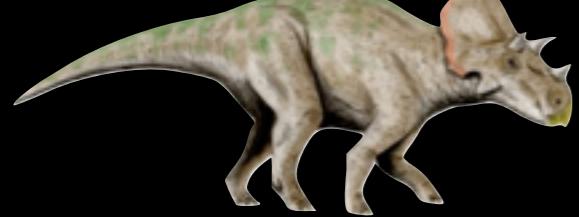


Modified
office hours today:
3-4



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



Rostral bone



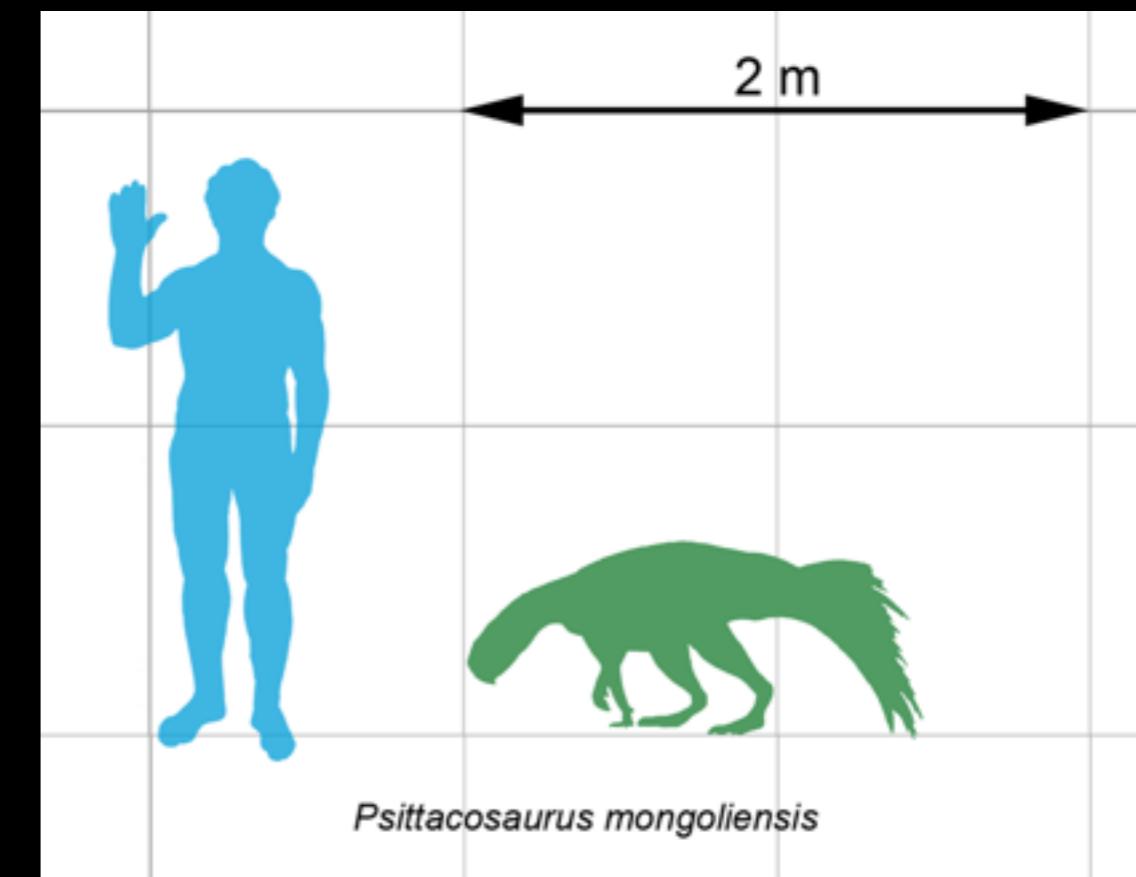
Psittacosaurus: ‘Parrot Lizard’



Short, almost round
dorsal profile



Very unique!

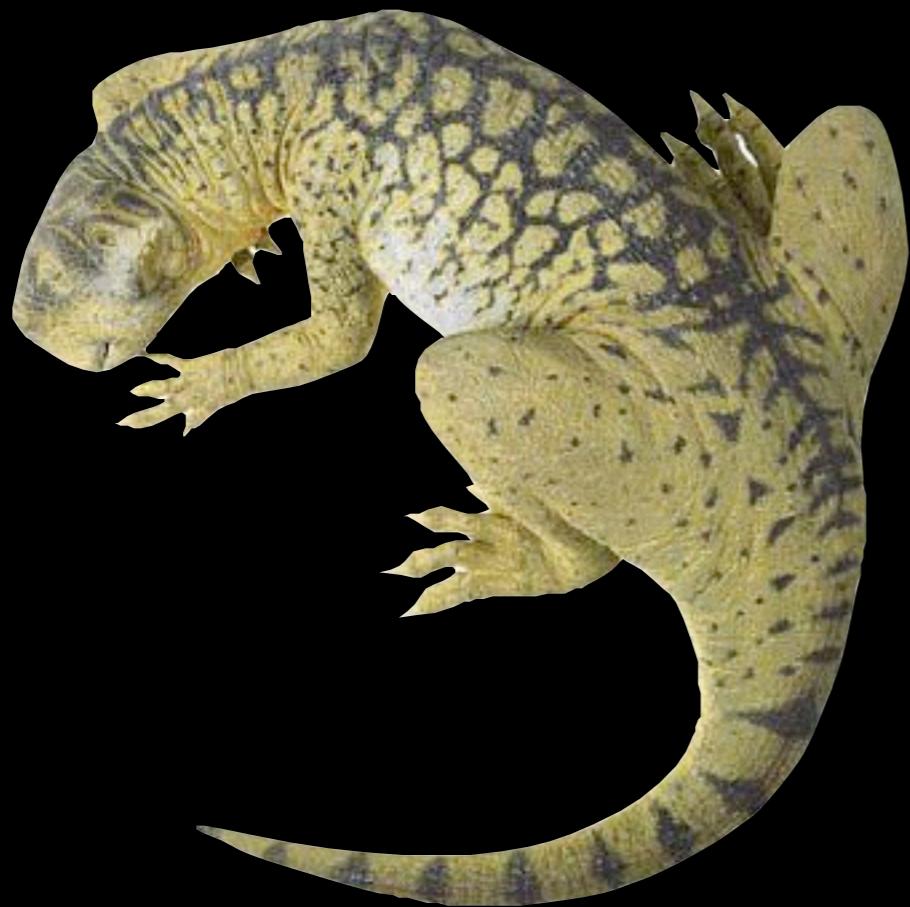
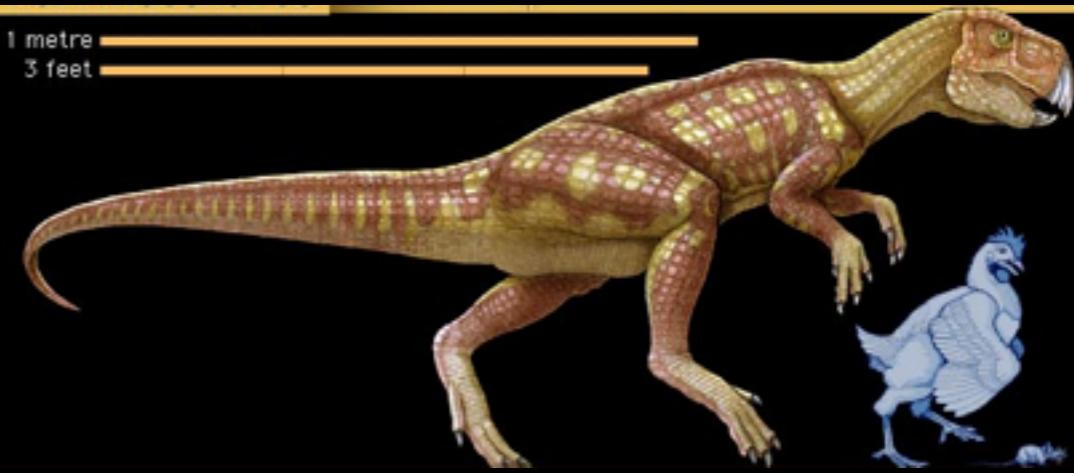
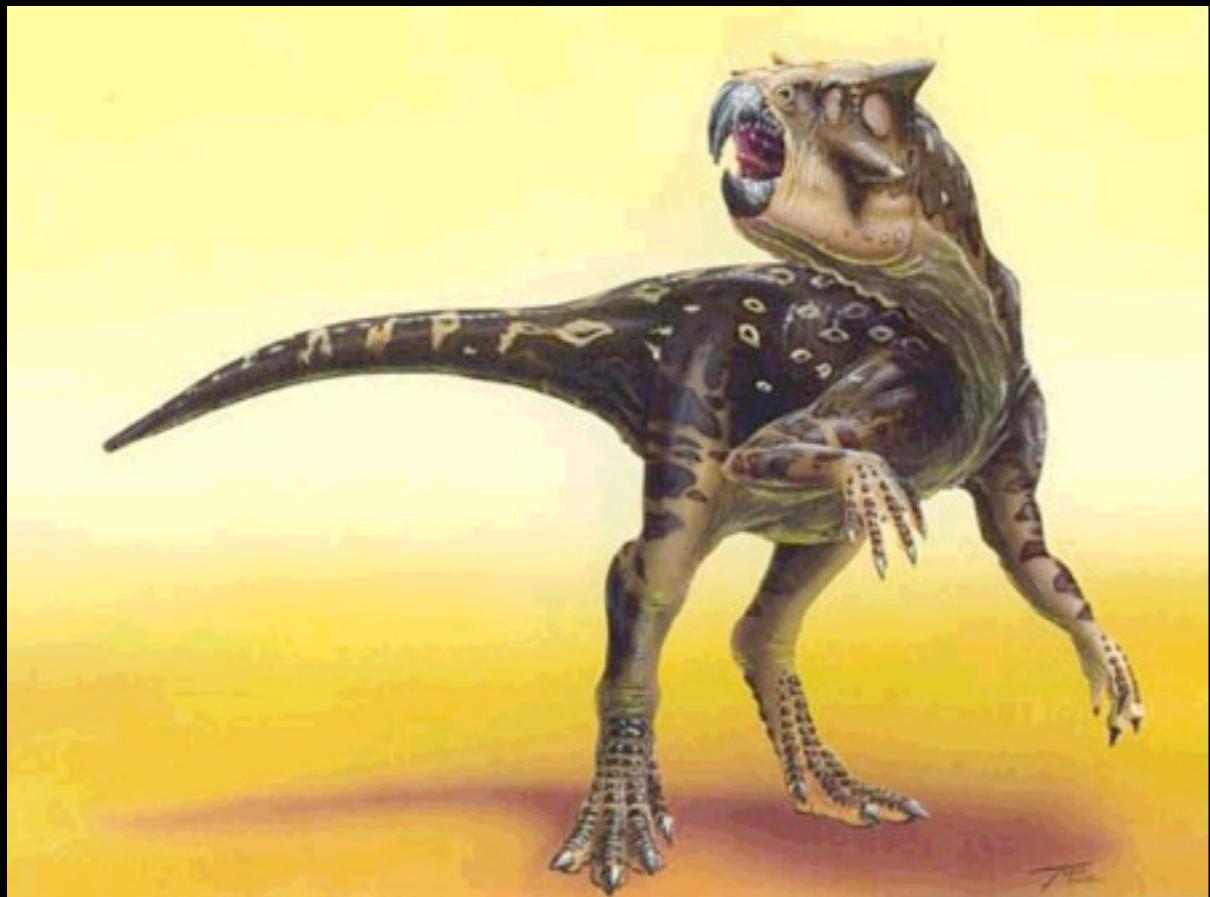


Ceratopsia

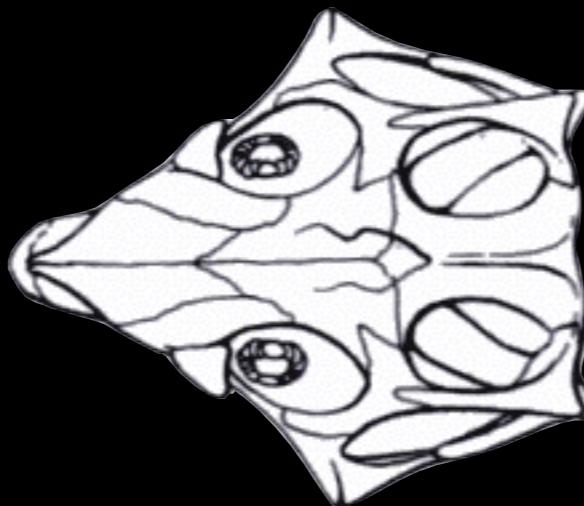
Psittacosaurus mongoliensis

Psittacosaurus: ‘Parrot Lizard’

1 metre
3 feet



Psittacosaurus: 'Parrot Lizard'



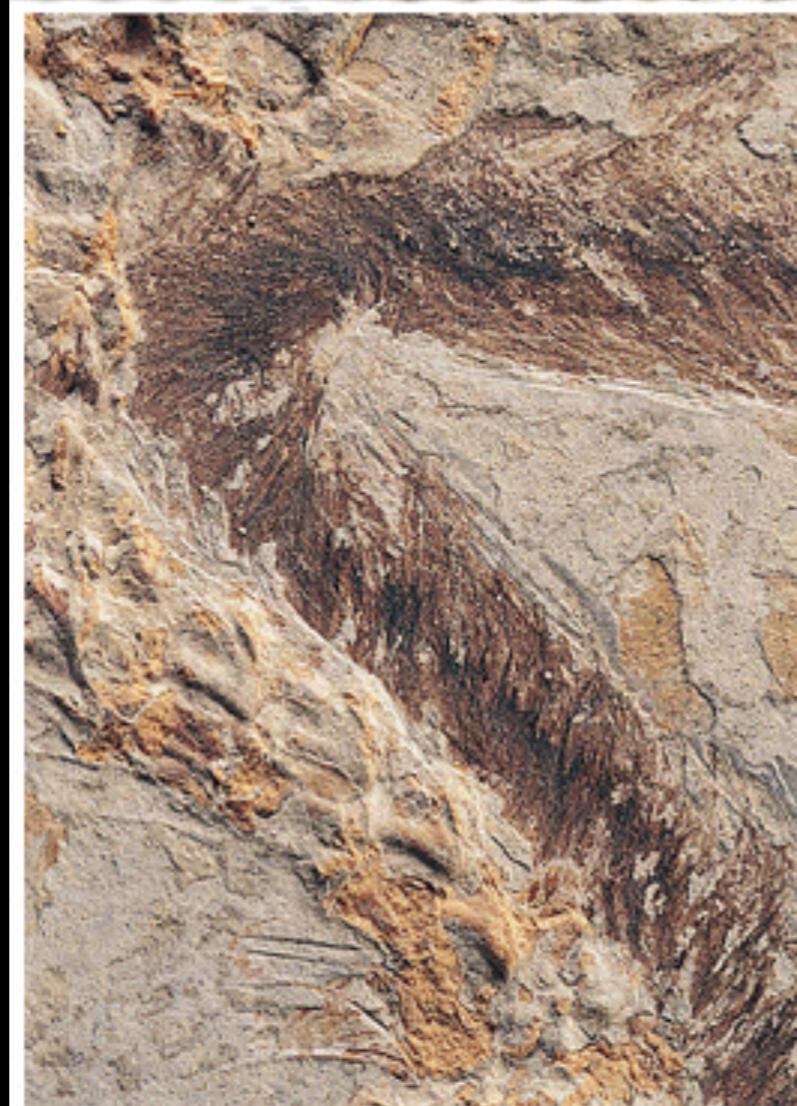
Shared, derived Characteristics

Small naris; positioned higher on skull
Reduction of 2 outer digits
Forelimb relatively long:
Bipedality
Aid for foraging?



