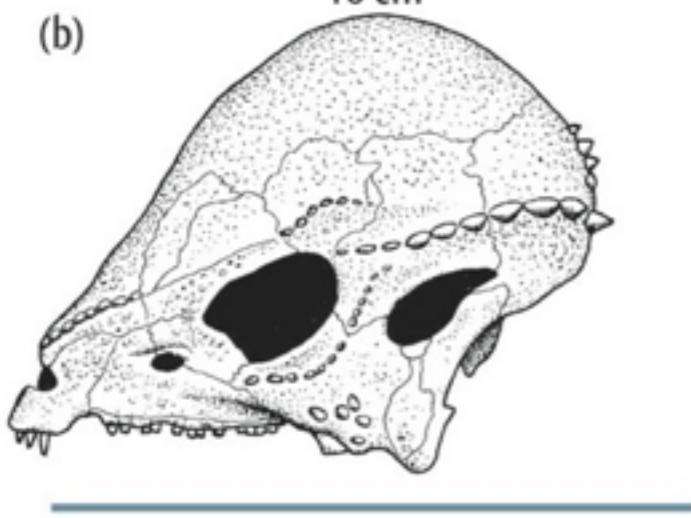




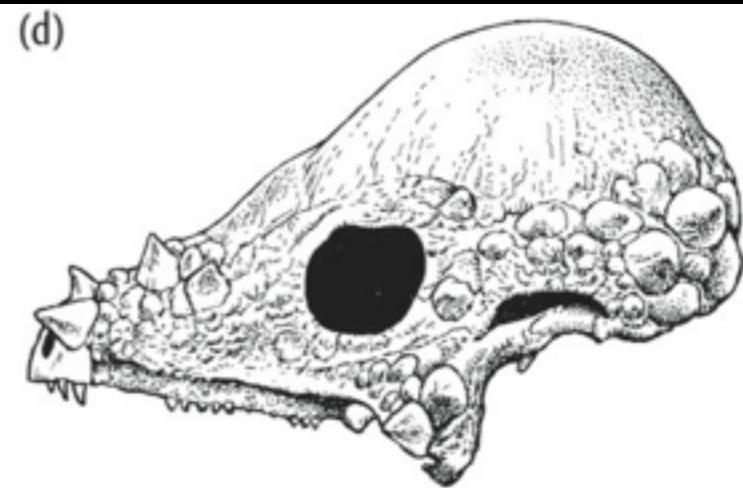
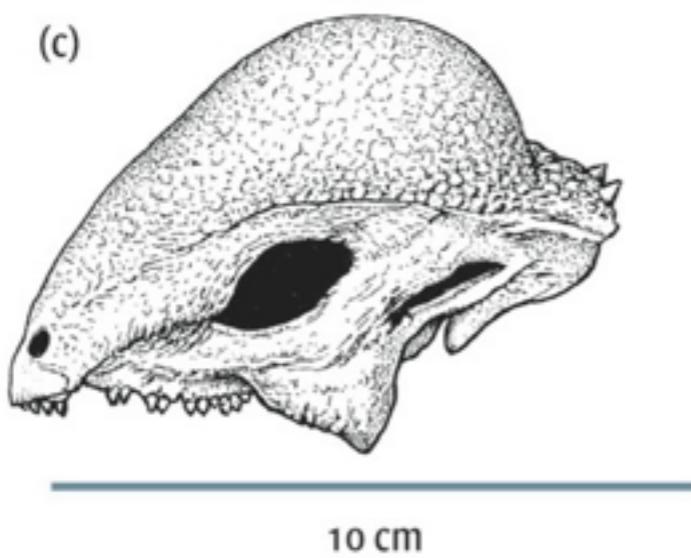
Homalocephale



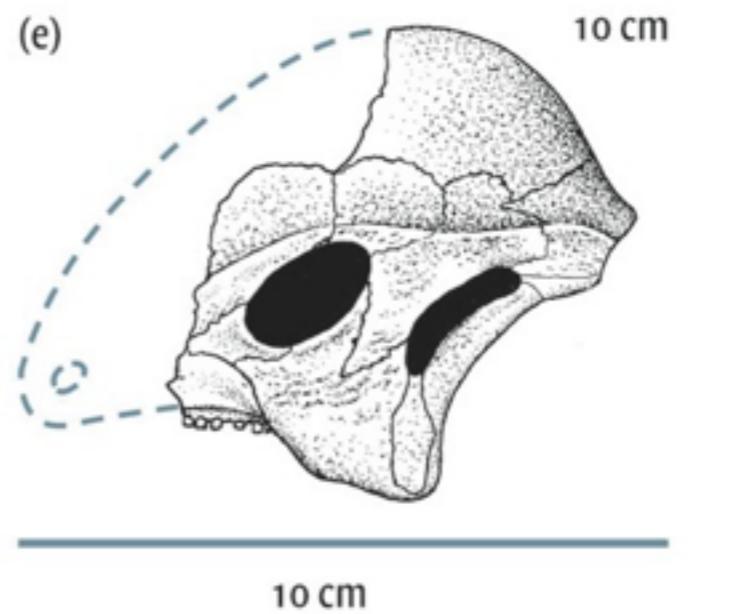
Prenocephale



Stegoceras



Pachycephalosaurus



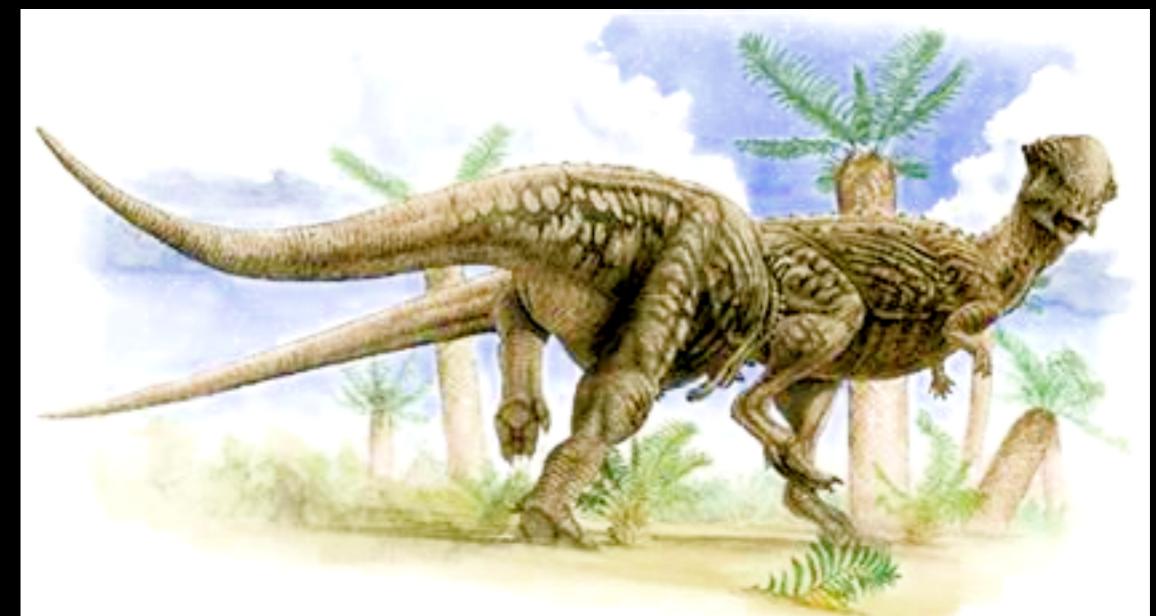
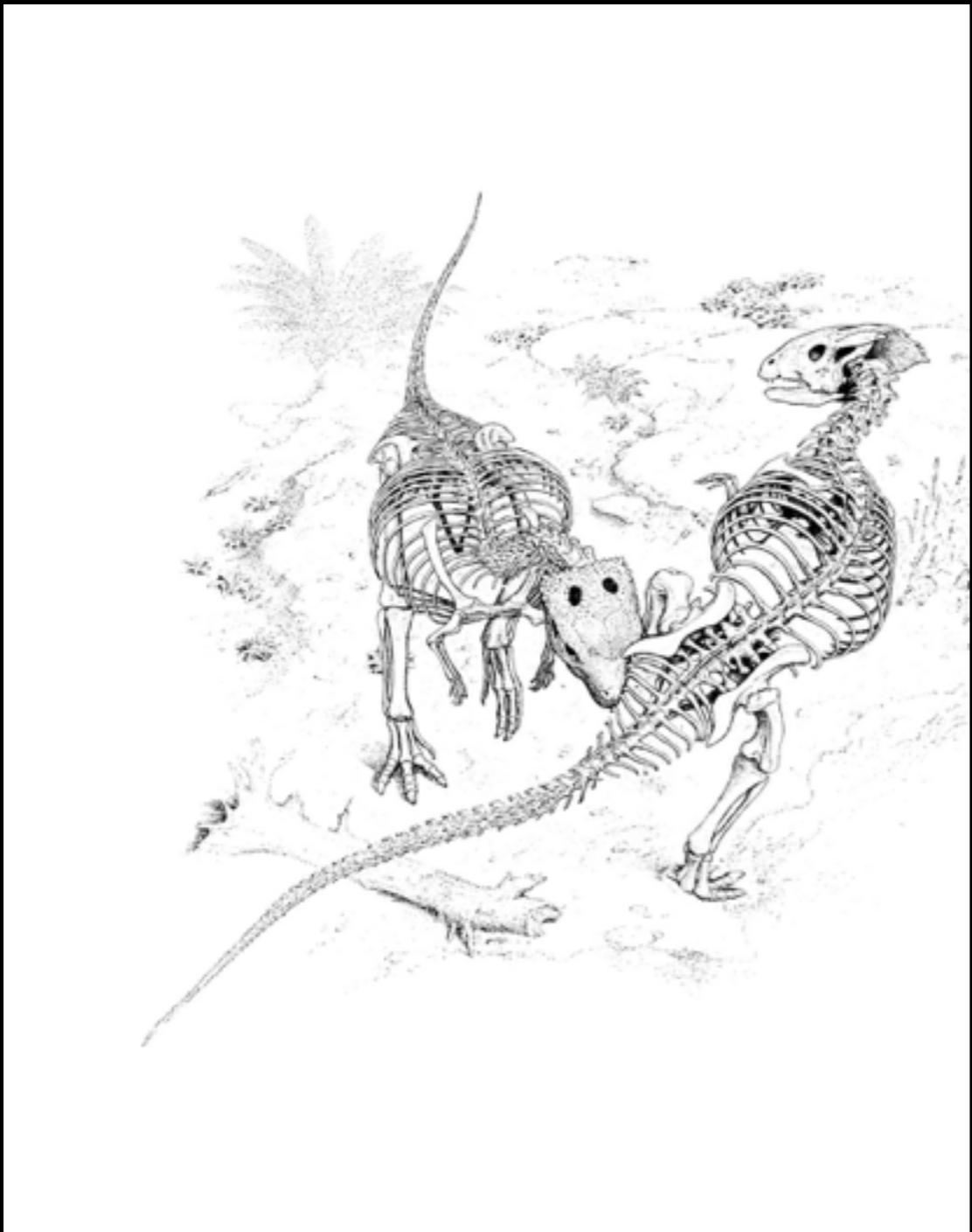
Tylocephale