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

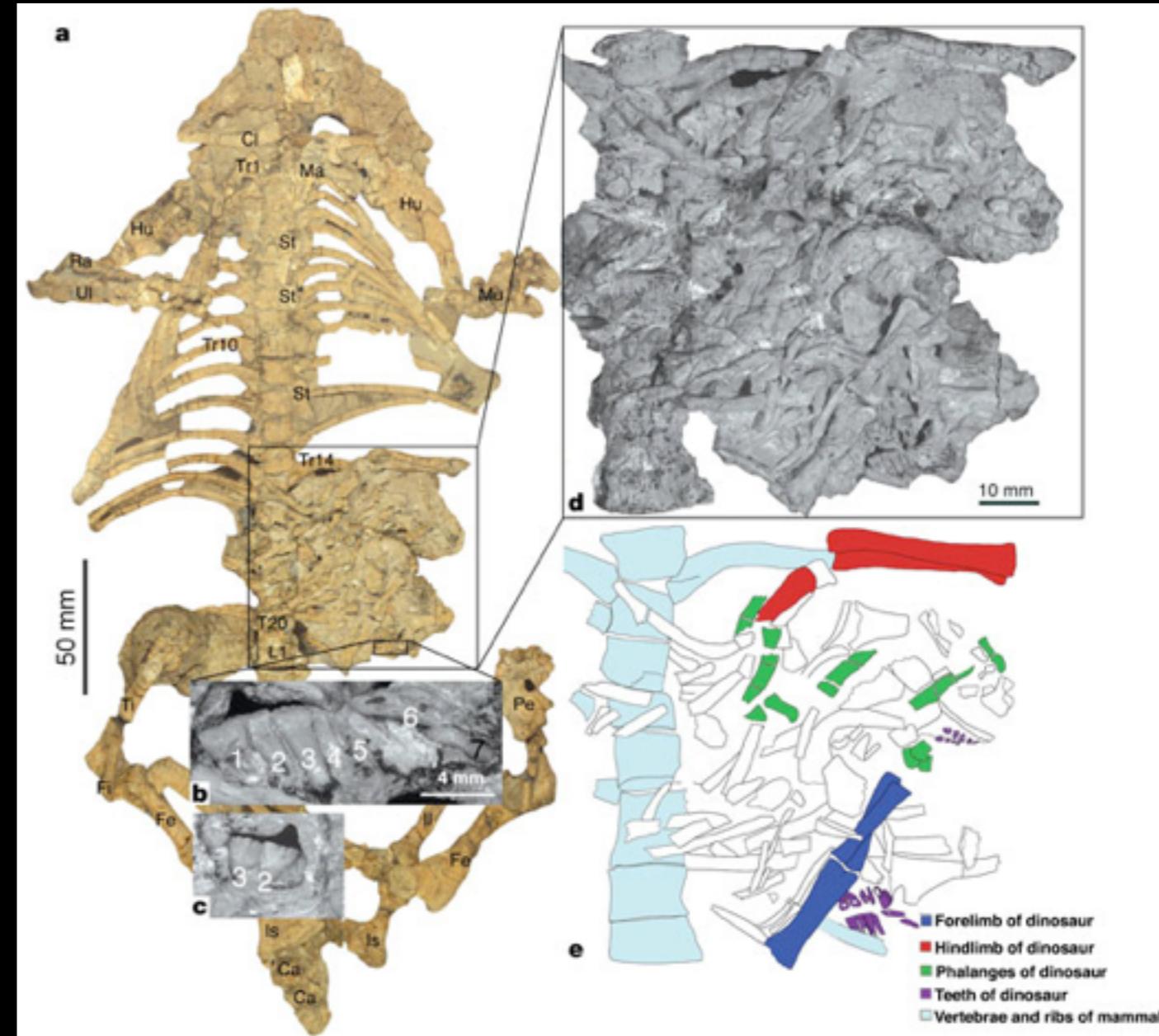


*Amazing nests
Suggests some degree of
maternal care*

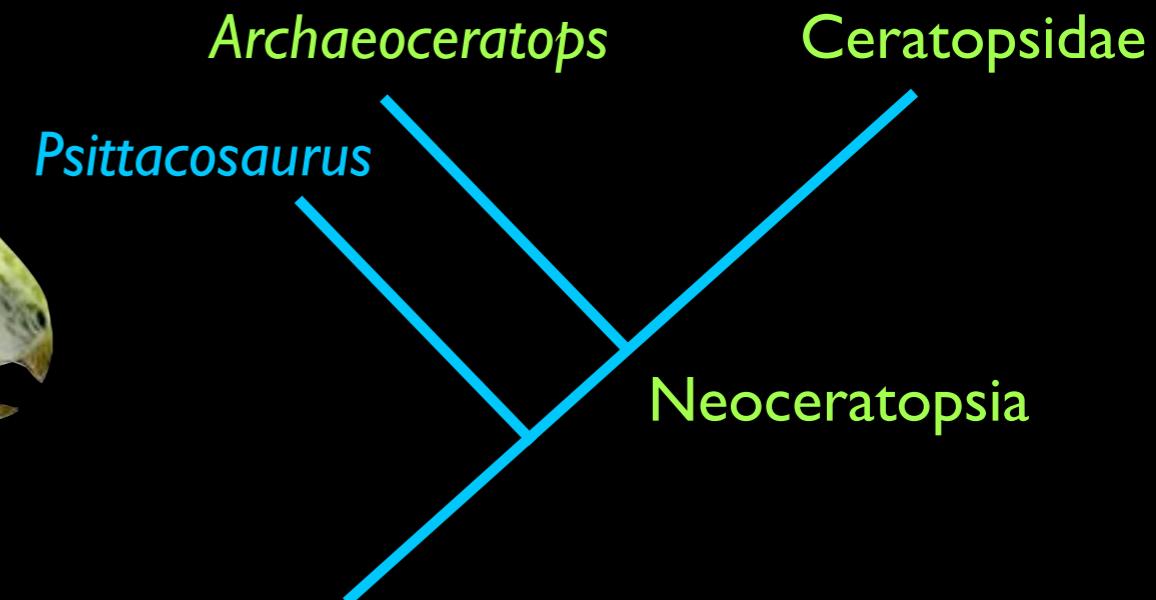
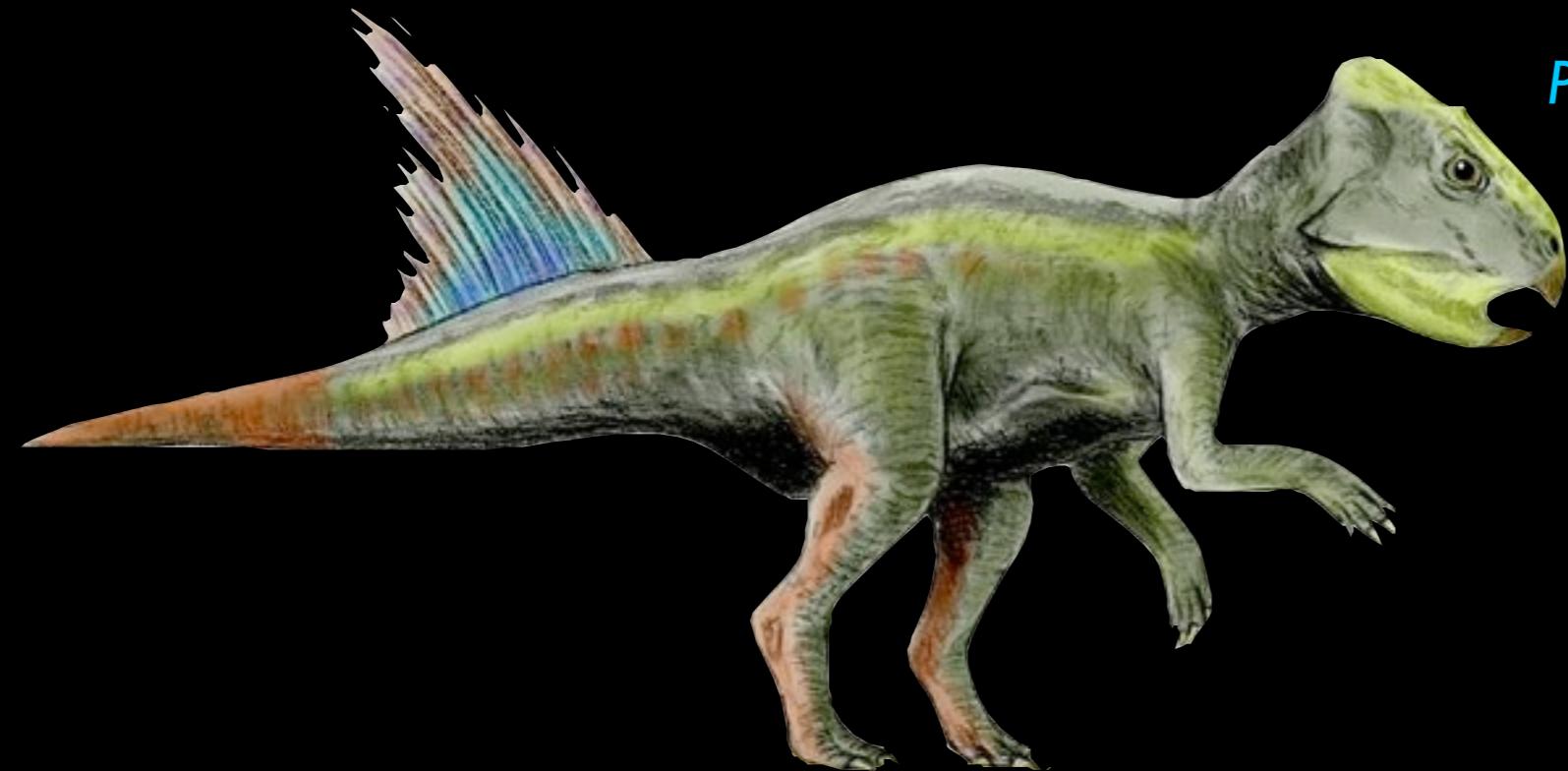


How embarrassing...

*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

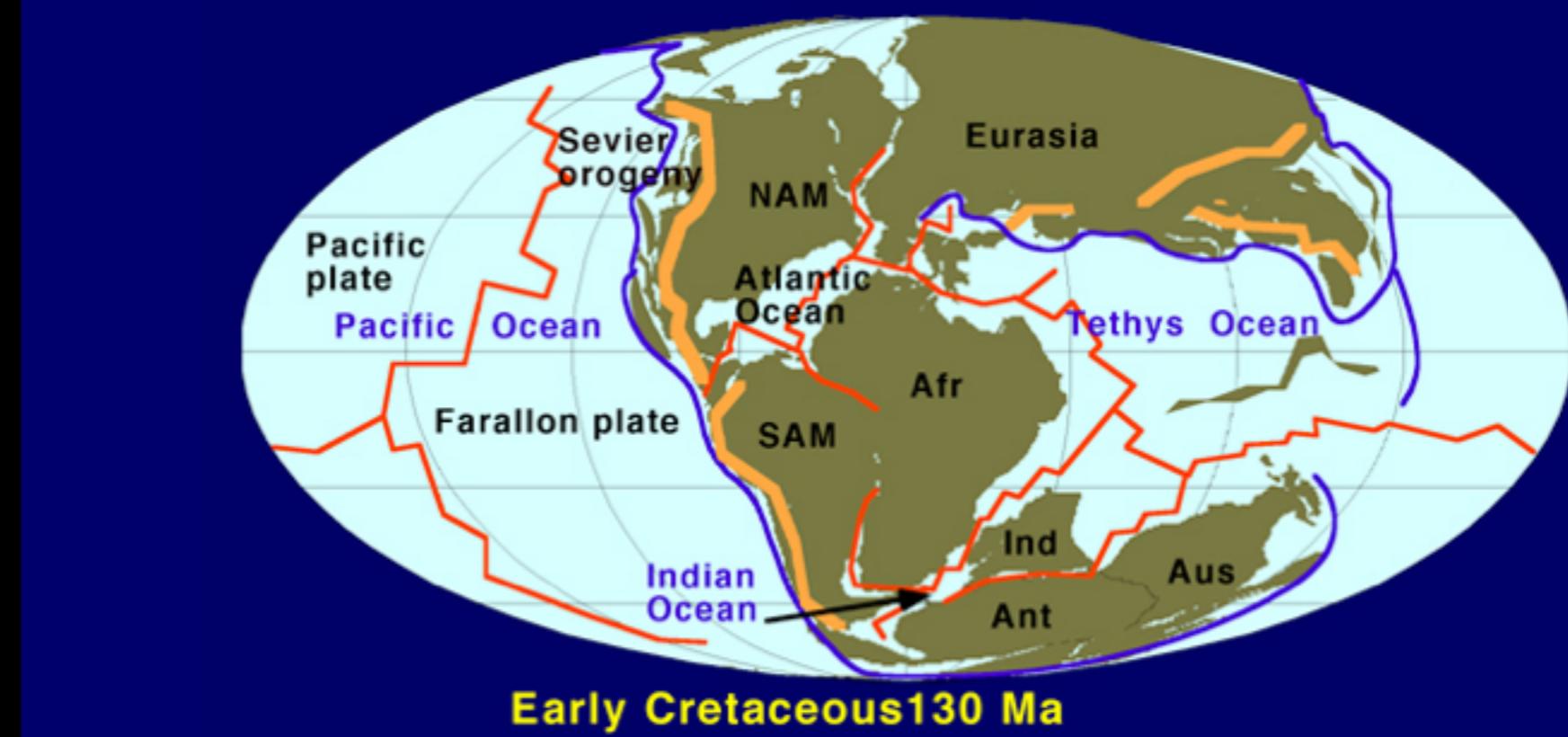
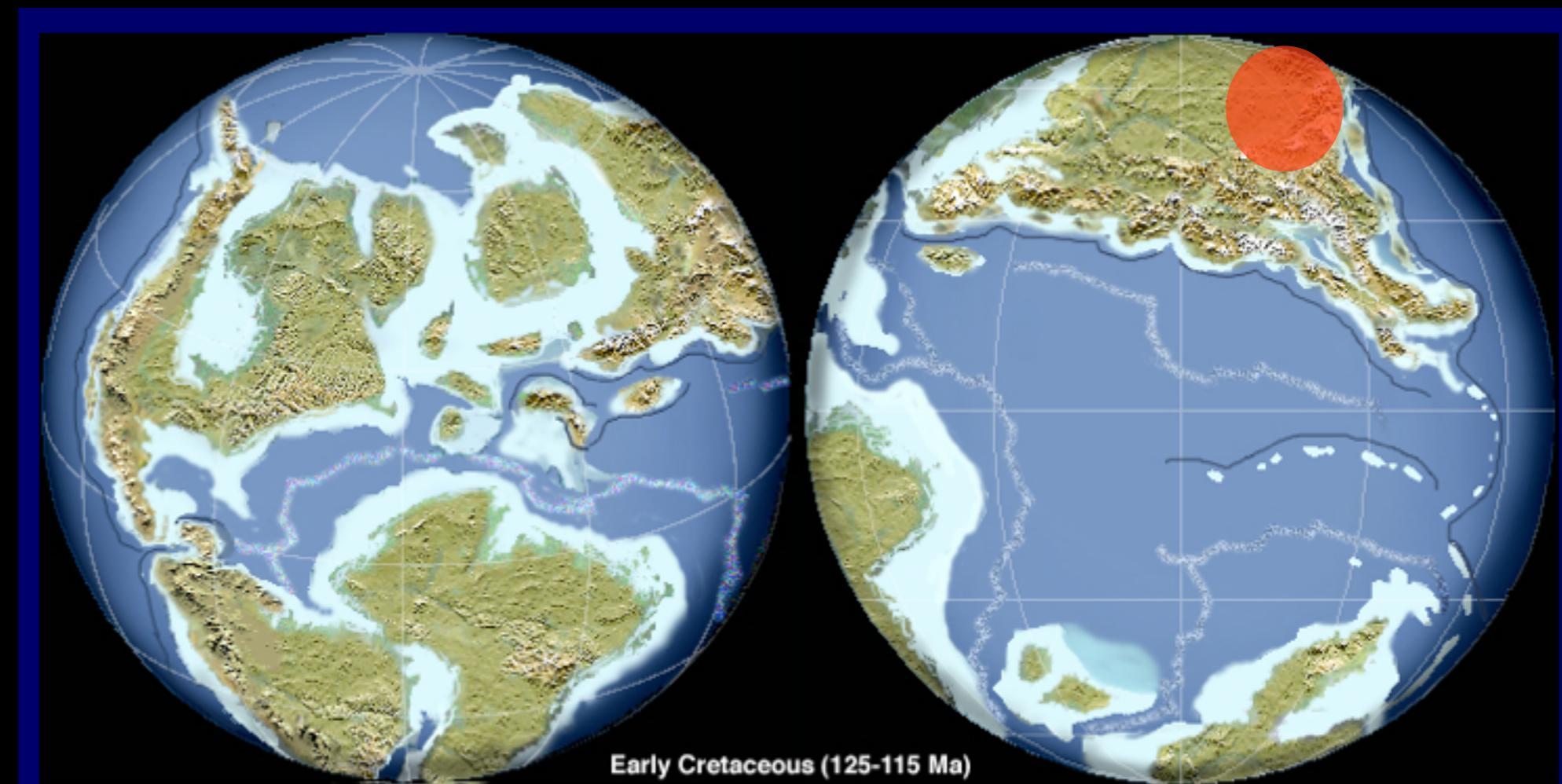
Upwardly hooked lower beak