Head butting Pachycephalosaurs

Bone structure was probably strong enough to withstand collision

Convex nature would favor glancing blows

Instead, dome and spines seem better suited for “flank butting”



So... if head butting is the result of male-male competition, what should we expect to find?

Sexual dimorphism...

if males are primarily using their domes to headbutt, male domes will be under strong selective forces, while female domes will not.

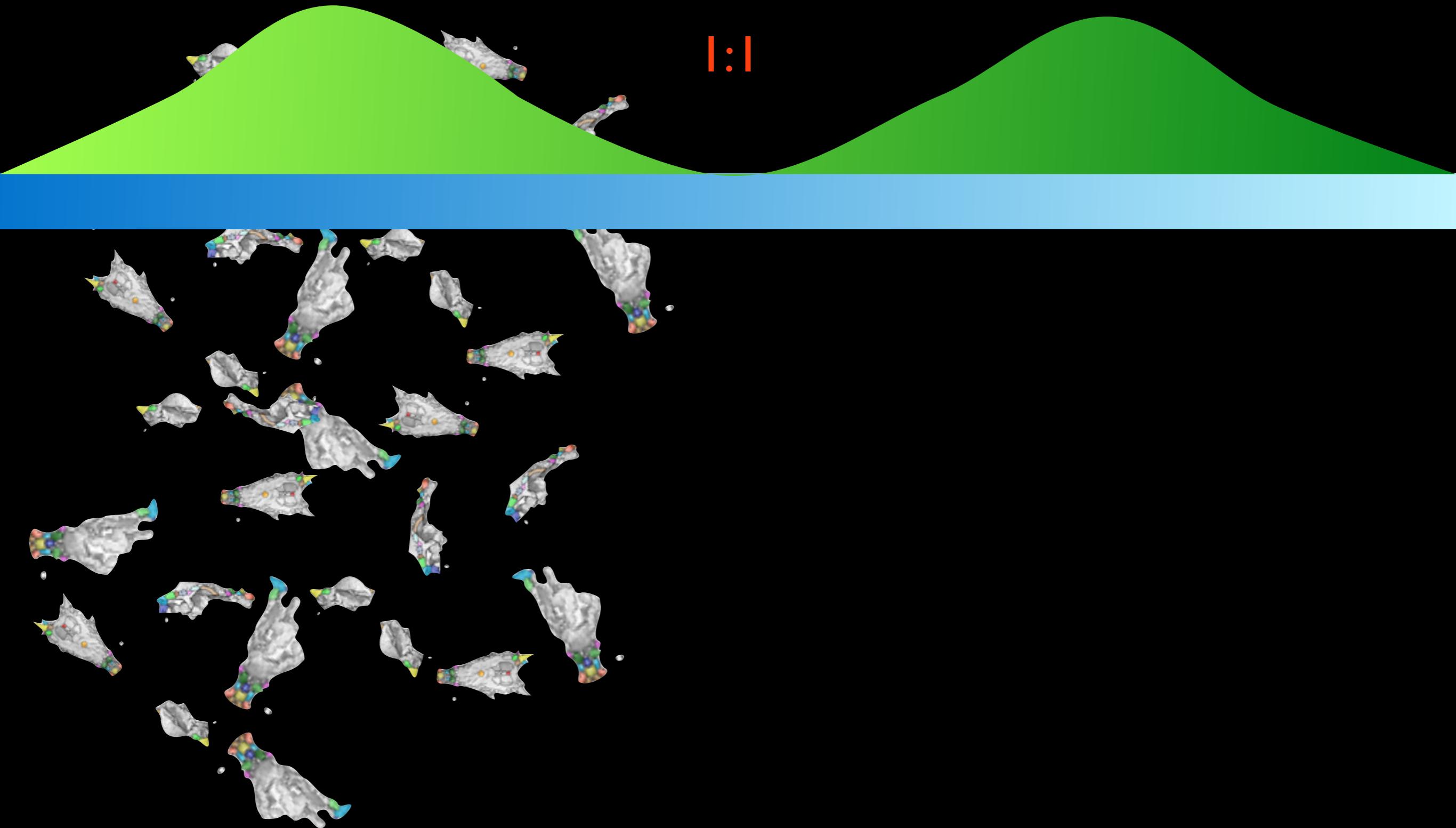




Smaller

Larger

|:|



The strange case of Hell's Creek.





Hell Creek formation, Montana (Upper Cretaceous)