All Neoceratopsians (except most basal) => quadrupedal

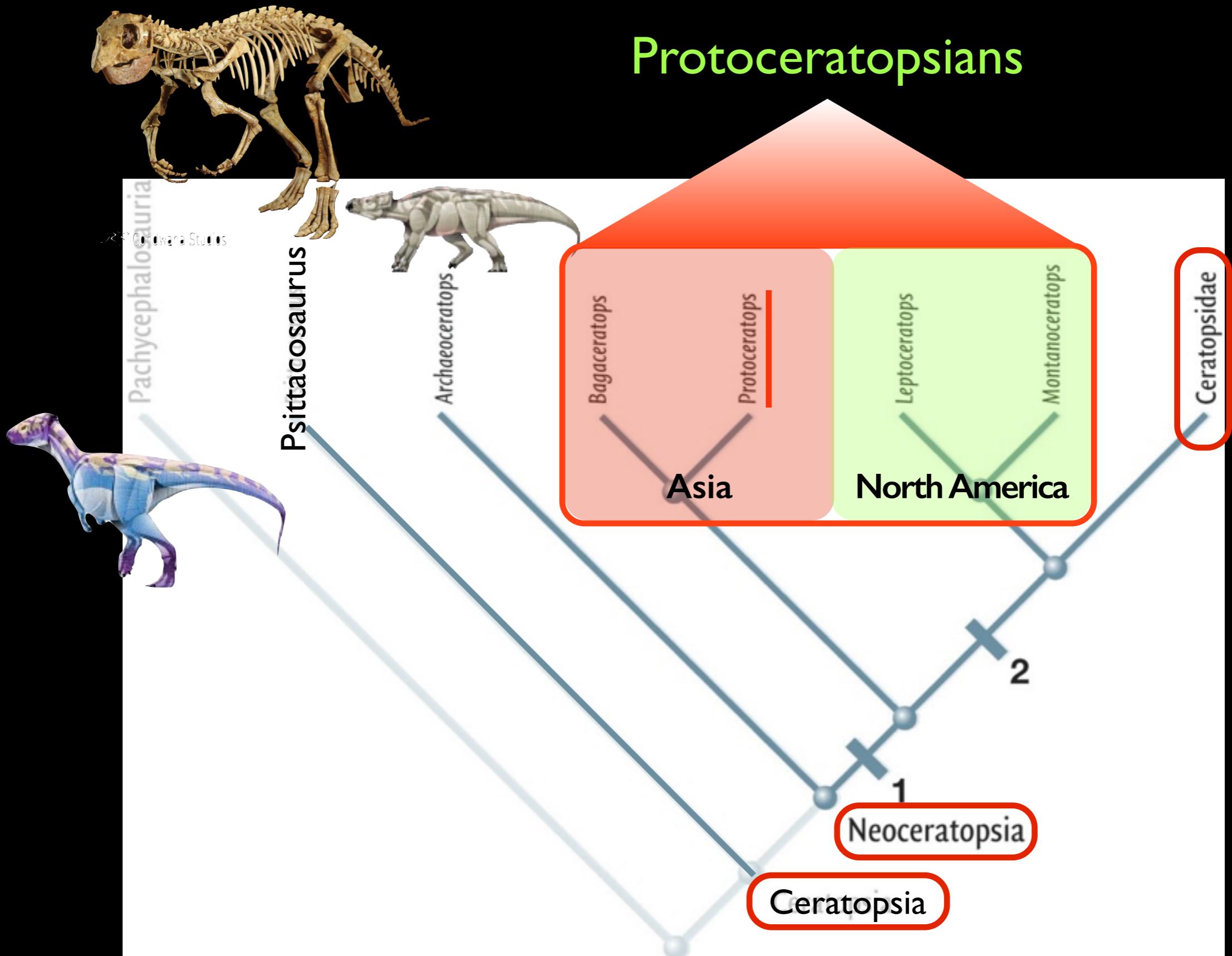
Psittacosaurus

Archaeoceratopsia

Modern Mongolia-region
Modern China
Early Cretaceous



Protoceratopsians





First eastward migration
early-mid Cretaceous

Bagaceratops



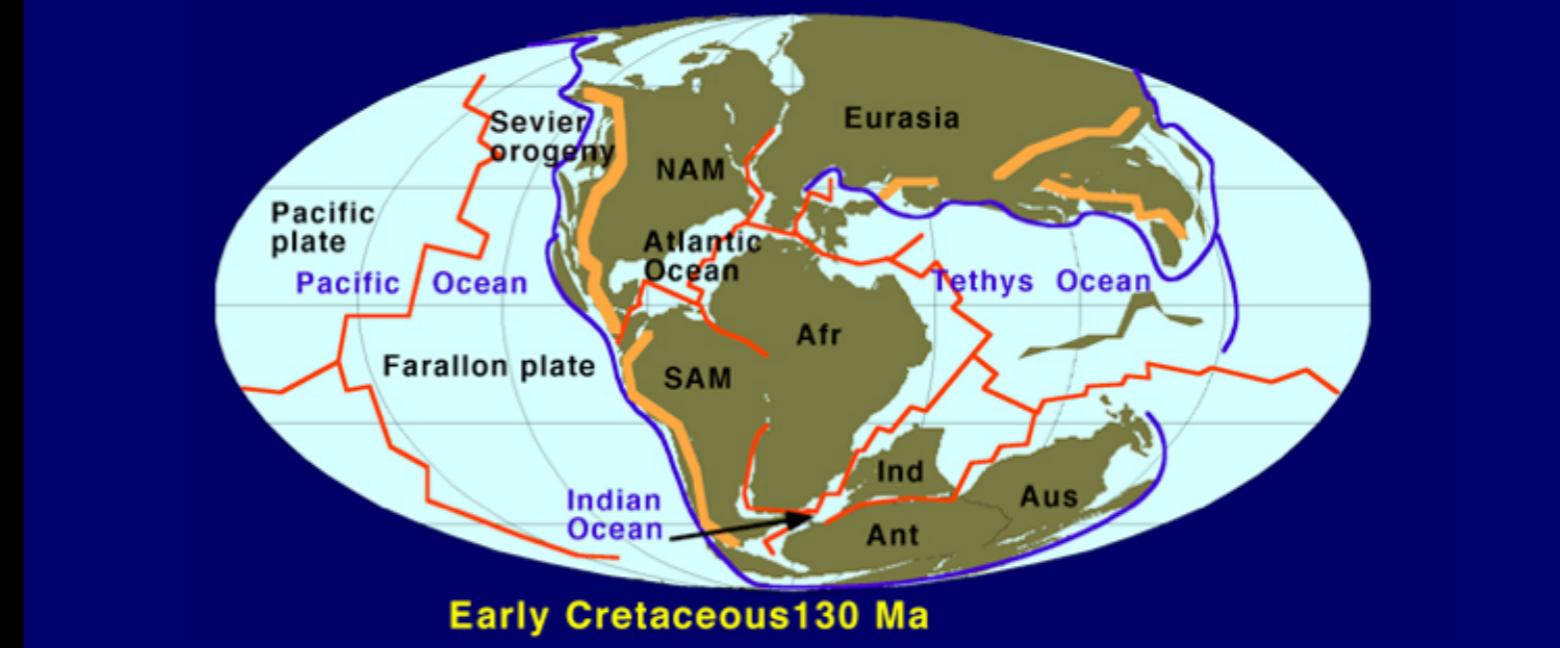
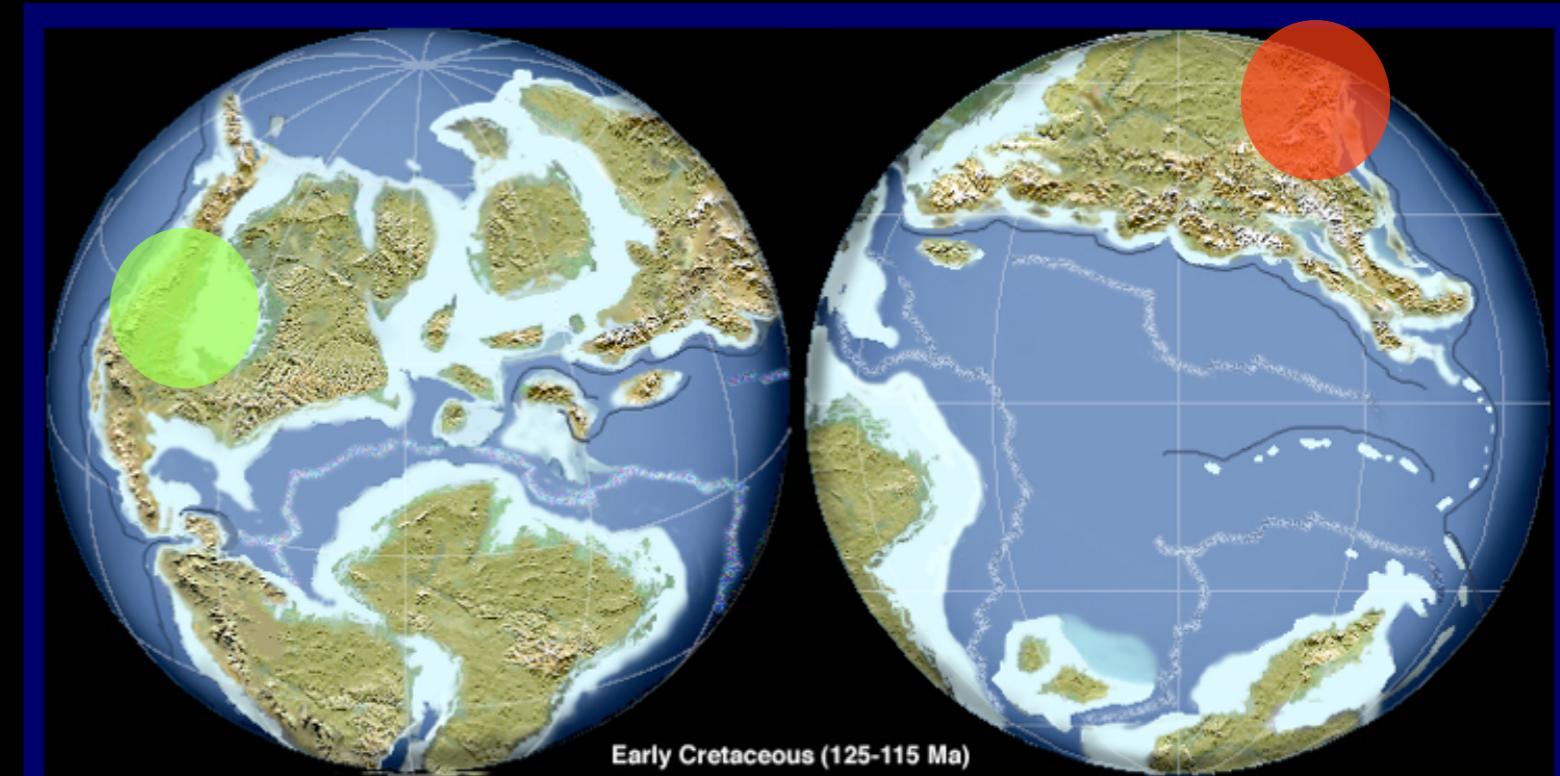
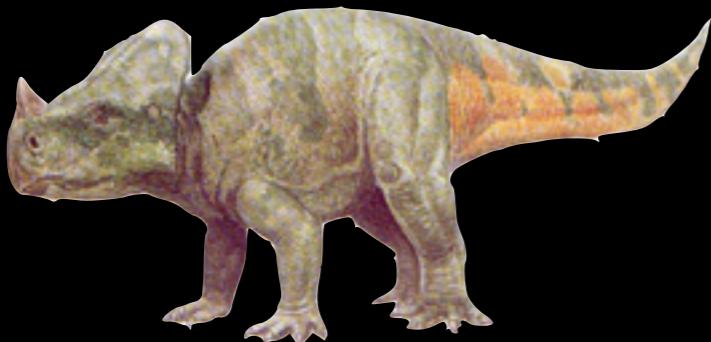
Protoceratops