Stygimoloch



Pachycephalosaurus



Dracorex



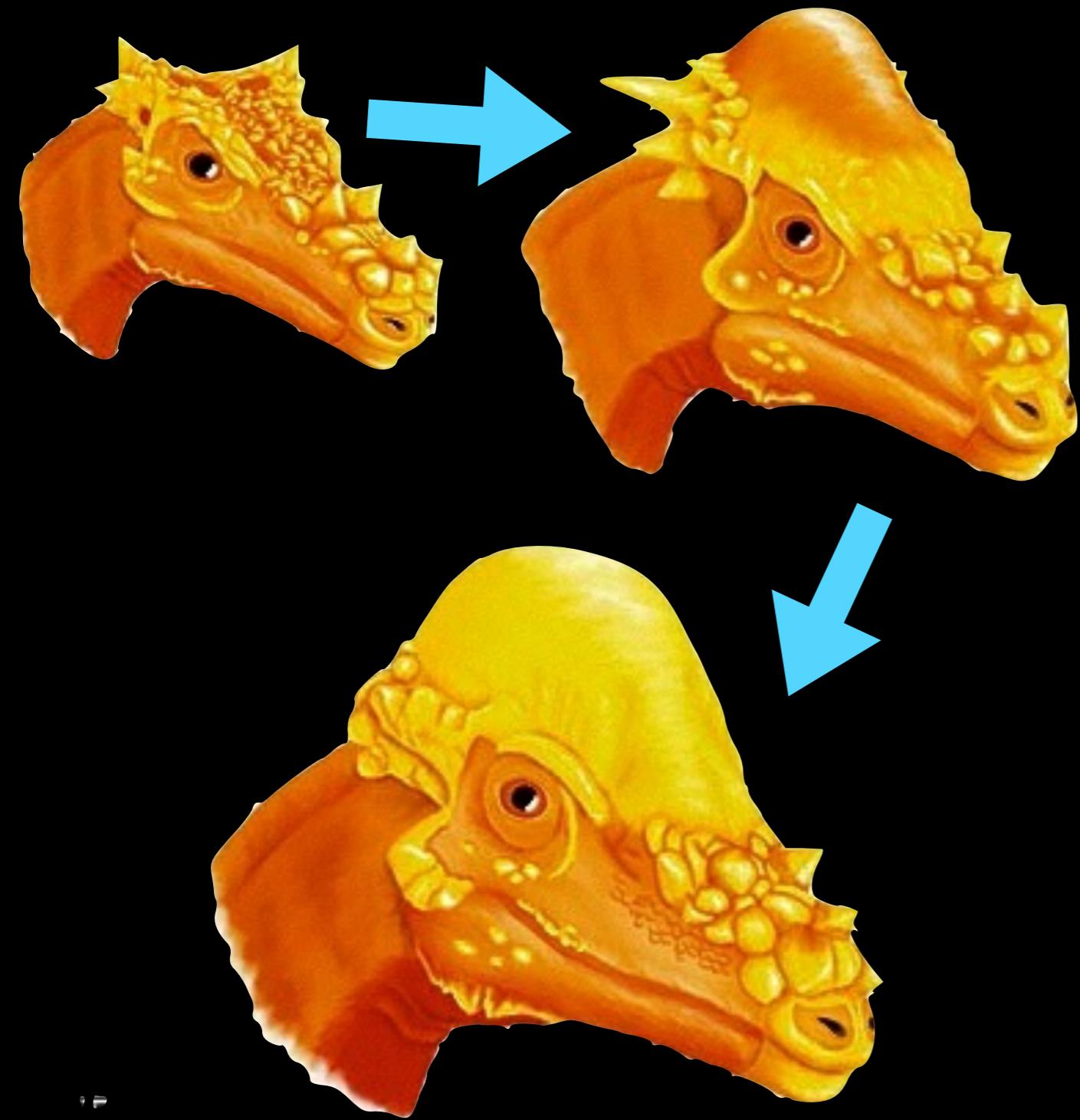
*Dracorex
hogwartsia*



*Dracorex
discolor*



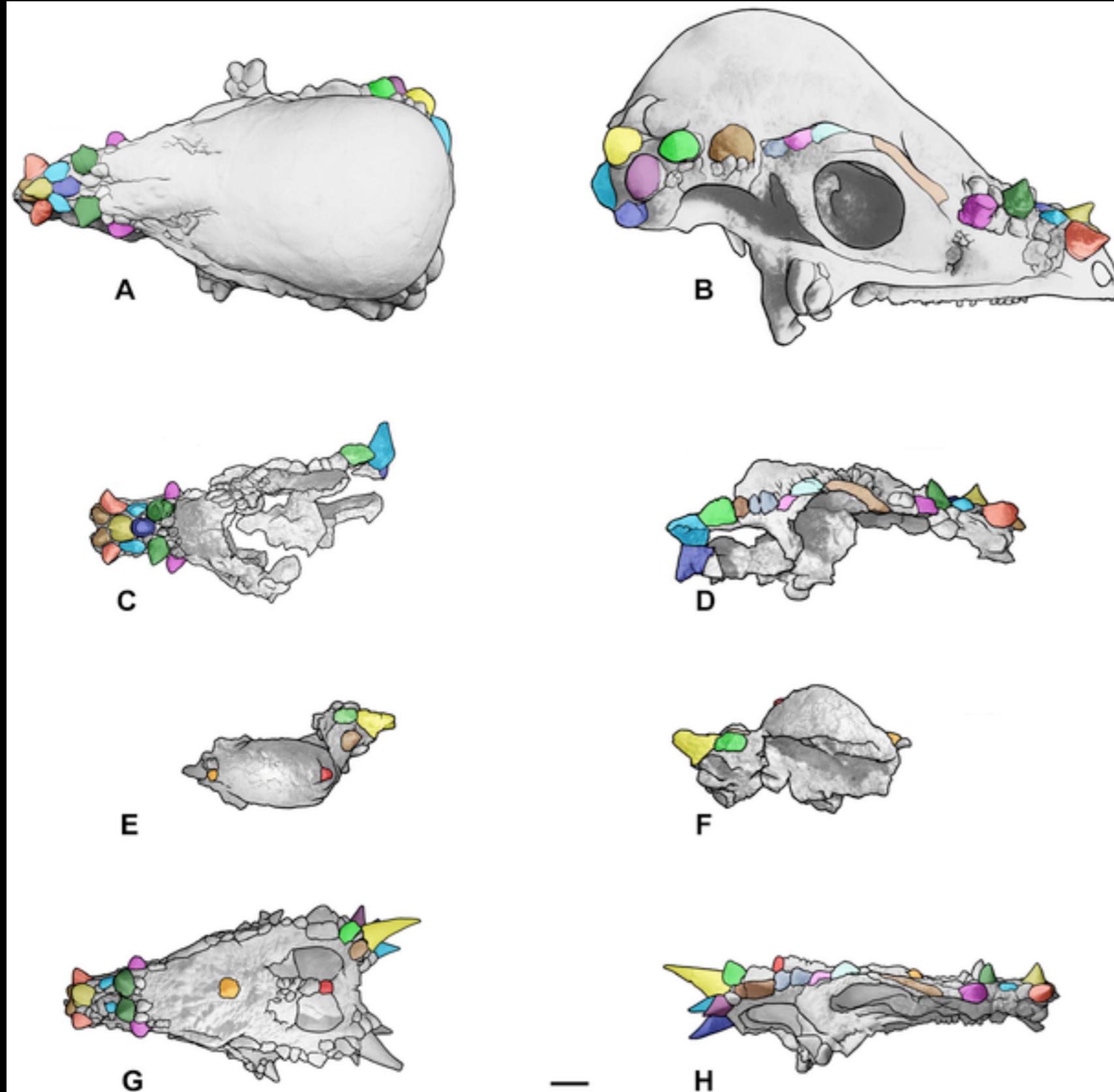
A Modern Day Dinosaur Extinction



Two Hypotheses:

1. These animals are independent species
 2. These animals are an ontogenetic series
- GROWTH

Ontogeny of Pachycephalosaurus wyomingensis



[http://www.youtube.com/watch?](http://www.youtube.com/watch?v=GcZnupsB5Ps&feature=PlayList&p=B109C00BD252F27D&playnext_from=PL&playnext=1&index=43)

v=GcZnupsB5Ps&feature=PlayList&p=B109C00BD252F27D&playnext_from=PL&playnext=1&index=43



4-6
months



11-13
months



13-17
months



17-20
months



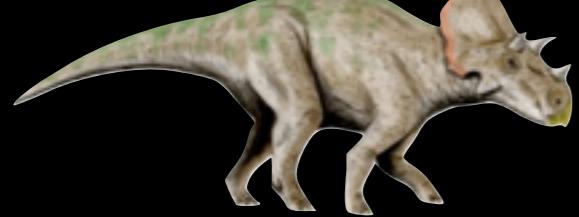
3.5
years



Horns Go Wild



Ceratopsia: Shared, Derived Characteristics



Ornamentation on posterior margin of skull

Typically a frill; modified parietal bone

Skull with narrow & deep beak-like snout

Flared cheeks

(results in triangular shaped skull when viewed from the top)

Rostral Bone: UNIQUE!

New bone on tip of upper jaw

Covered by a horny beak



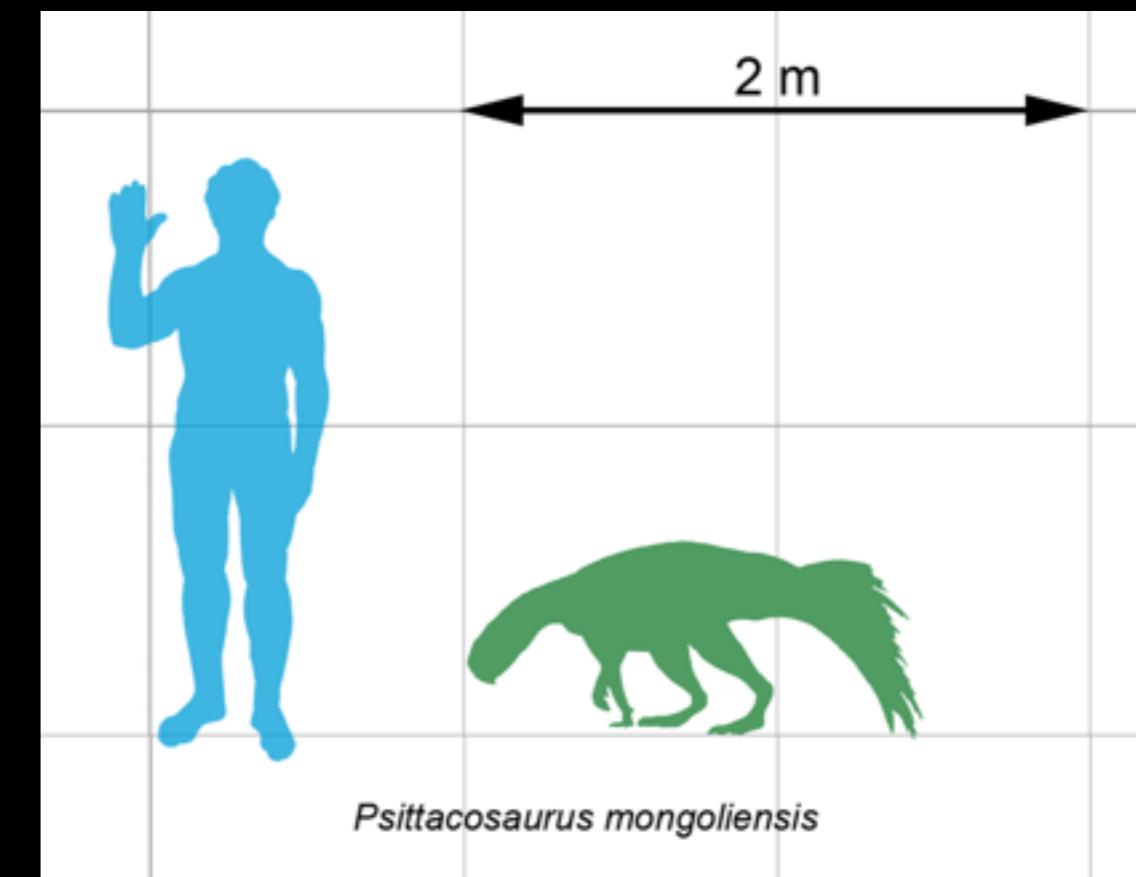
Psittacosaurus: ‘Parrot Lizard’



Short, almost round
dorsal profile



Very unique!