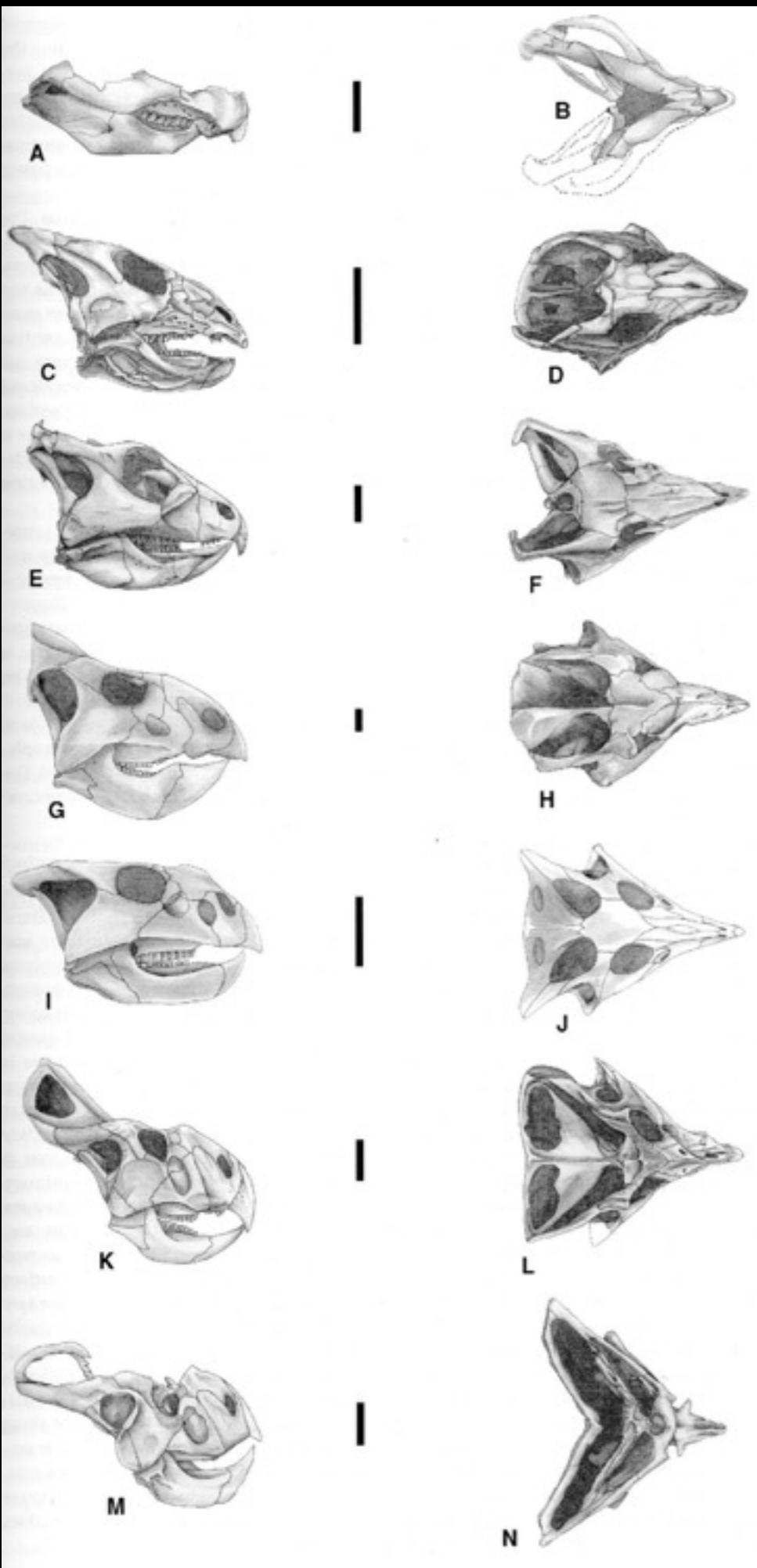
Leptoceratops



Montanoceratops



Basal Neoceratopsia



Chaoyangsaurus

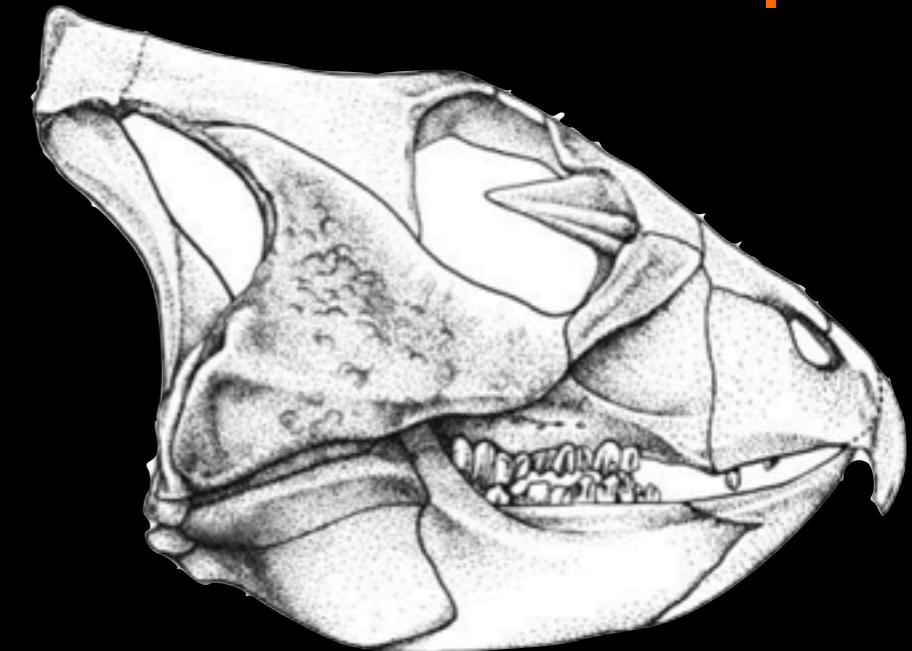
Liaoceratops

Archaeoceratops

Leptoceratops

Bagaceratops

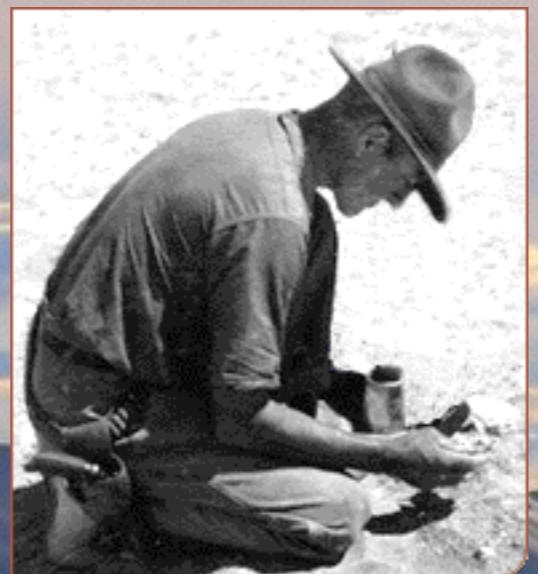
Protoceratops



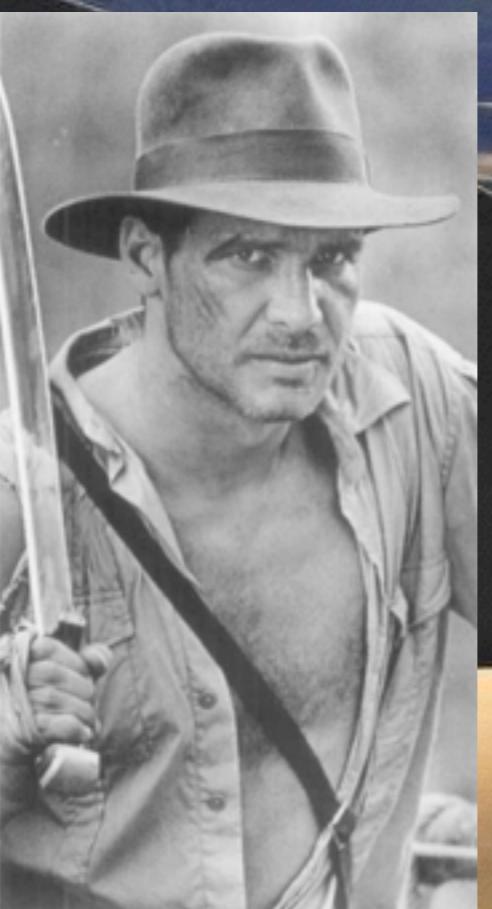
Archaeoceratops



Protoceratops



Roy Chapman Andrews



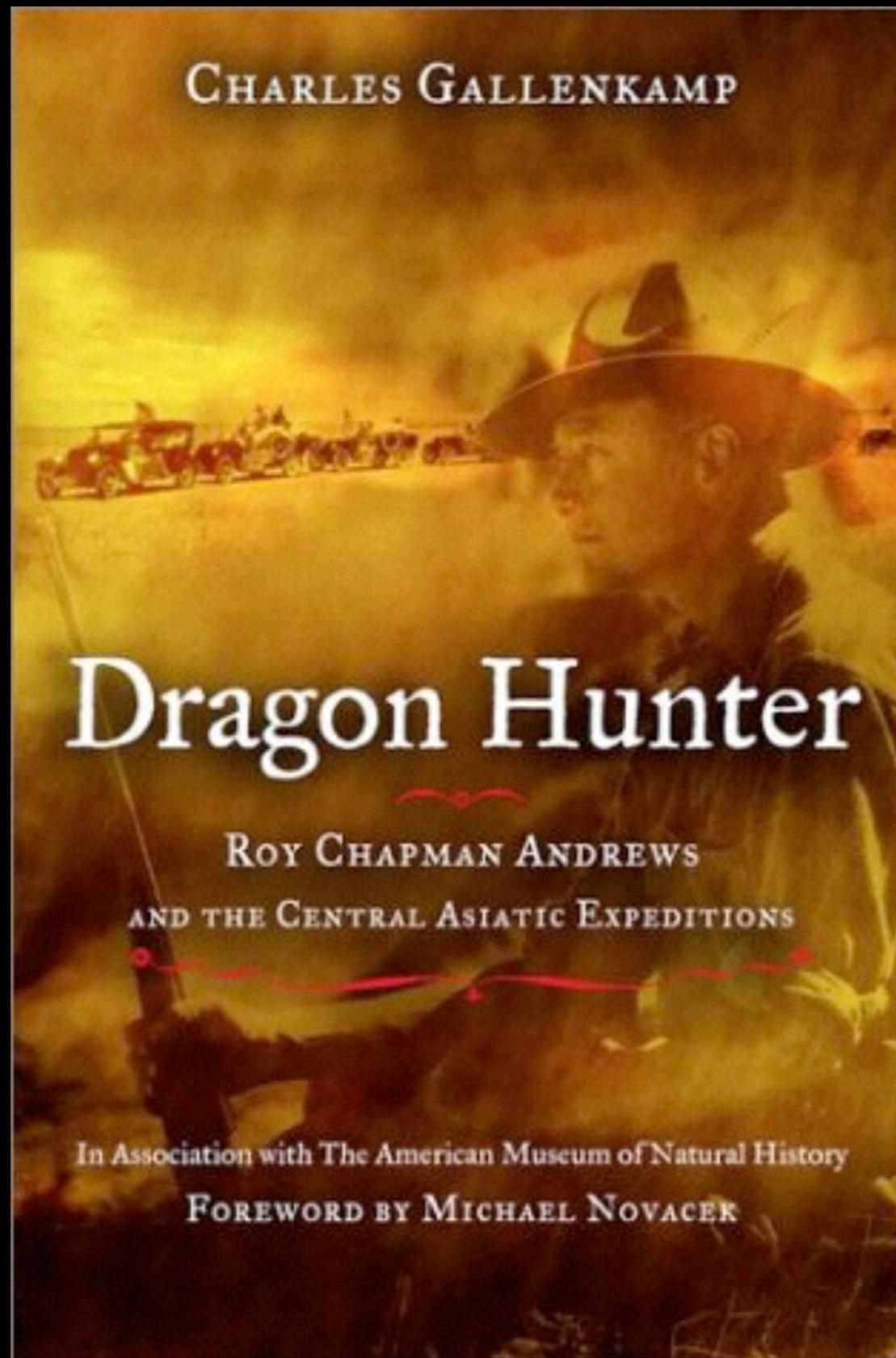
175 km mi

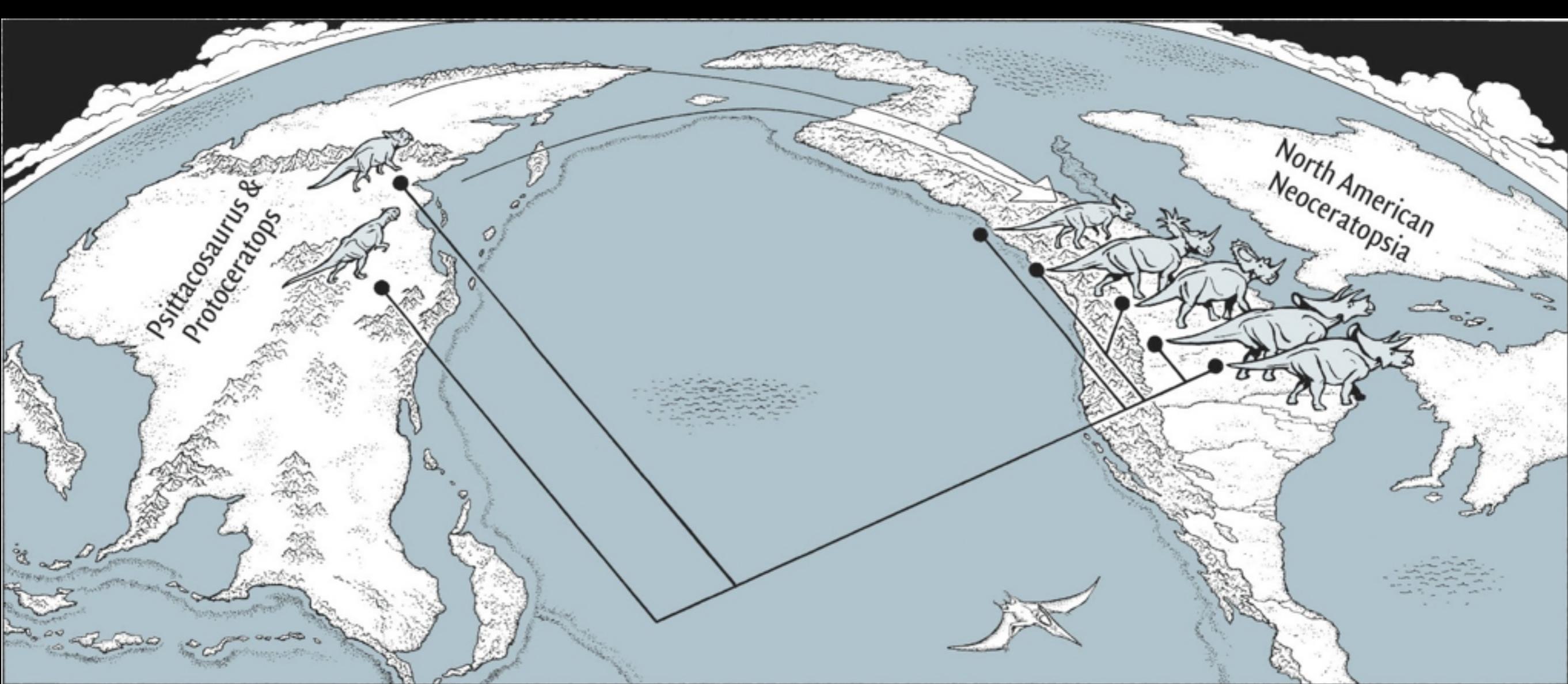
Source: MSN Encarta

Roy Chapman Andrews: Gobi Expedition 1923-1925



Roy Chapman Andrews: Gobi Expedition 1923-1925





Earliest Ceratopsian dinos: Primarily Asia

Early Neoceratopsian dinos: Asia and North America

Ceratopsidae dinos: North America only

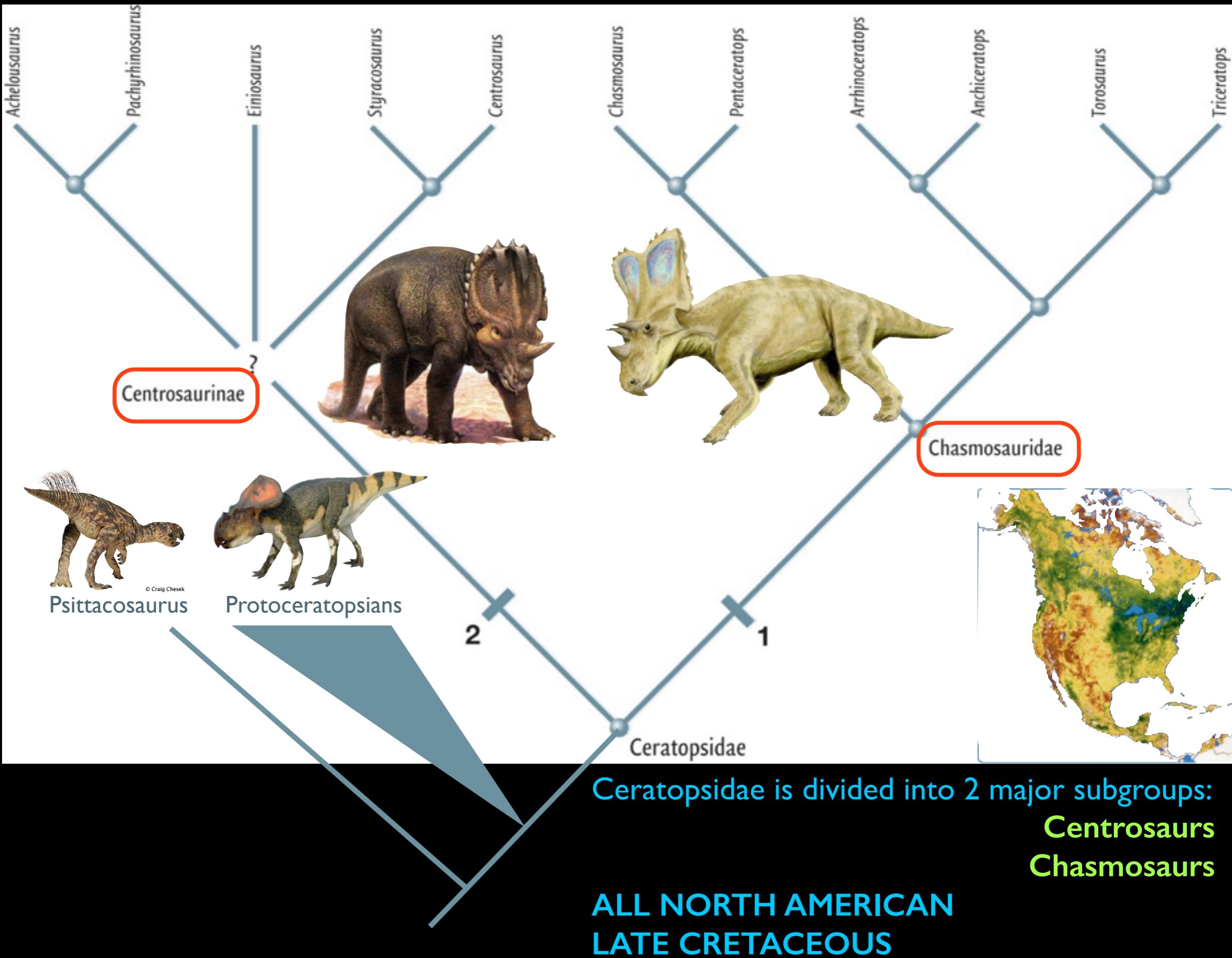
Derived

Late Cretaceous



Late Cretaceous





Shared, derived traits of Ceratopsidae

Enormous skulls (up to 8.5 ft among Torosaurus)

Western North America (Alaska => New Mexico)

Latest Cretaceous

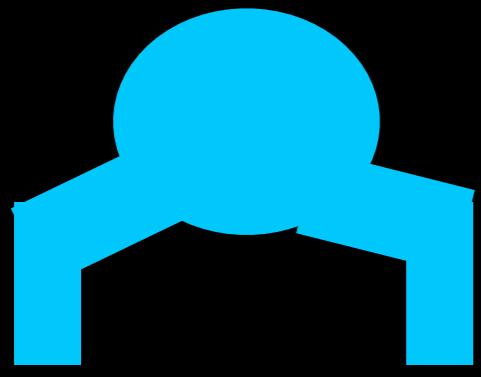
Large frills

Orbital or nasal horns/protuberances

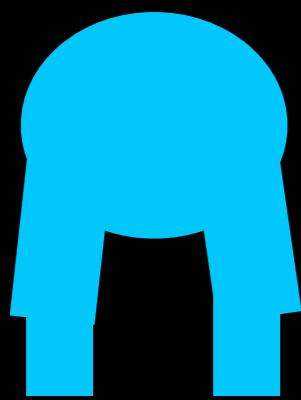
Large nasal openings

Complex dental battery





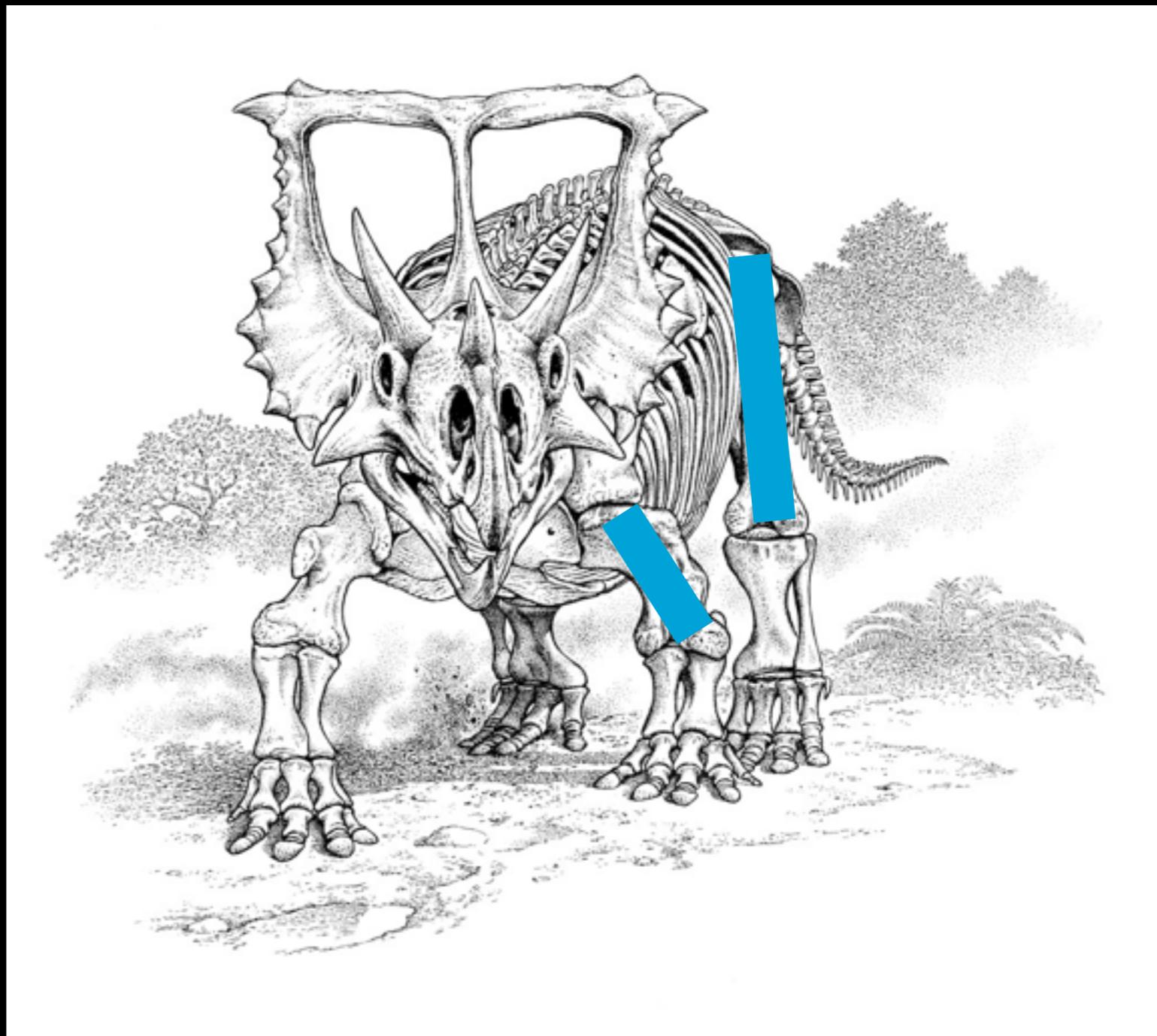
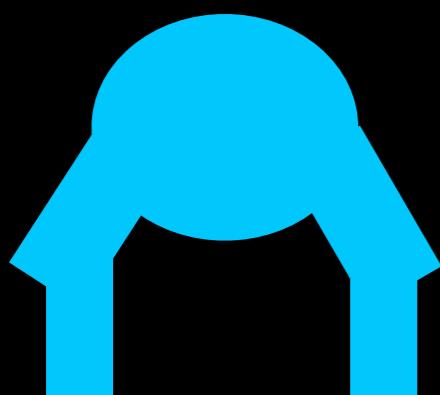
sprawling



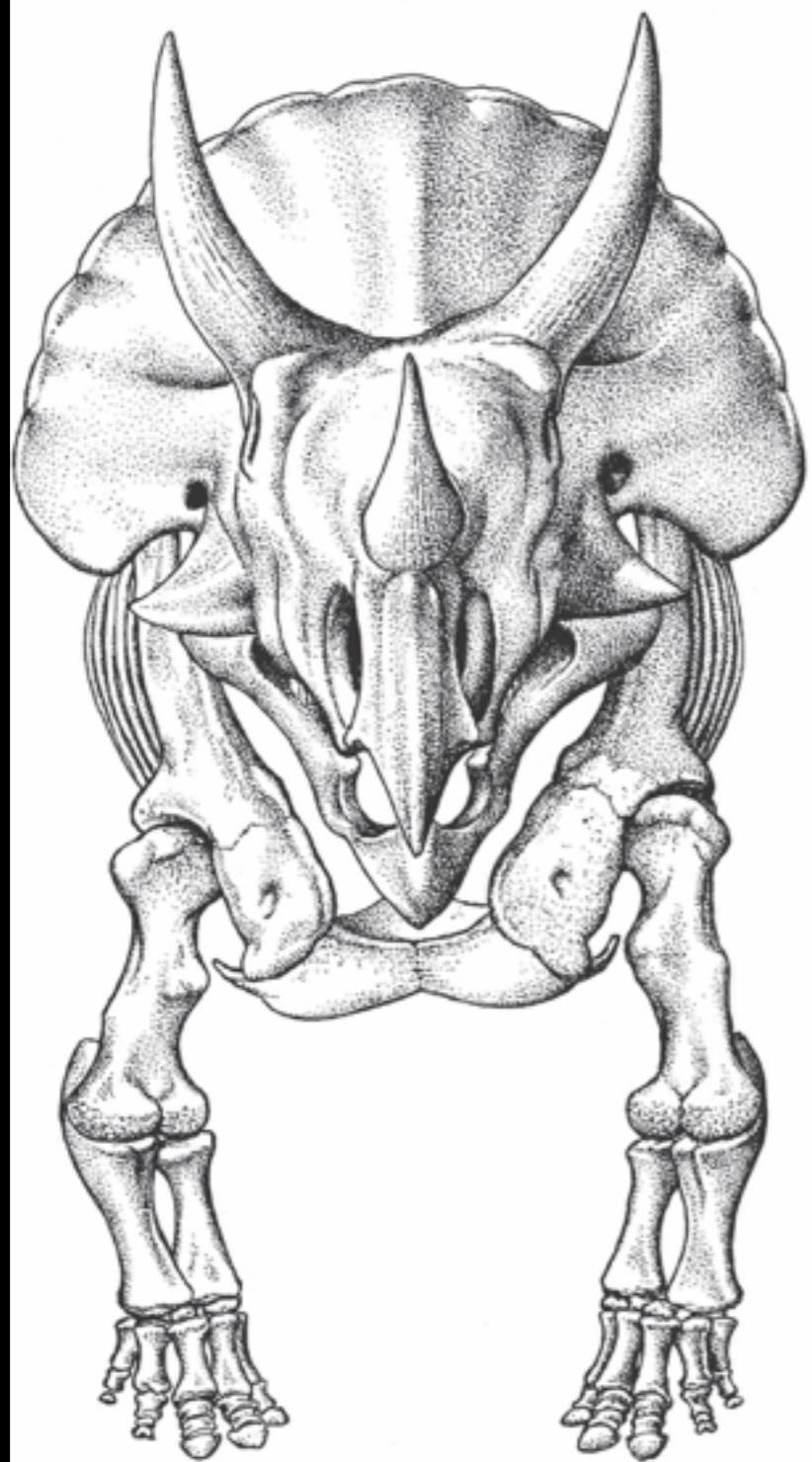
vs.

erect

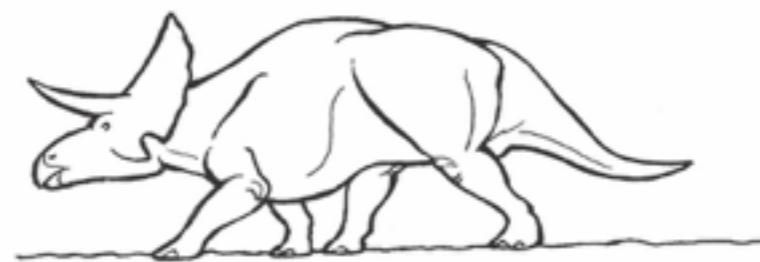
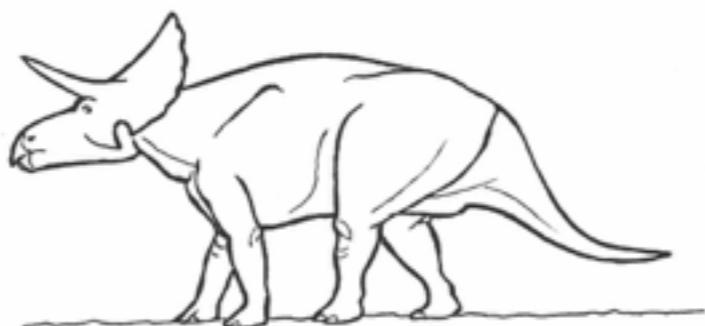
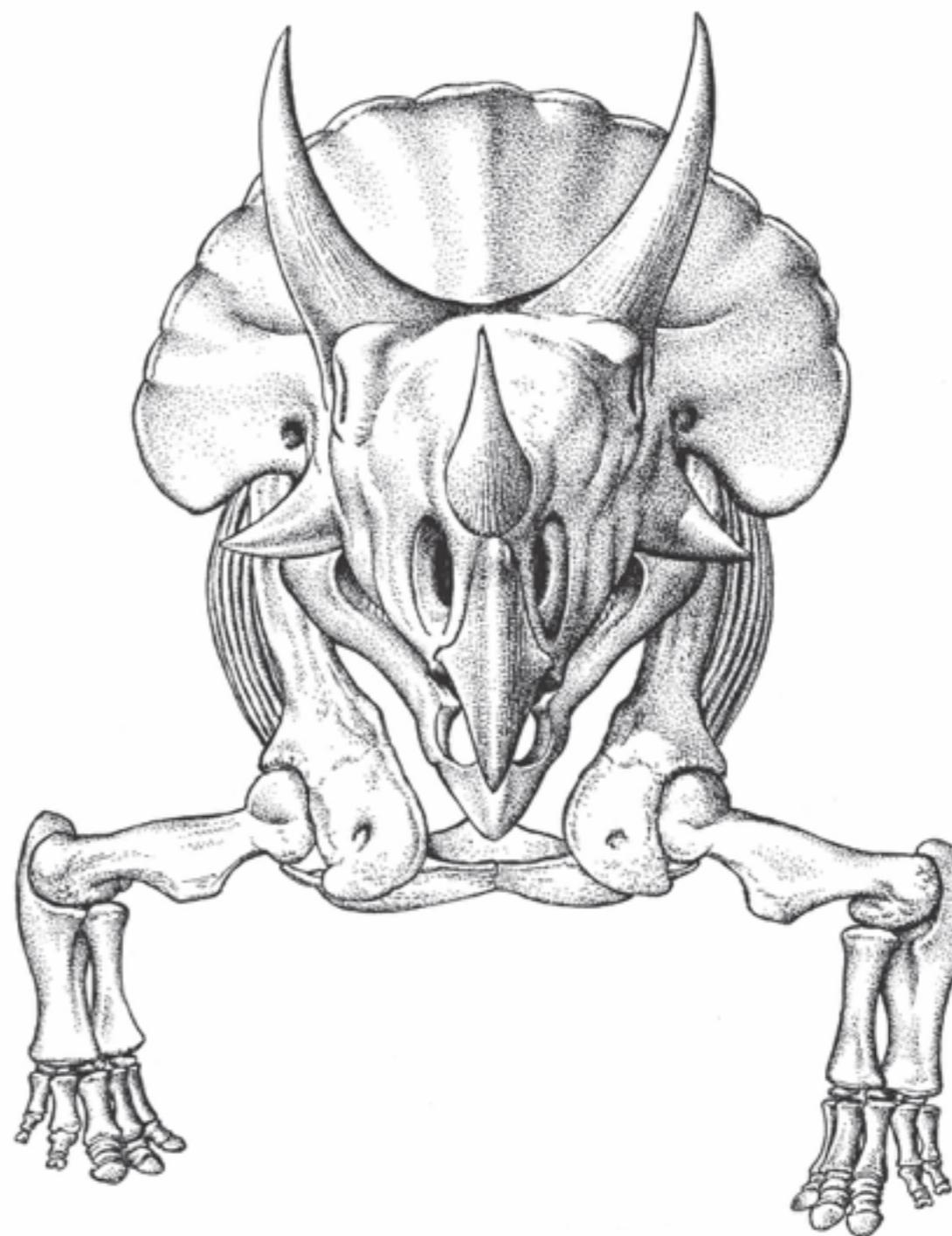
probably semi-erect

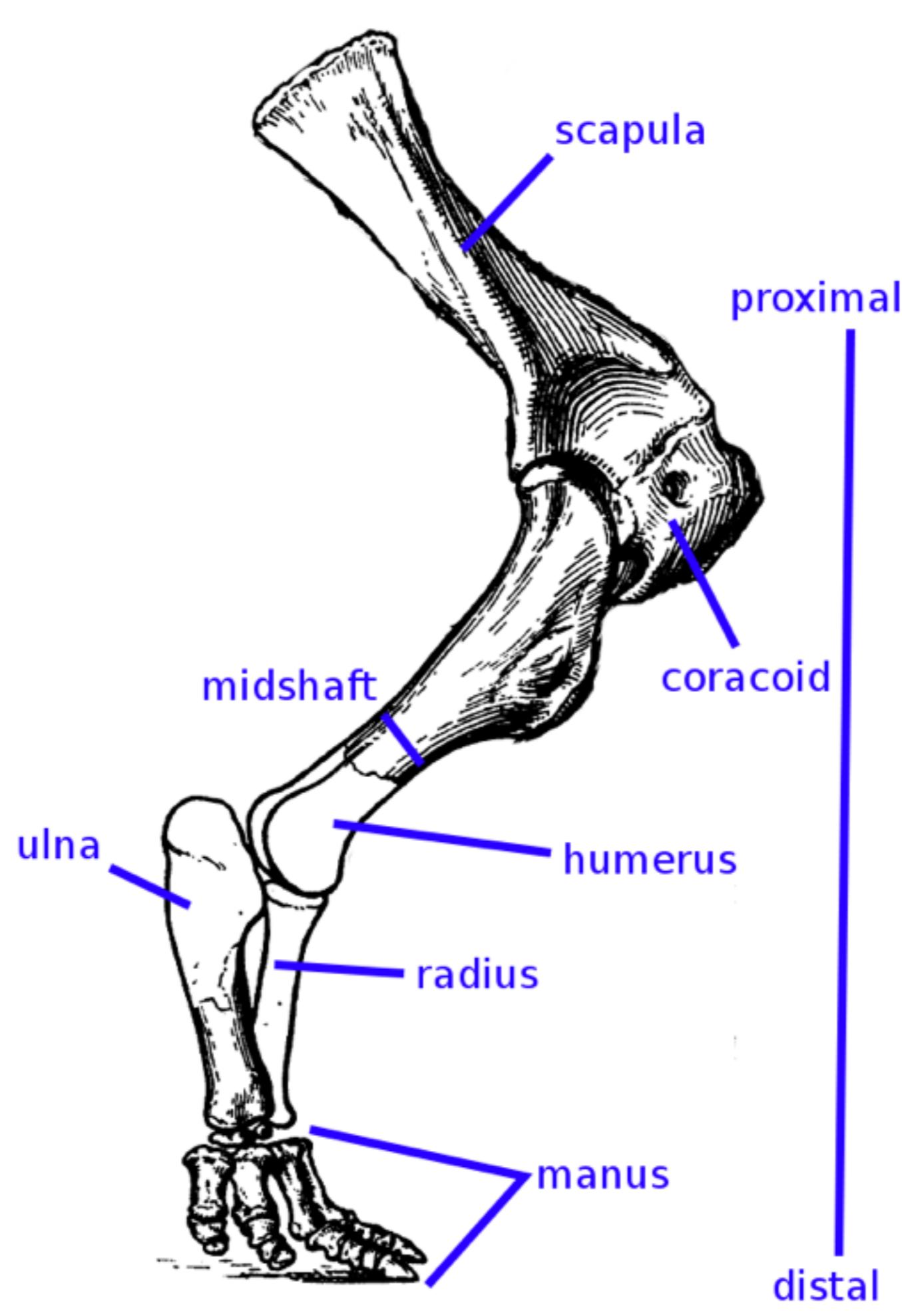


(a)