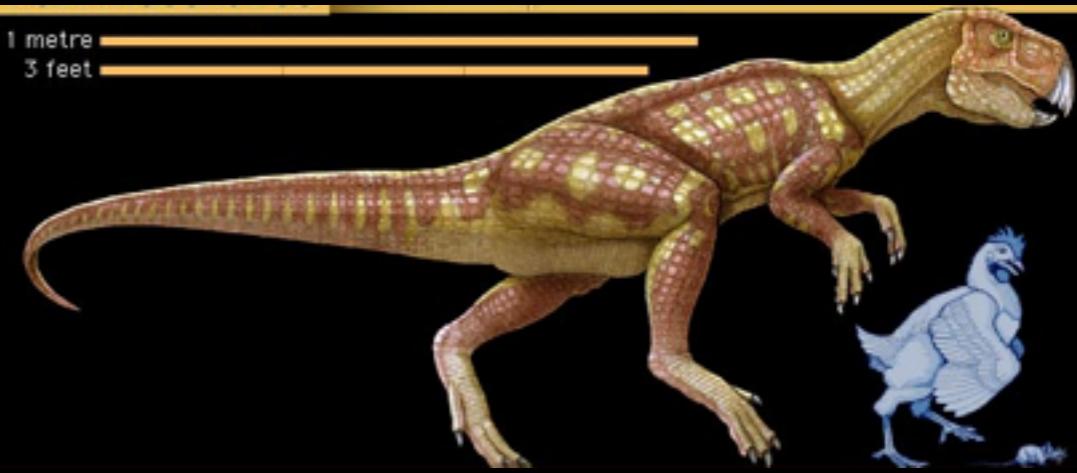
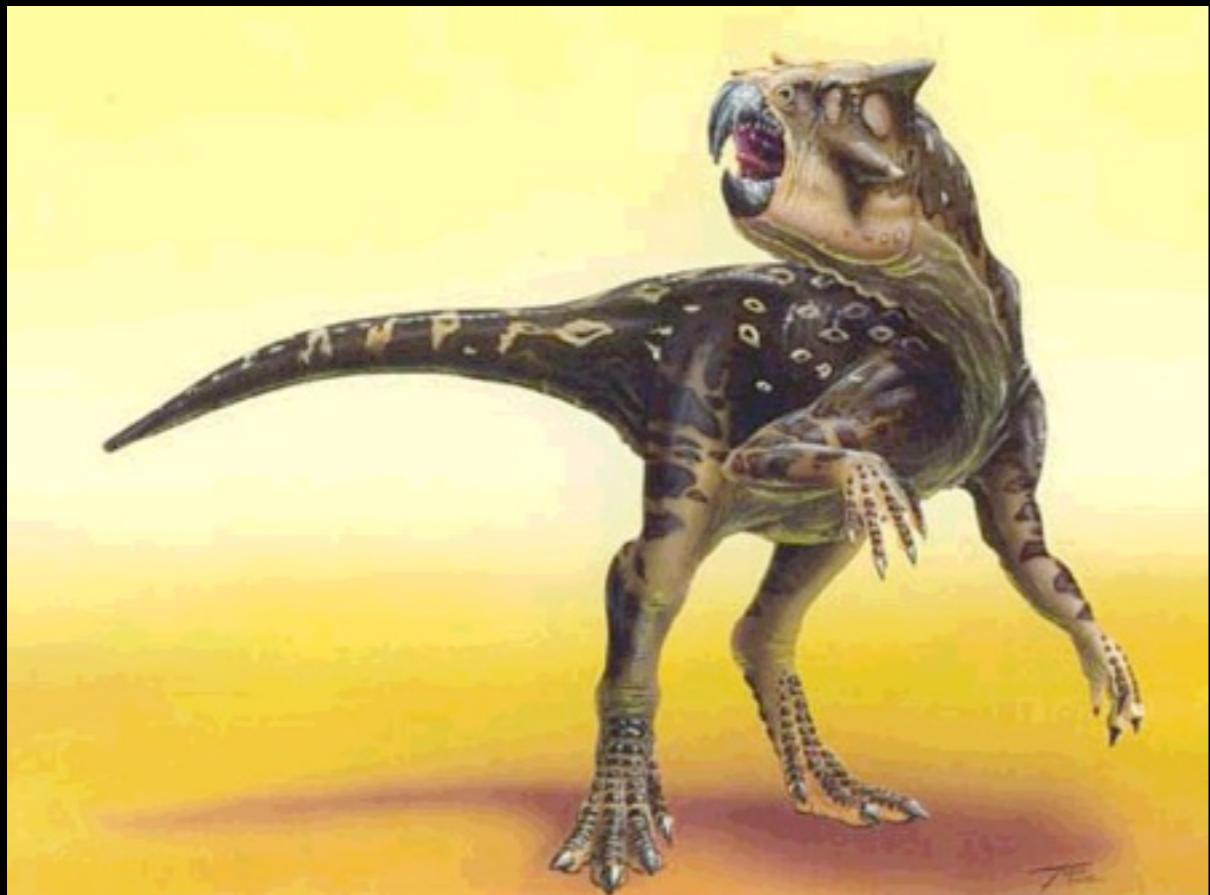


Ceratopsia

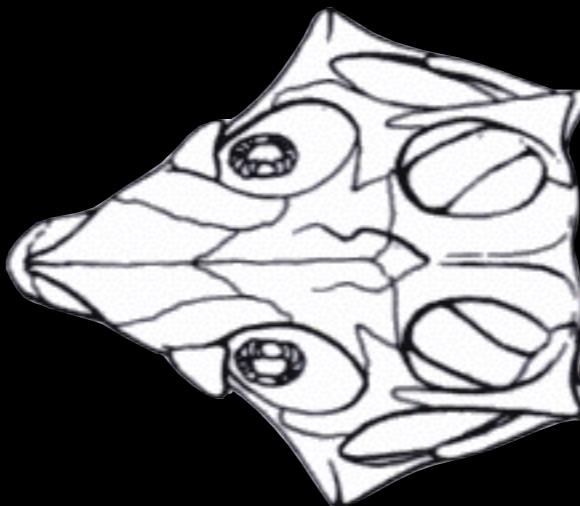
Psittacosaurus mongoliensis

Psittacosaurus: ‘Parrot Lizard’

1 metre
3 feet

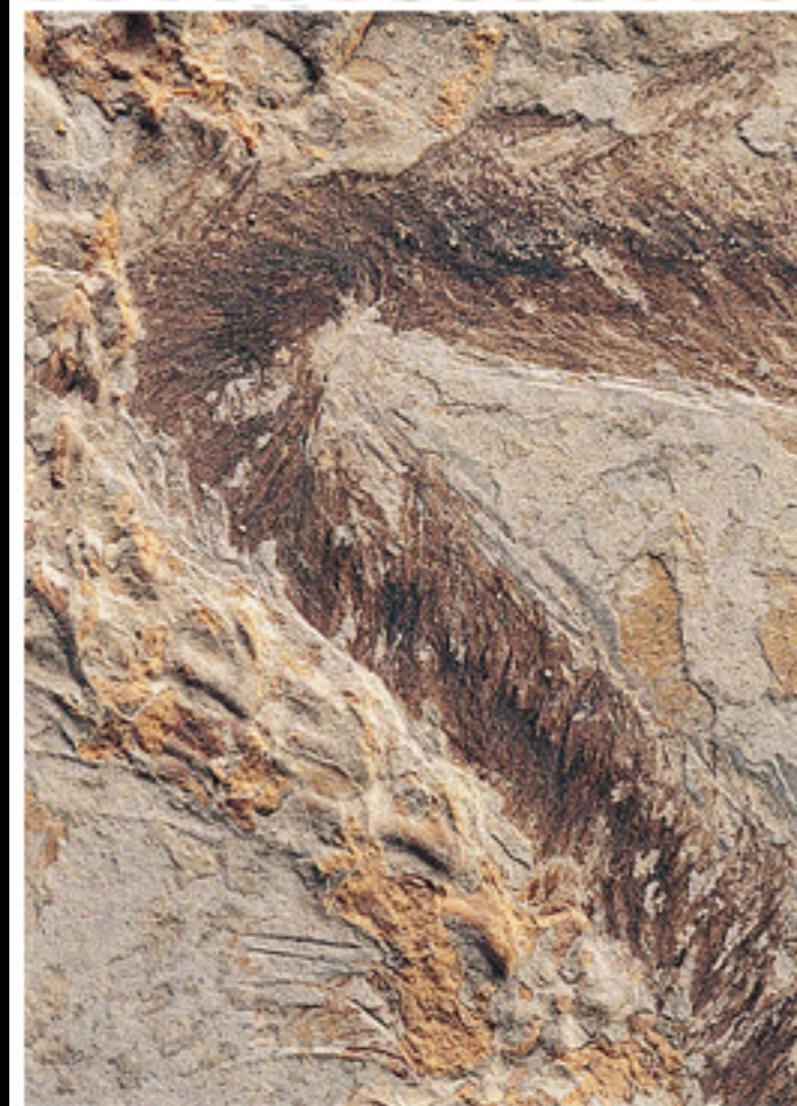


Psittacosaurus: ‘Parrot Lizard’



Psittacosaurus SKIN

Preserved skin from a China specimen
Most of the body covered in large, irregular scales
Hollow tubular bristles arranged down the tail
No evidence that these structures are related to Saurischian feathers but jury is still out
Possibly convergently evolved feather-like structures
Communication? Display?
Very cool.