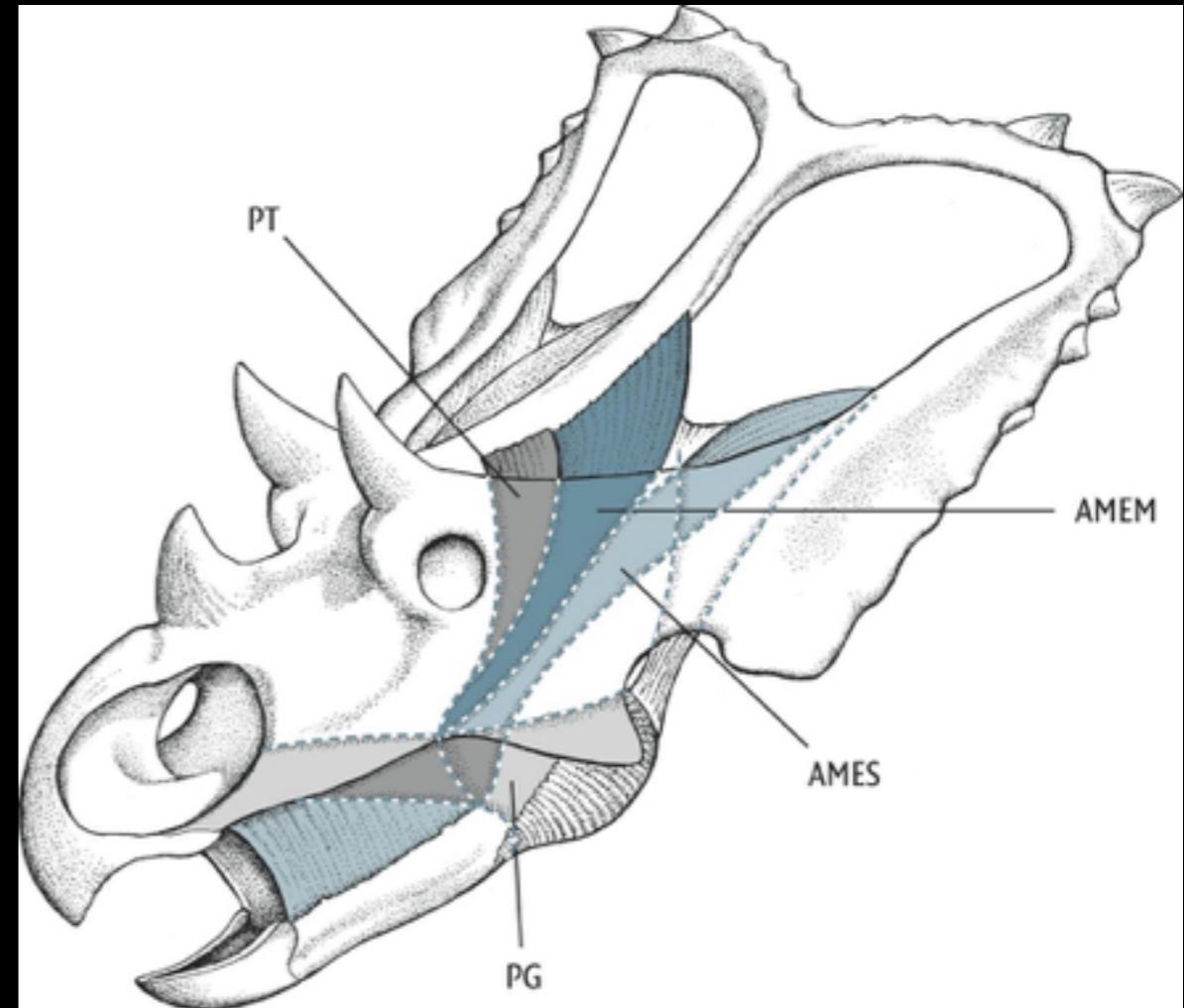
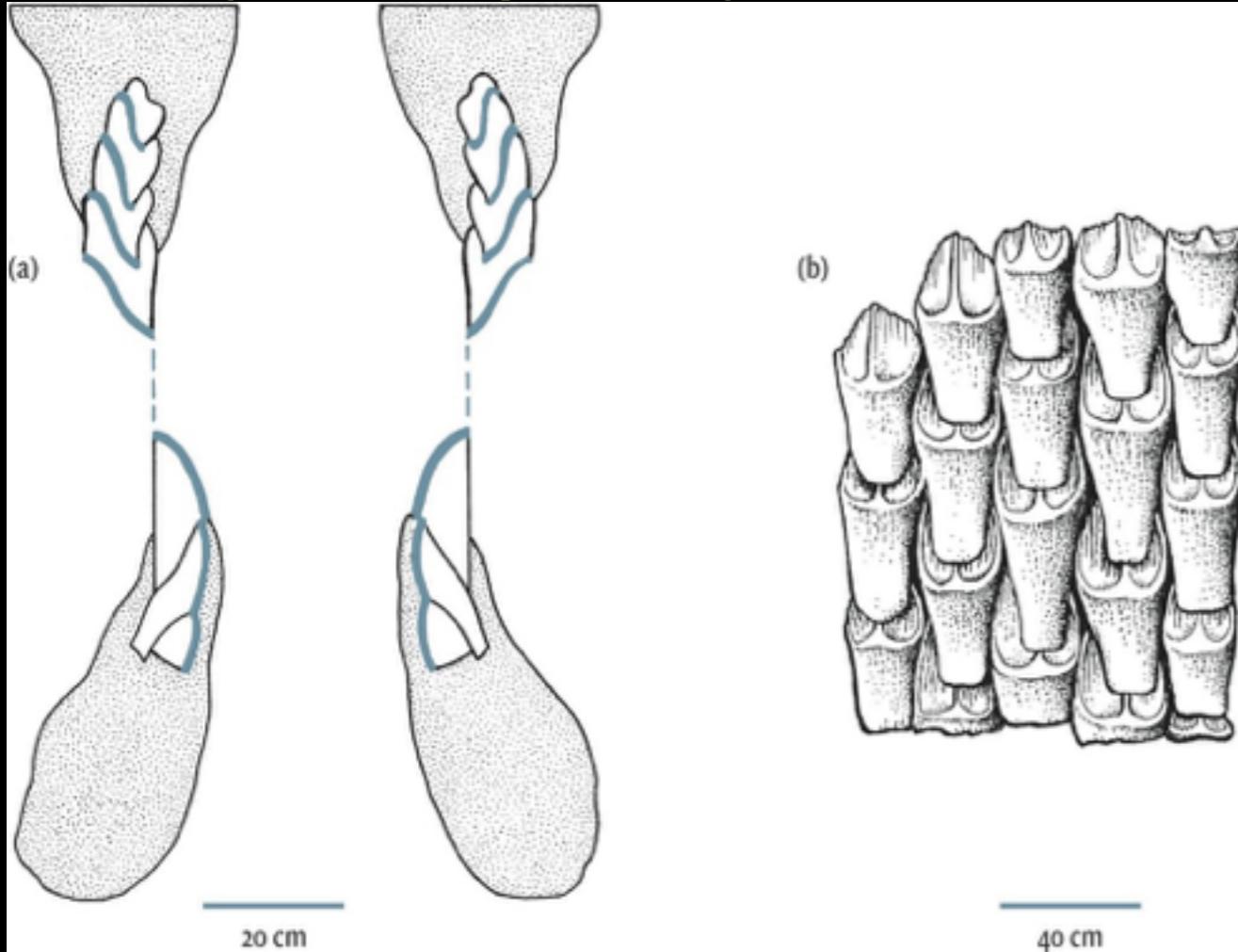


(b)





Diet! (Ceratopsidae)



Complex dental battery

Double-rooted teeth: structural support

Adjacent teeth are locked together to maximize cutting edge

As teeth are worn, they are replaced by new teeth below

~ Never run out of teeth

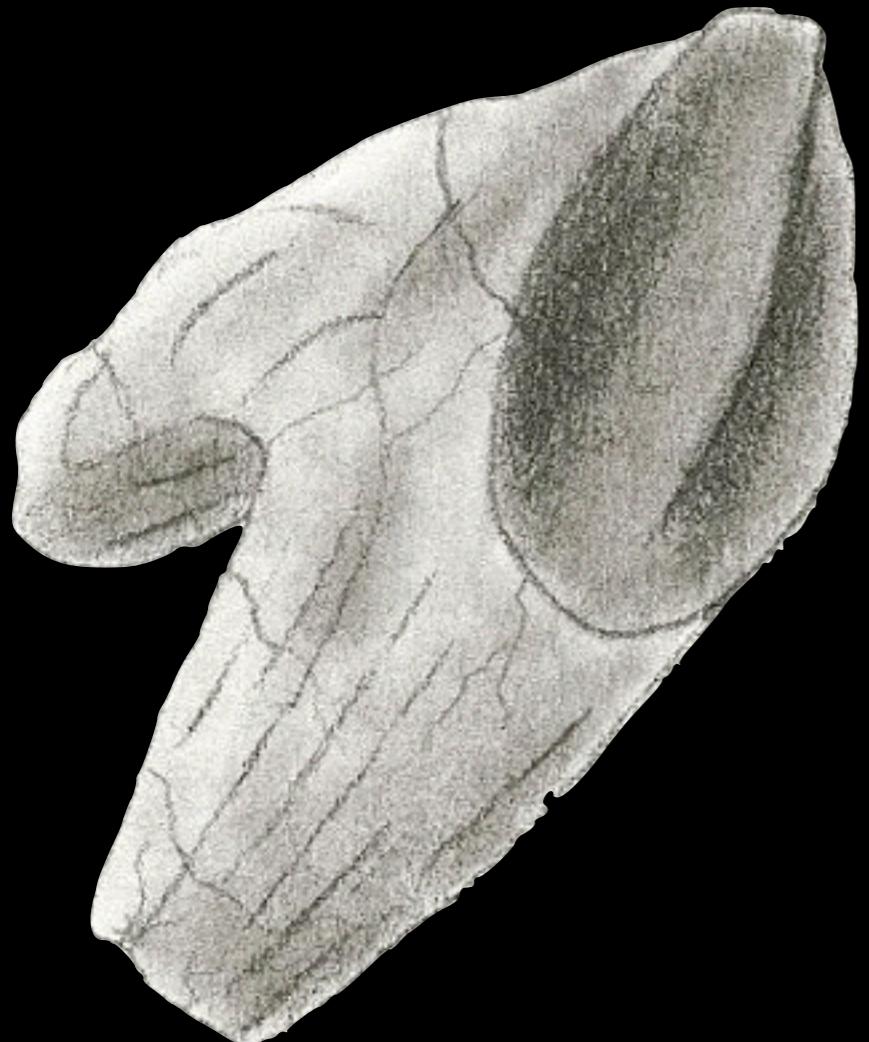
Top teeth are self-sharpened by cutting action

Large hyoid: long tongue



Musculature!

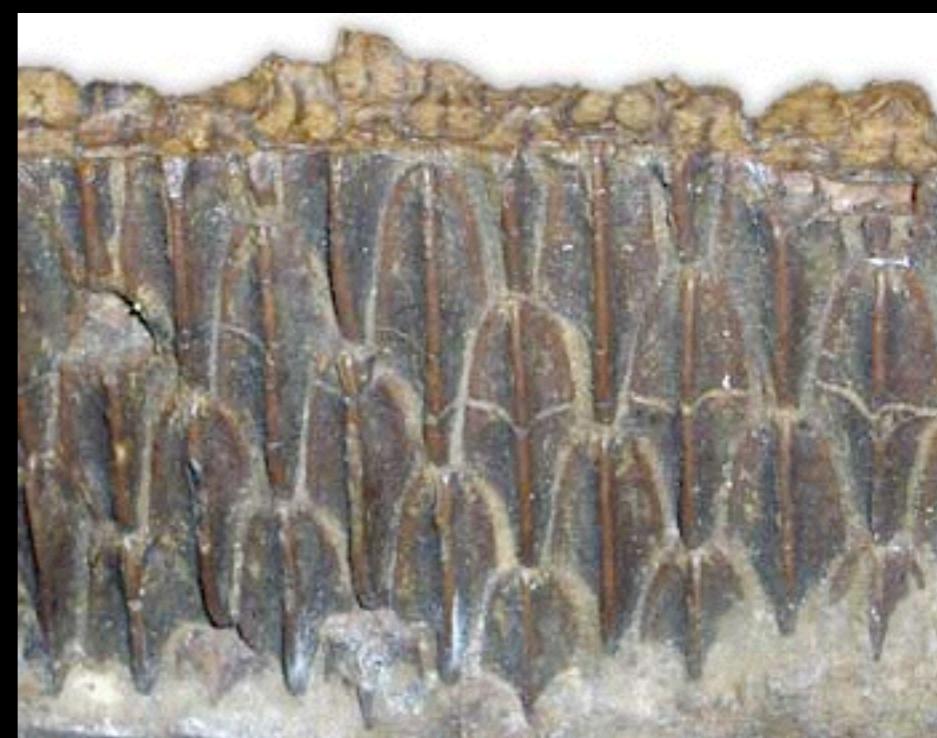
Large chewing muscles attached from a large coronoid process on the lower jaw up through the upper temporal opening and onto the frill



Ceratopsidae dental battery...
Analogous to the Hadrosaur dental battery
Not related- convergent evolution!