Psittacosaurus Social Lives

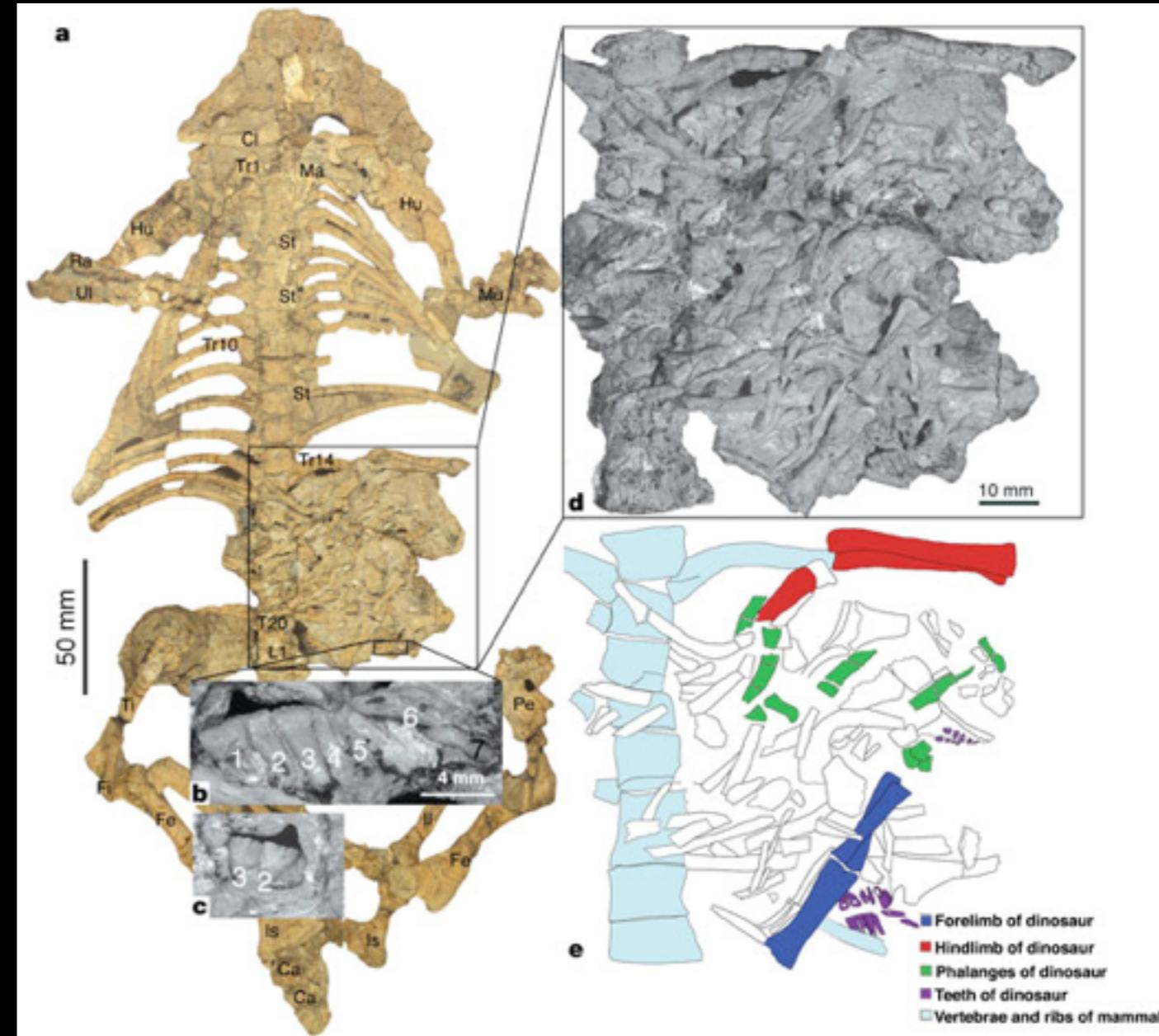


*Amazing nests
Suggests some degree of
maternal care*

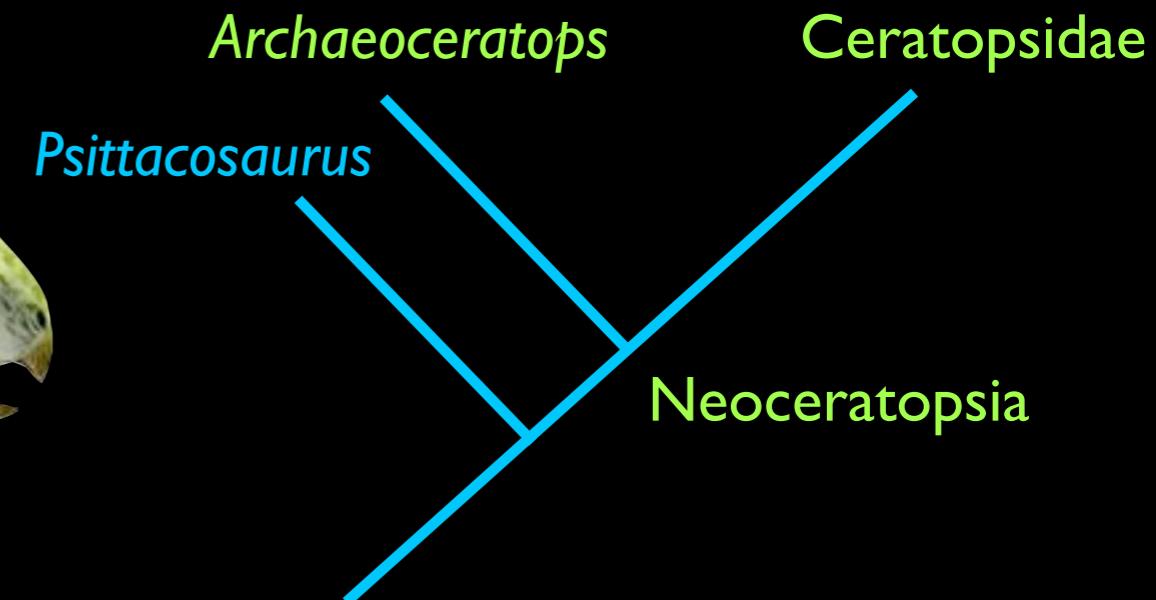
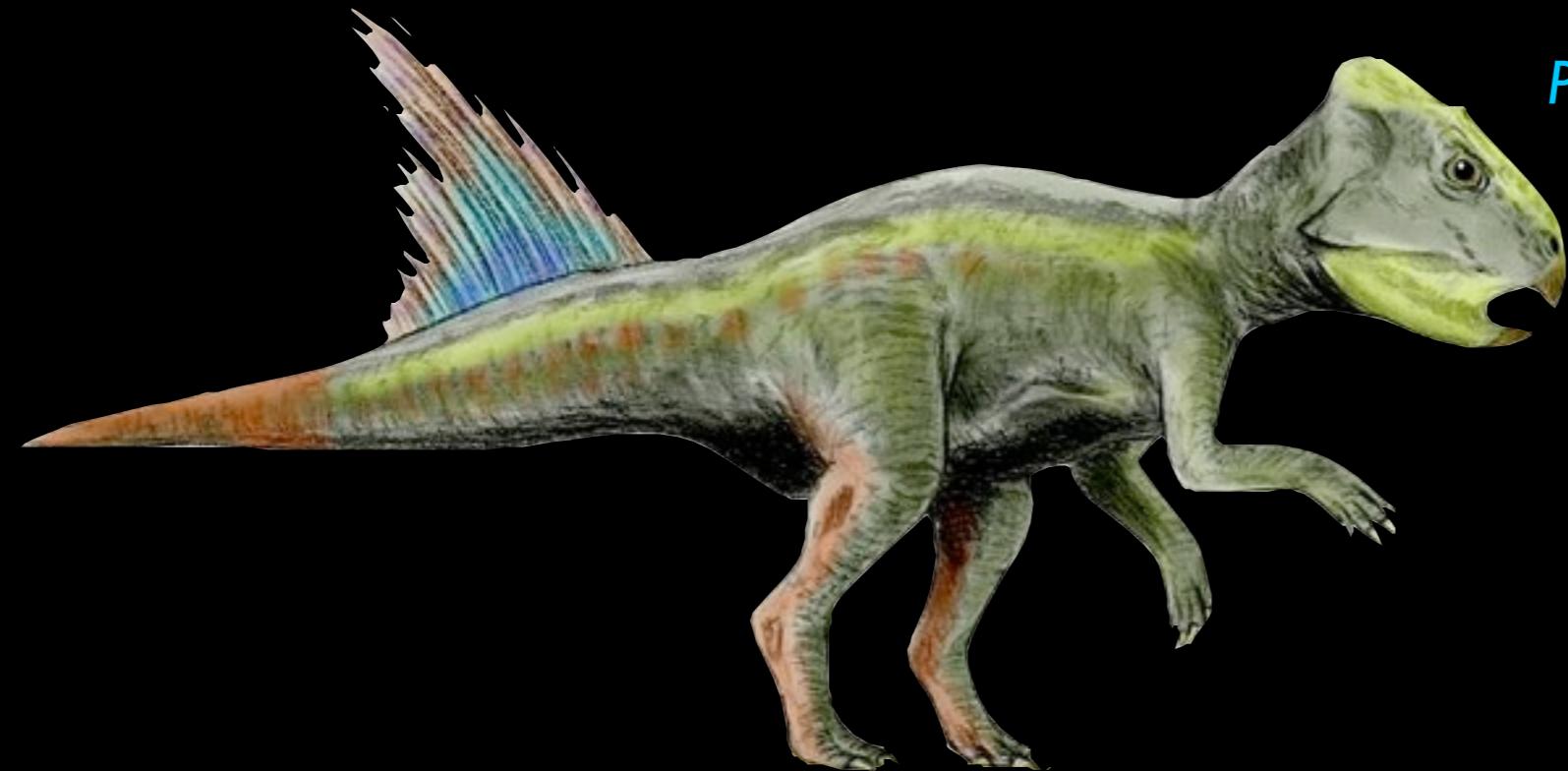


How embarrassing...

*Juvenile Psittacosaurus found in the stomach
of an early Cretaceous mammal:
Repenomamus robustus*



Archaeoceratops



Basal Neoceratopsian

Known from North-Central China; found in Early Cretaceous rocks

Hallmarks of more derived Neoceratopsians:

Emphasized boney frill

Larger head:body size ratio

3 fused vertebrae to support large head

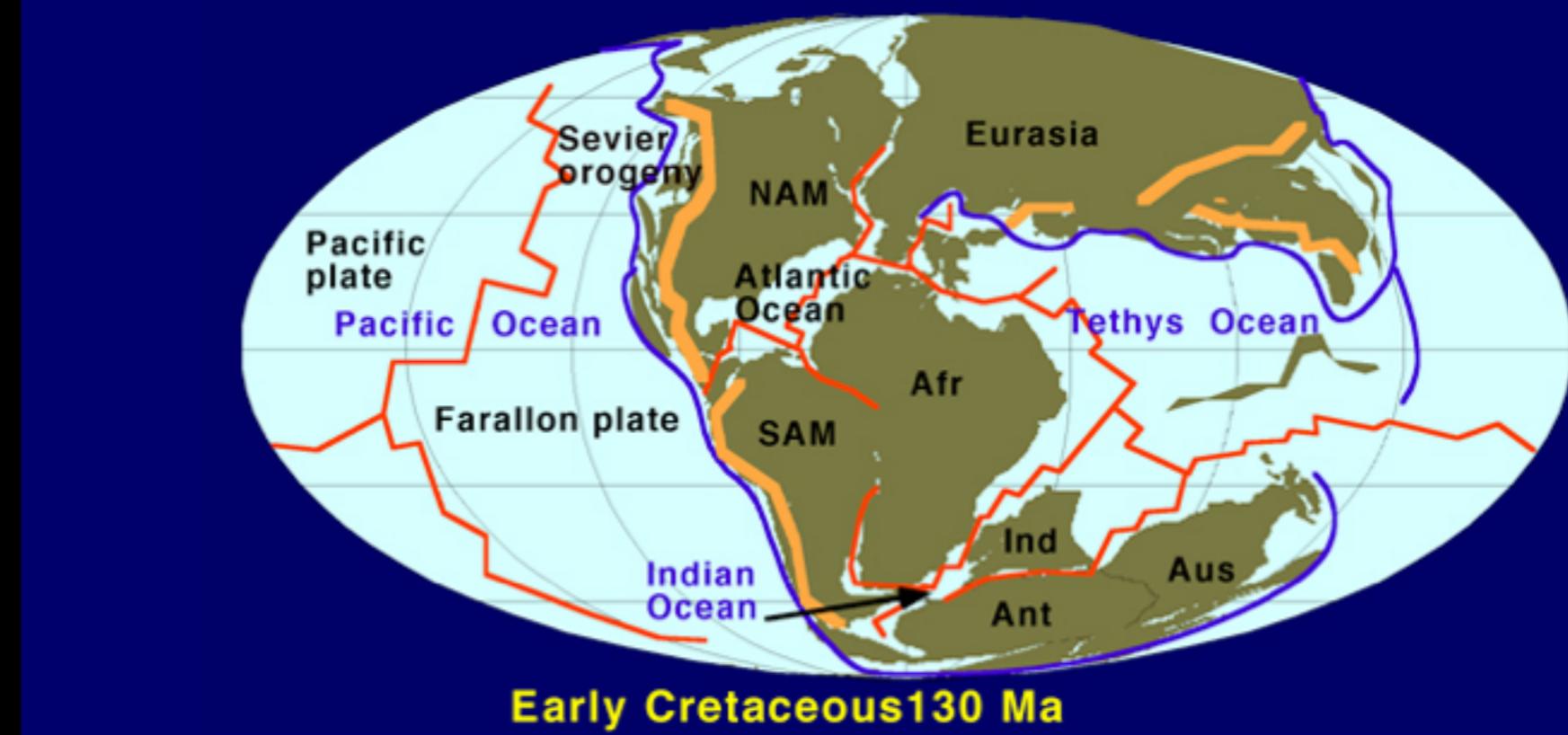
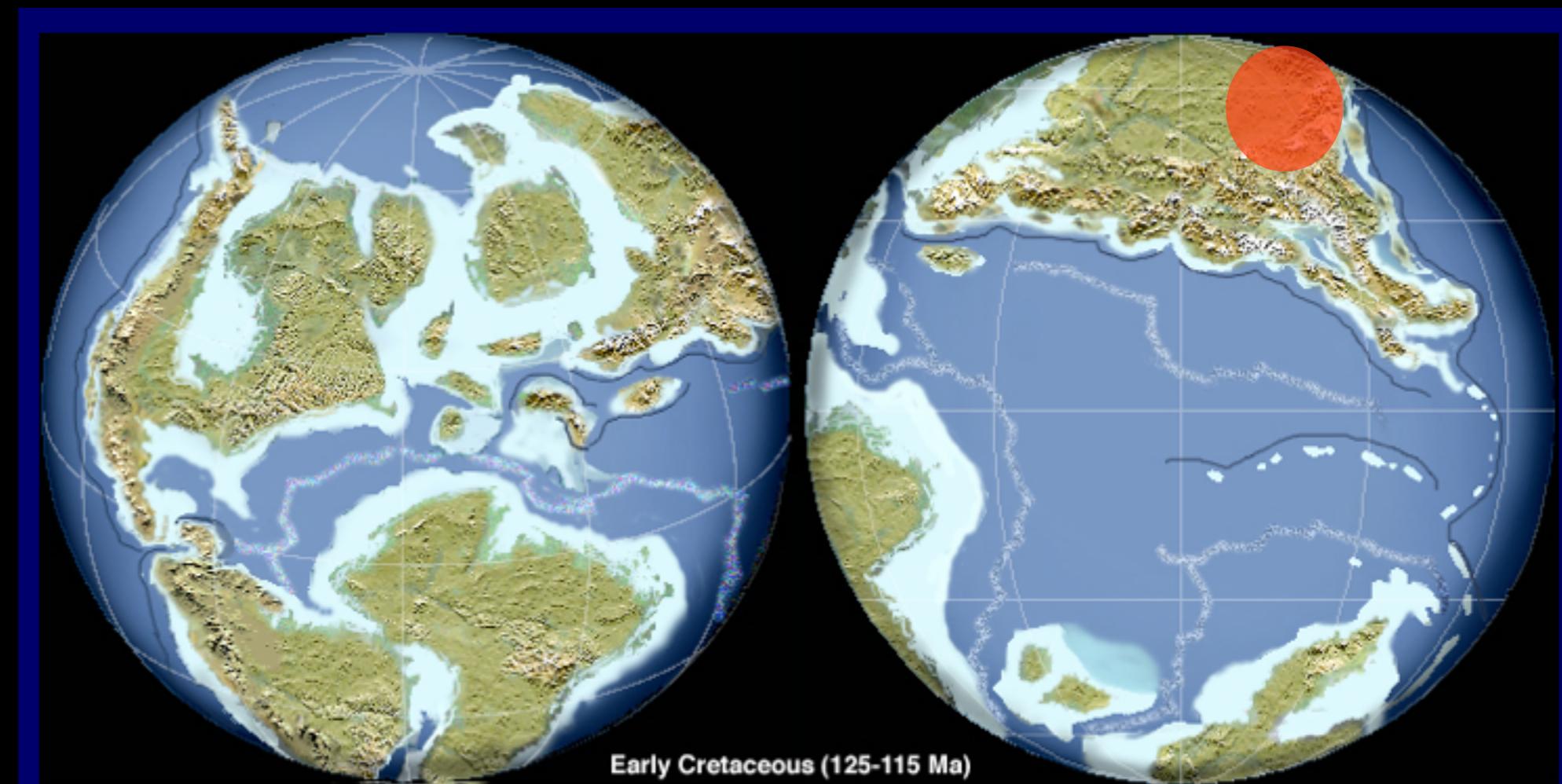
Upwardly hooked lower beak