Triceratops teeth

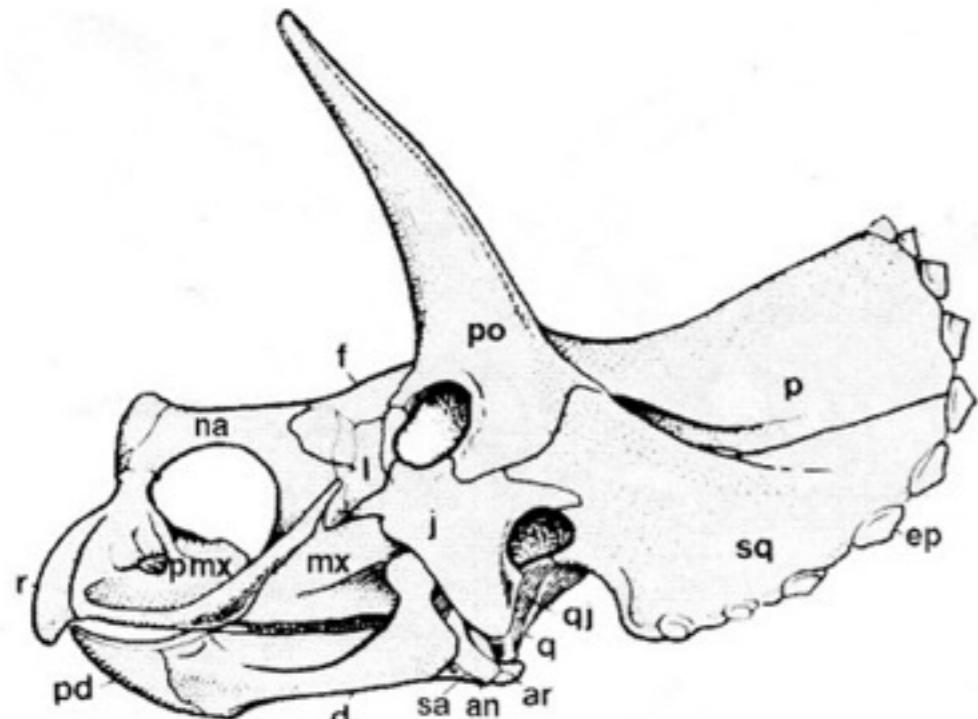


Hadrosaur teeth

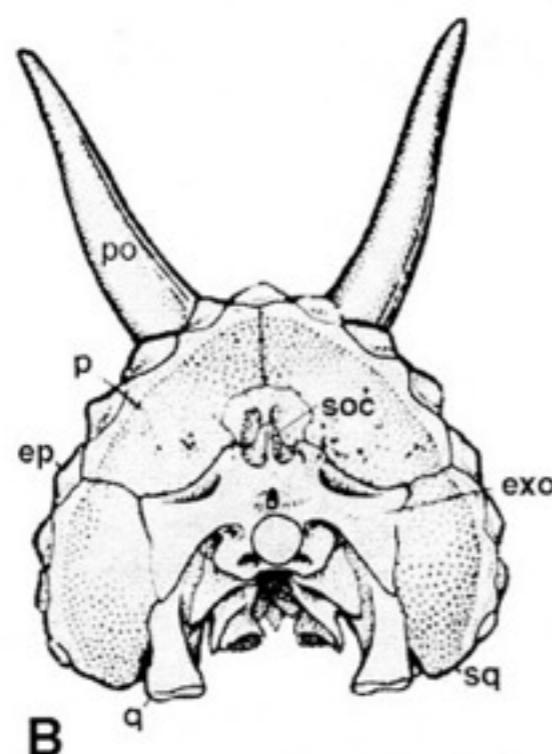
Diet! (Ceratopsidae)



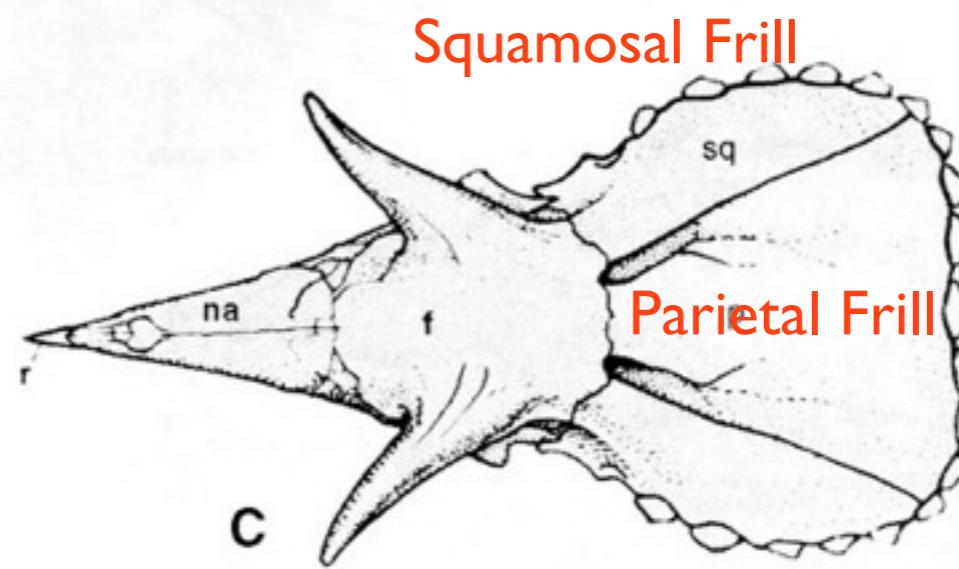
Large coronoid process for chewing muscle attachment



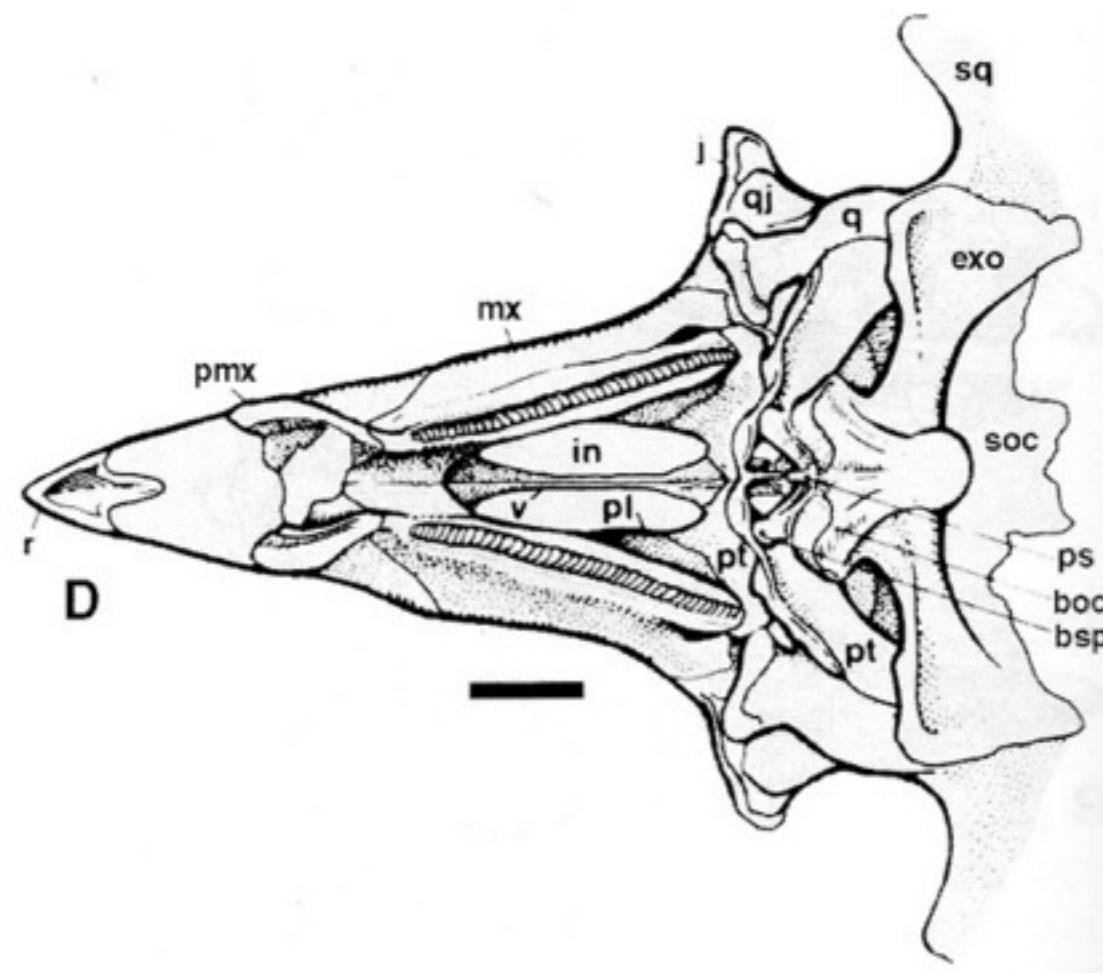
A



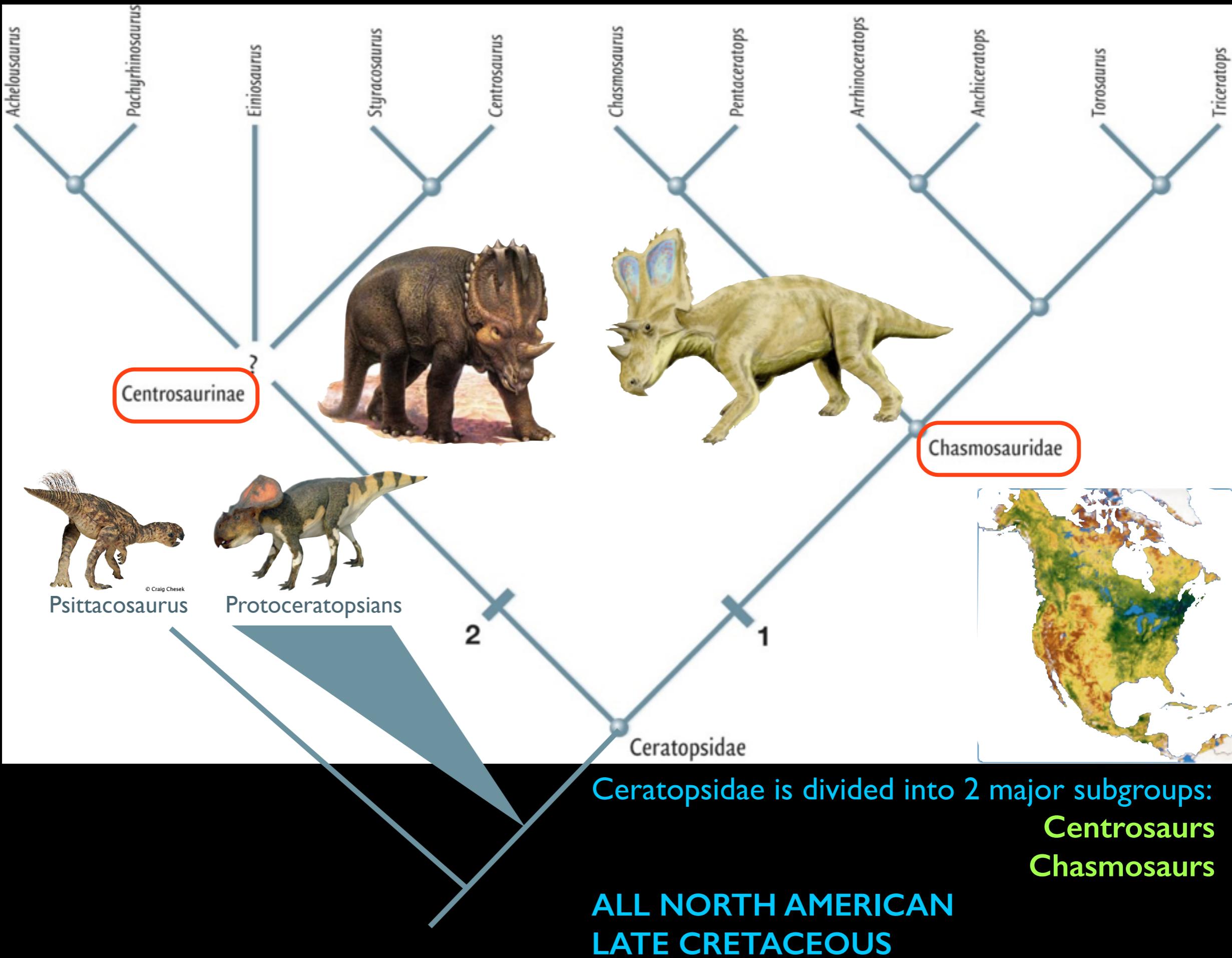
B



C



D



Centrosaurs (short-frilled)

Long nasal horns

Hooks and processes on the parietal frill (sometimes SPIKES!)

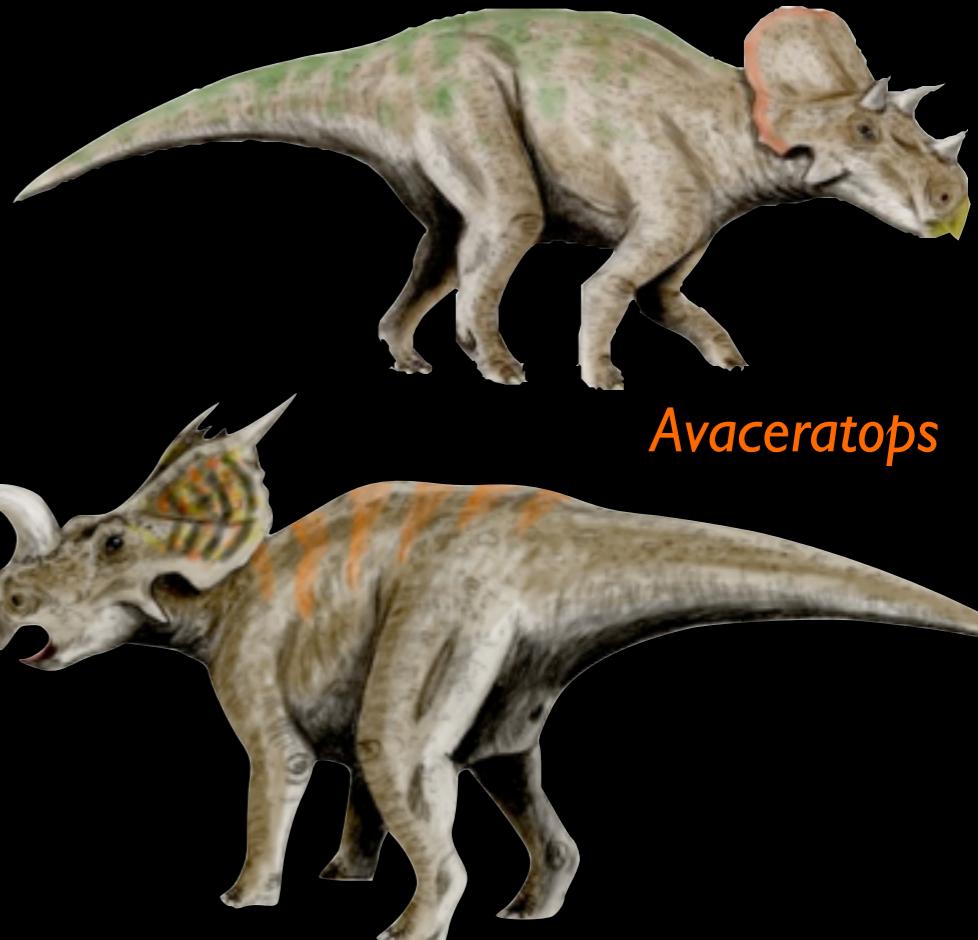
Some (*Pachyrhinosaurus*) had pitted/grooved pads