All Neoceratopsians (except most basal) => quadrupedal

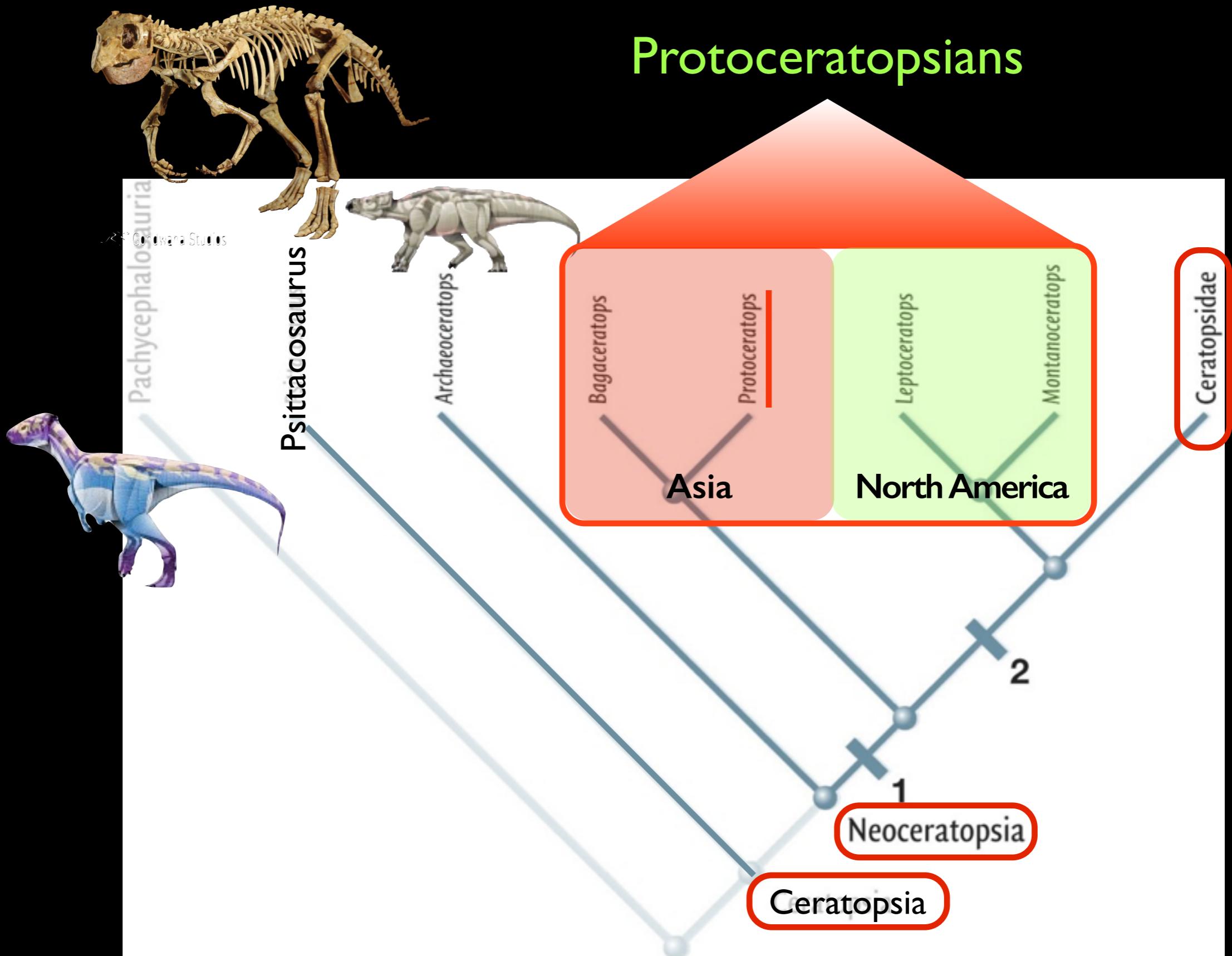
Psittacosaurus

Archaeoceratopsia

Modern Mongolia-region
Modern China
Early Cretaceous



Protoceratopsians





First eastward migration
early-mid Cretaceous

Bagaceratops



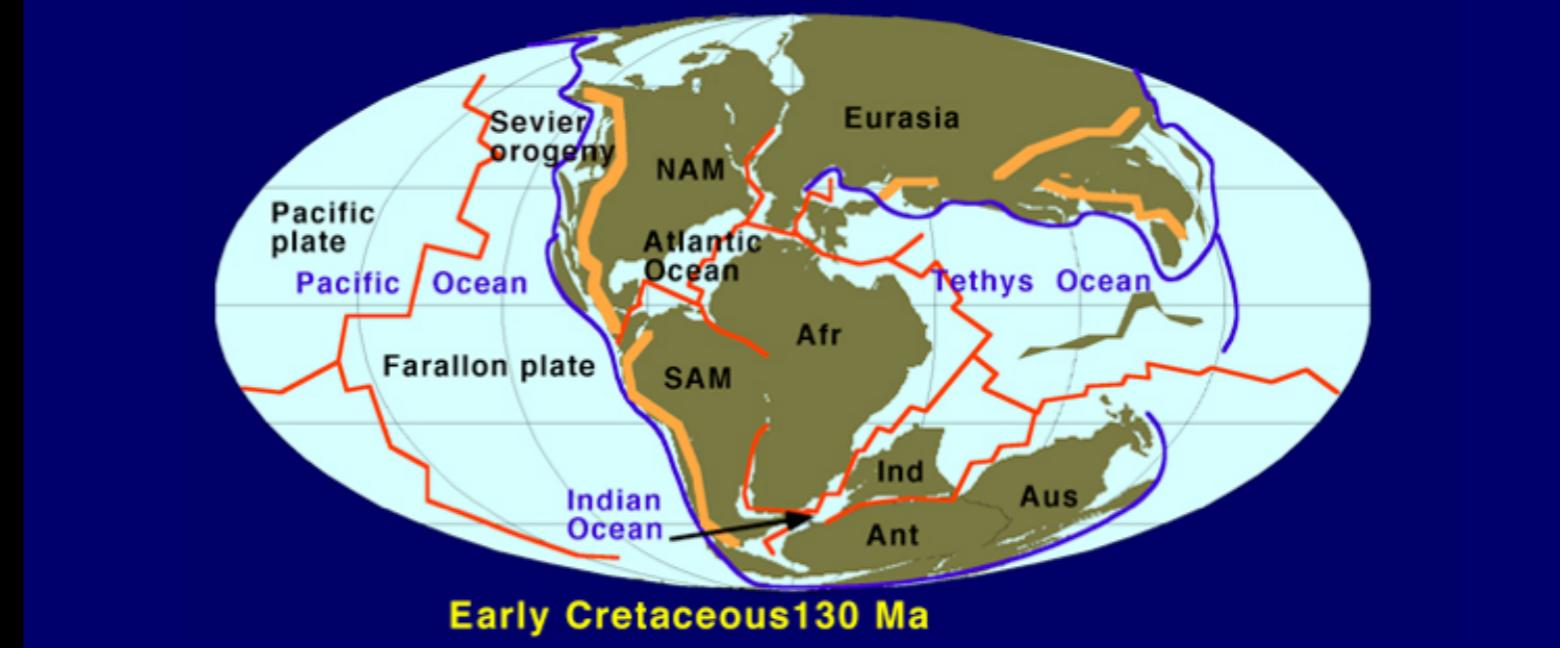
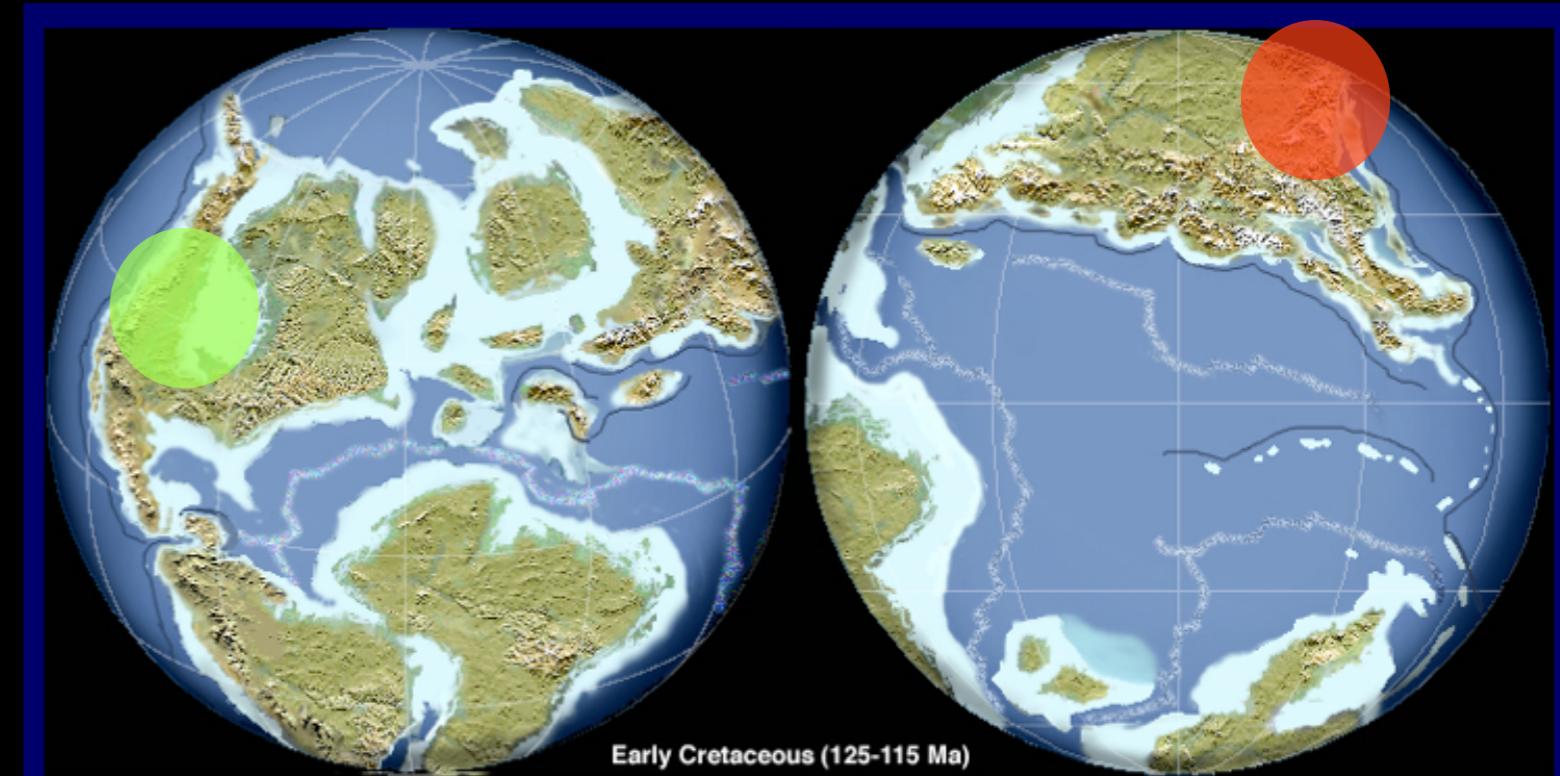
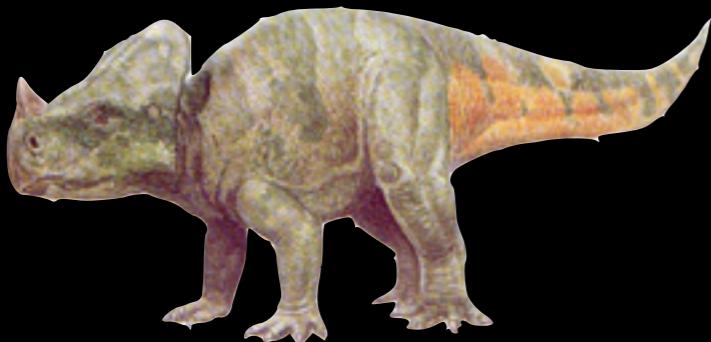
Protoceratops



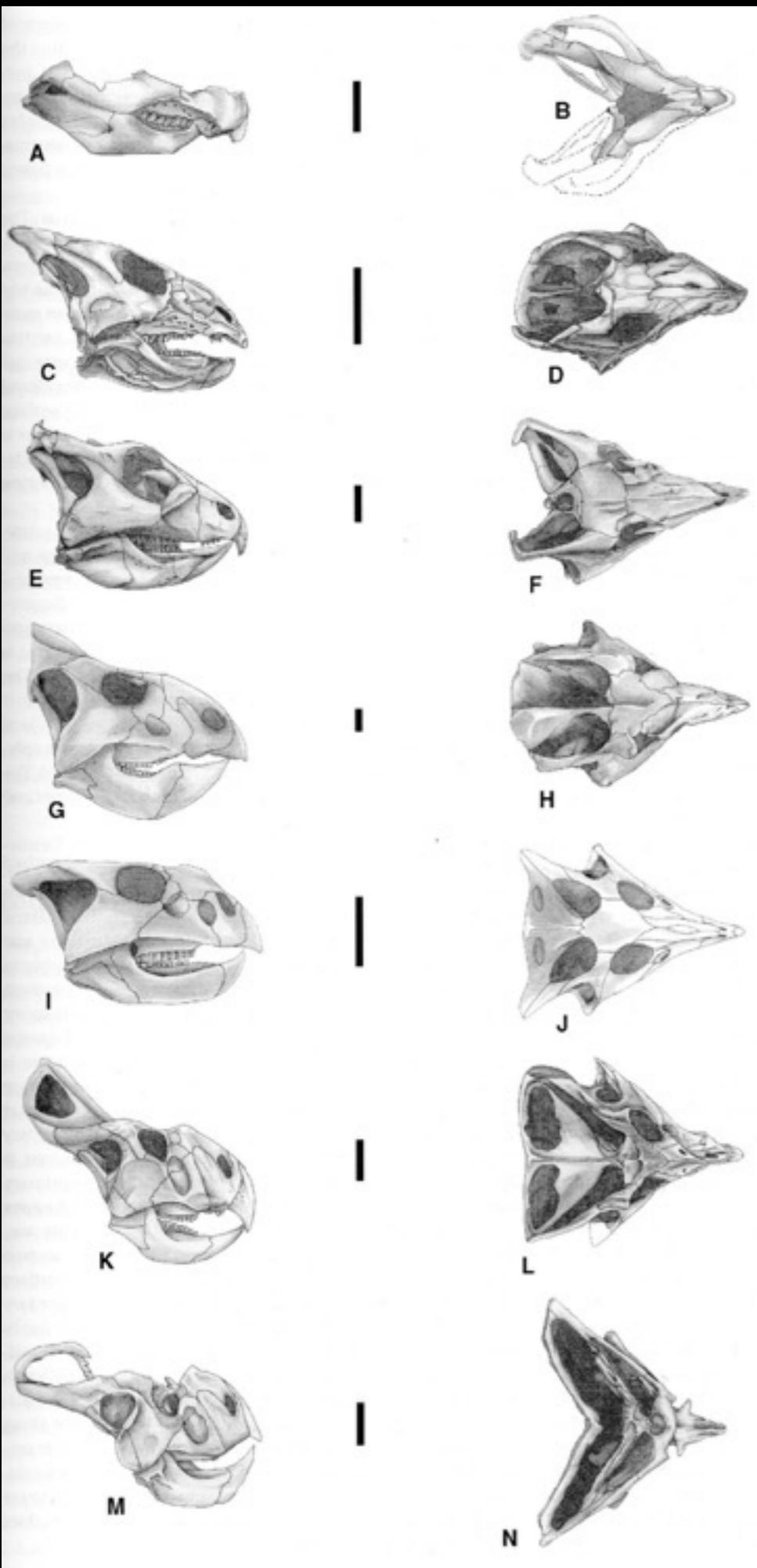
Leptoceratops



Montanoceratops



Basal Neoceratopsia



Chaoyangsaurus

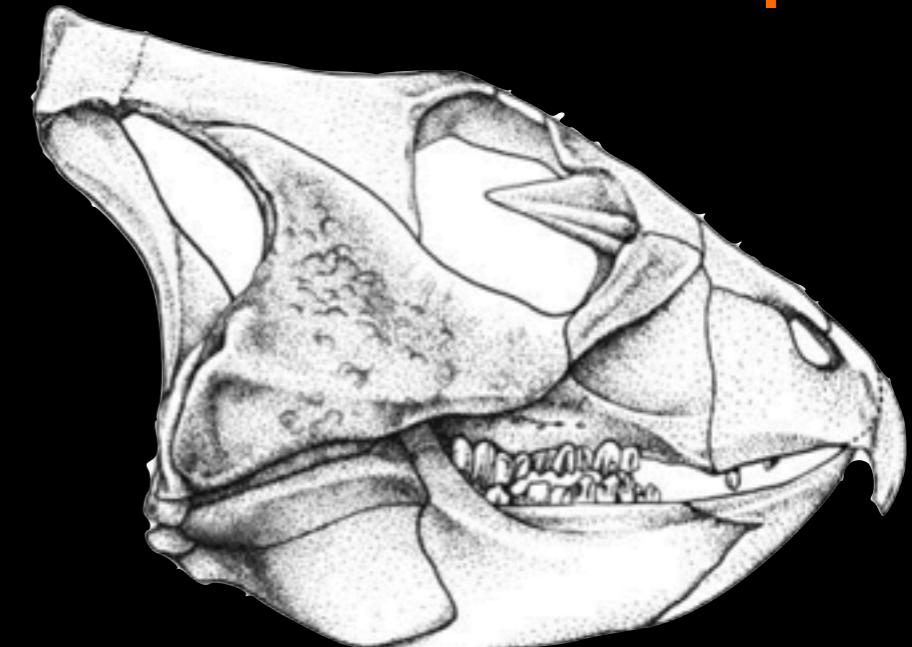
Liaoceratops

Archaeoceratops

Leptoceratops

Bagaceratops

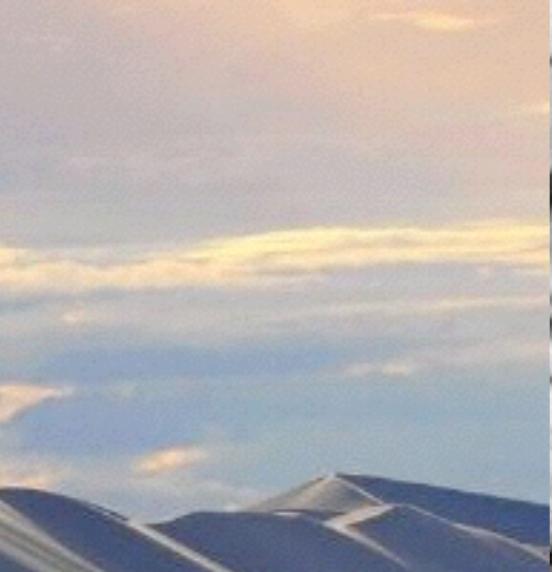
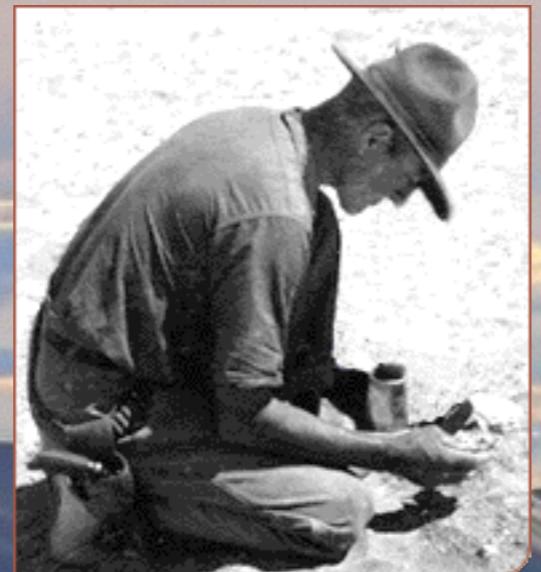
Protoceratops



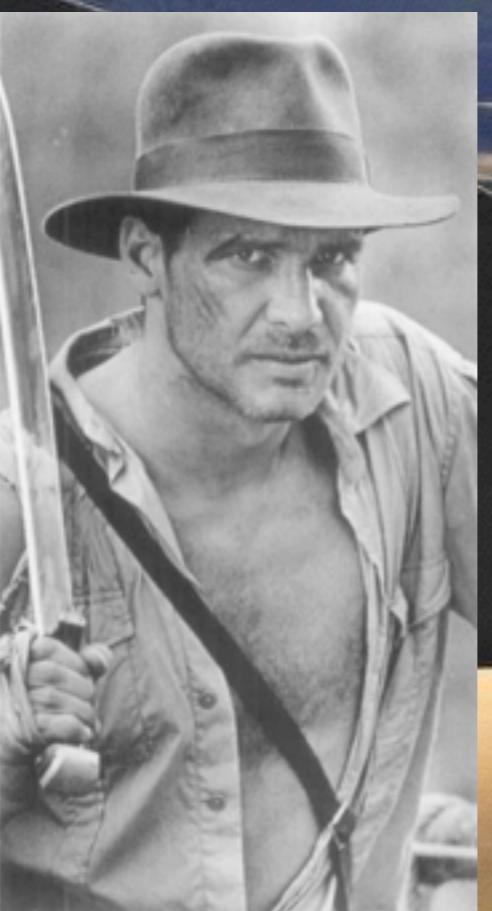
Archaeoceratops



Protoceratops



Roy Chapman Andrews



Roy Chapman Andrews: Gobi Expedition 1923-1925



Roy Chapman Andrews: Gobi Expedition 1923-1925