Centrosaurus



Achelousaurus

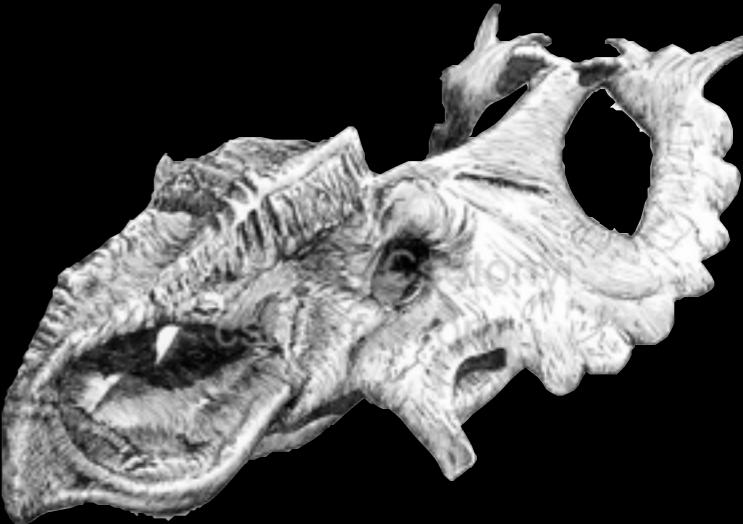


Einiosaurus

Avaceratops

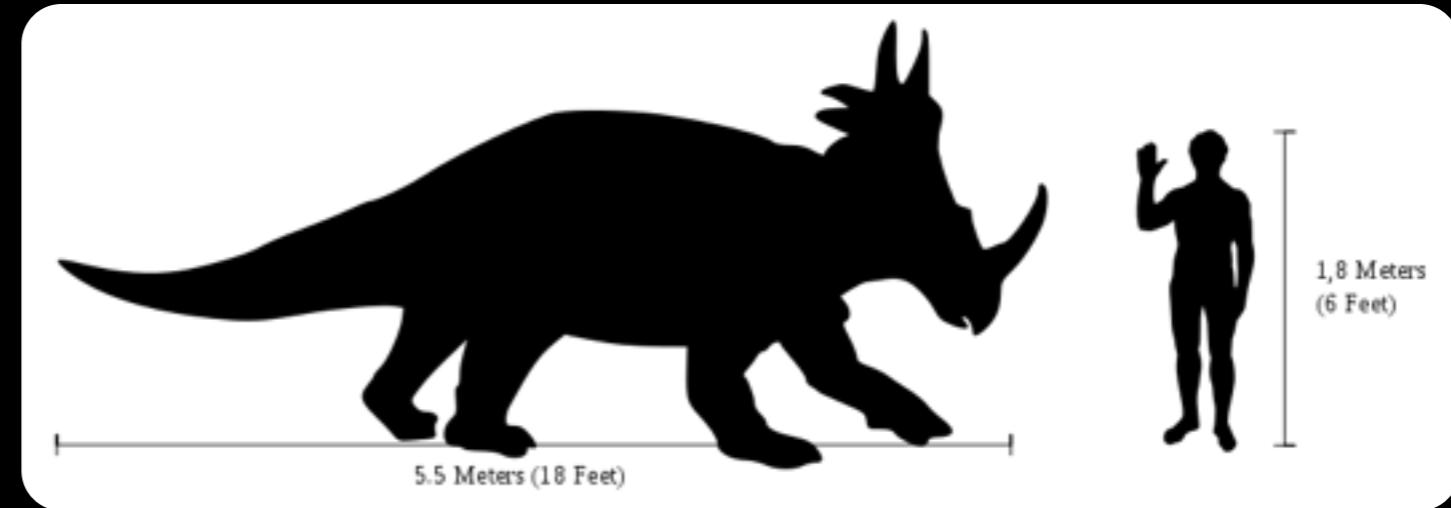
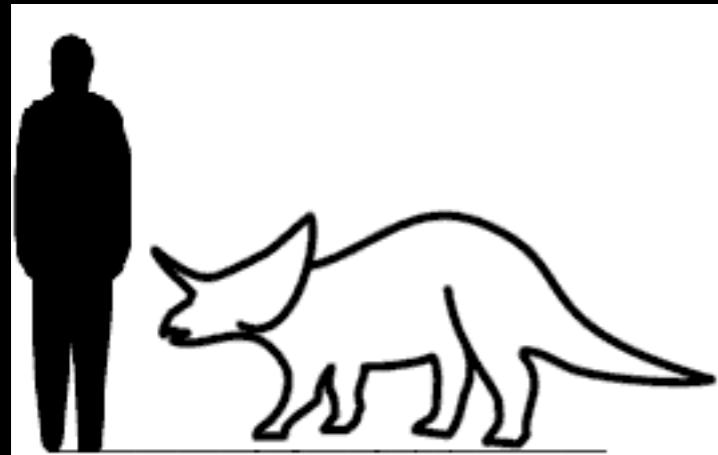


Styracosaurus



Pachyrhinosaurus

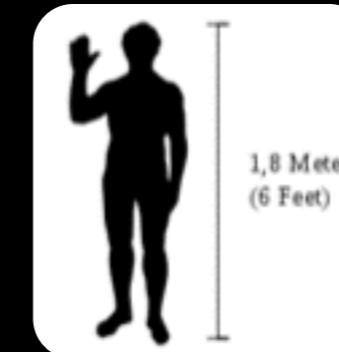
Centrosaurs



Avaceratops



Styracosaurus

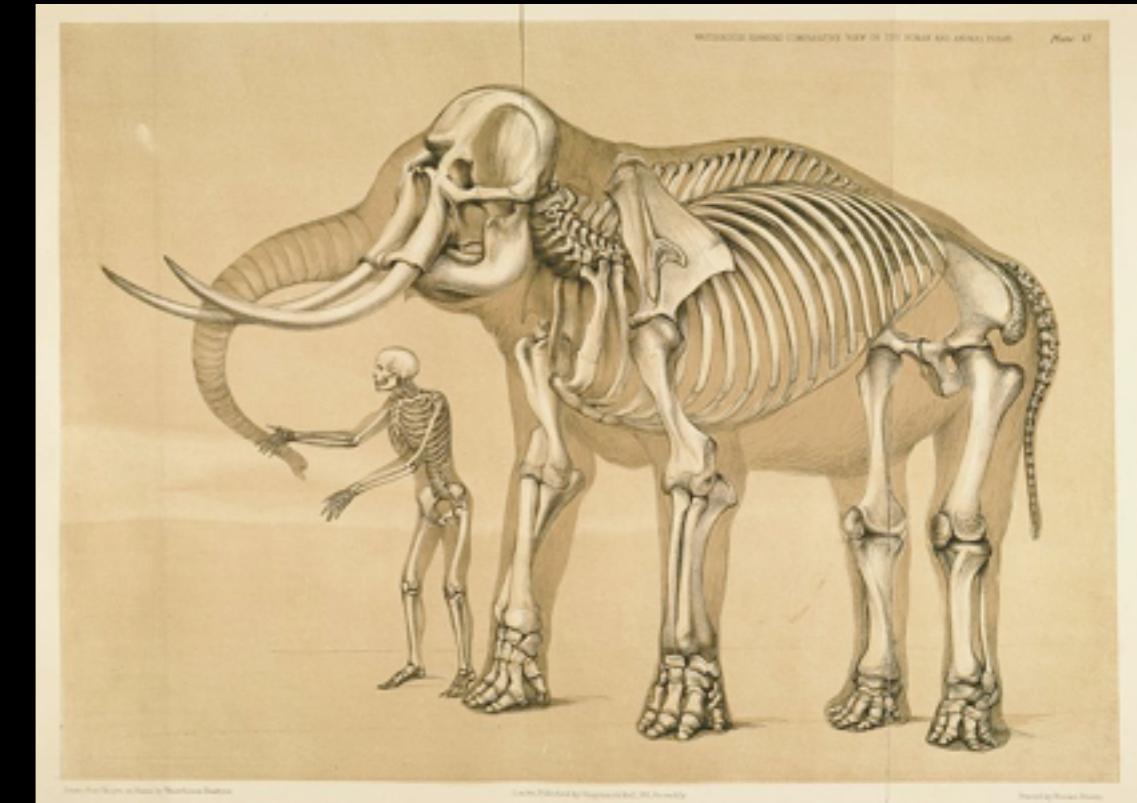


Centrosaurus

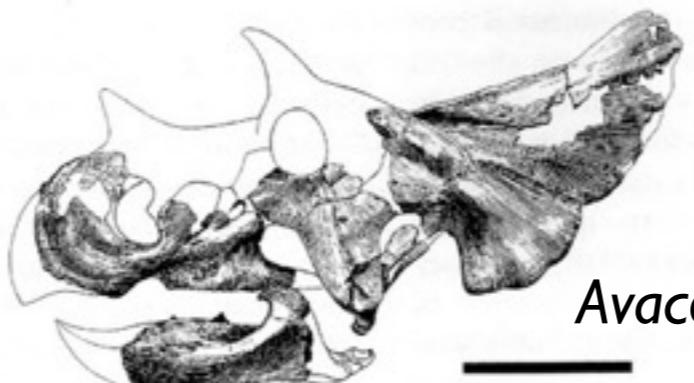
↔ 6 m



Achelousaurus

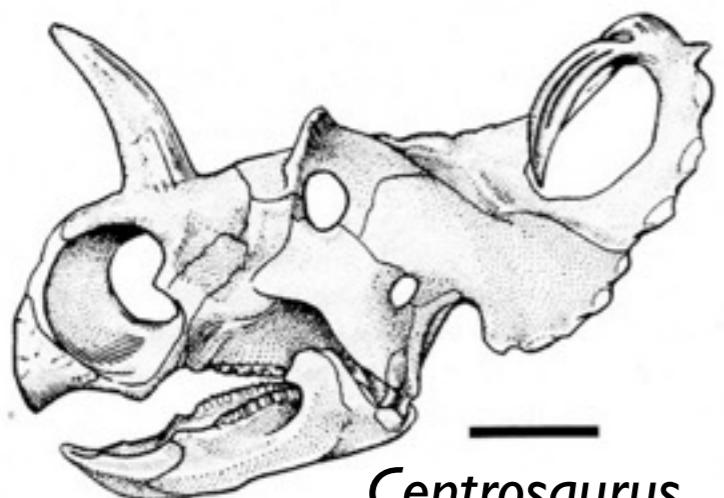


Centrosaurs



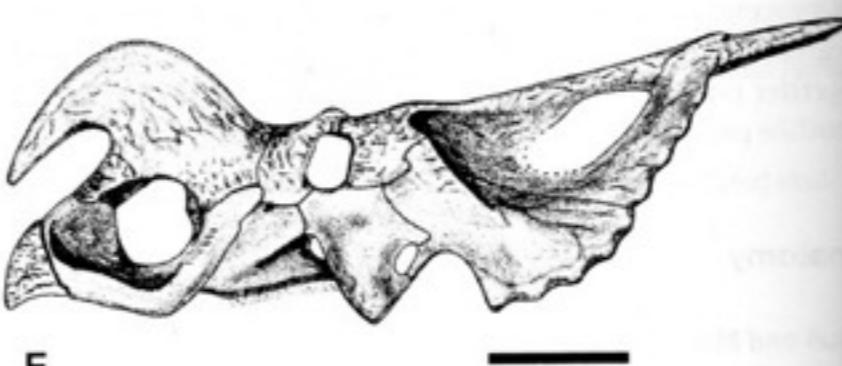
Avaceratops

A



Centrosaurus

B



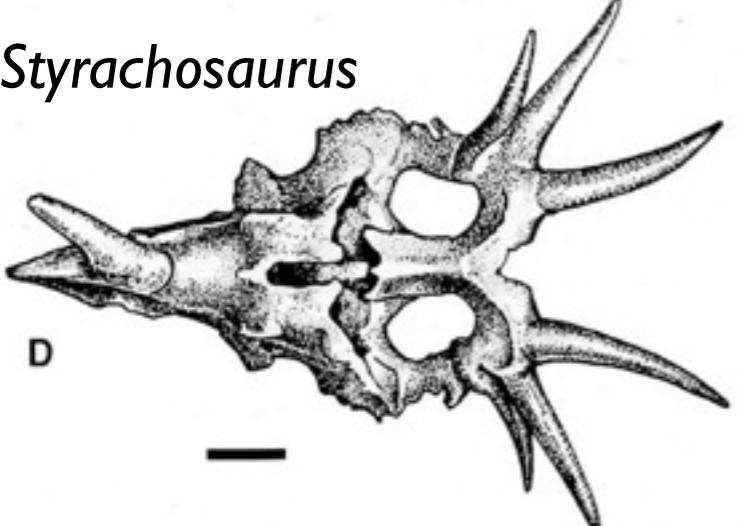
E

Einiosaurus

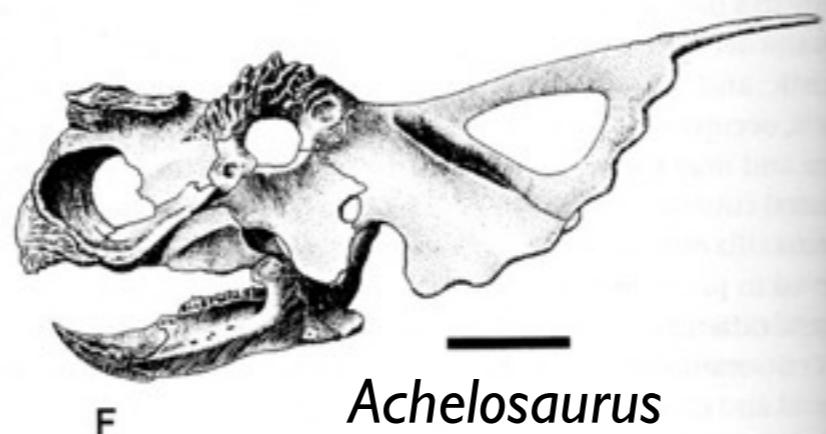


C

Styrachosaurus

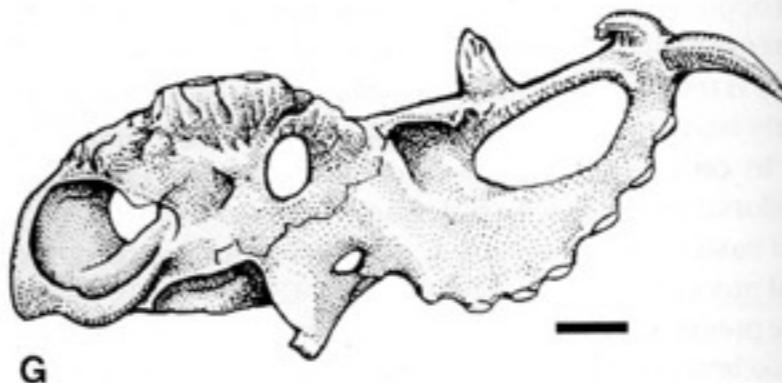


D



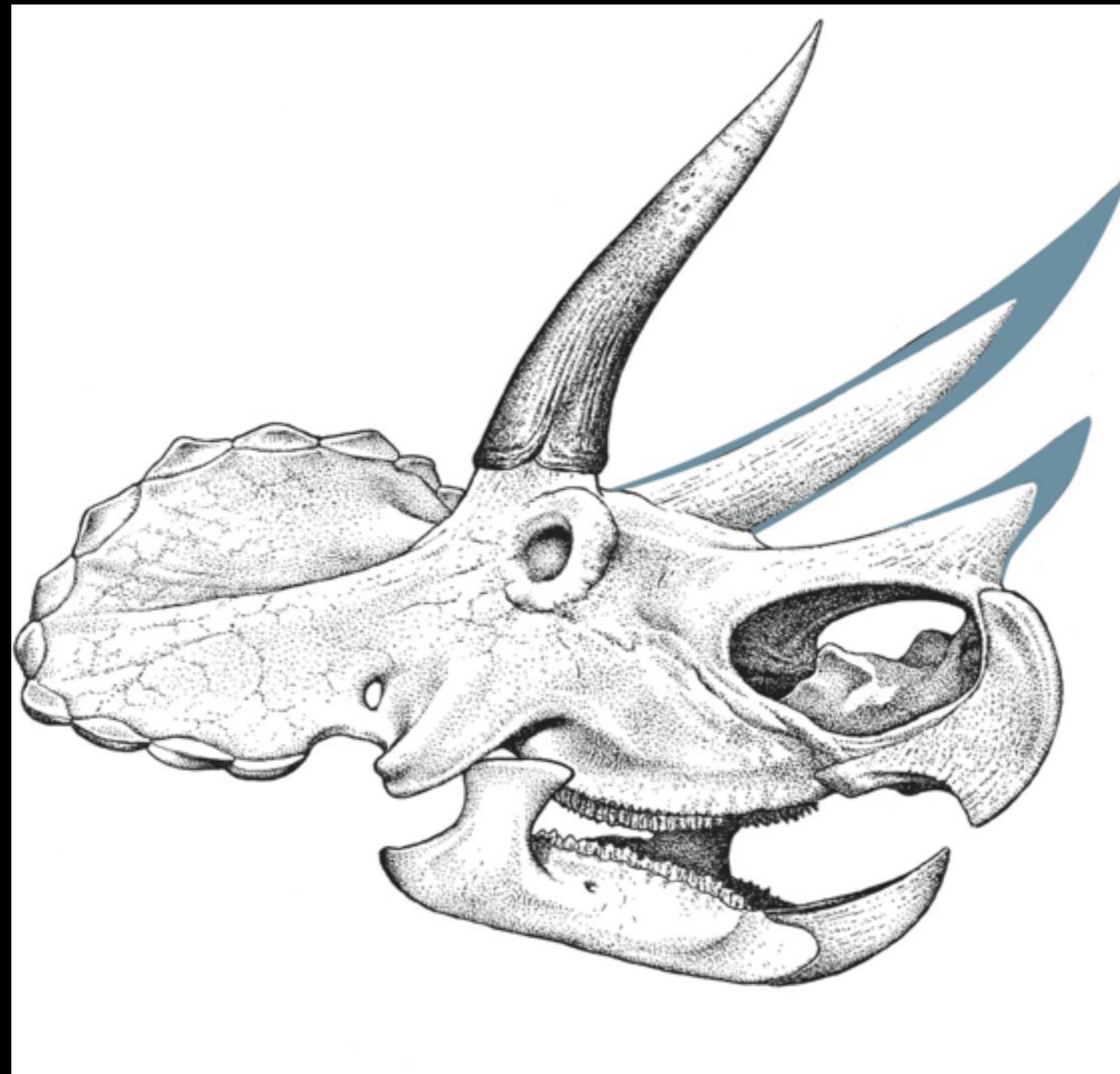
F

Achelosaurus

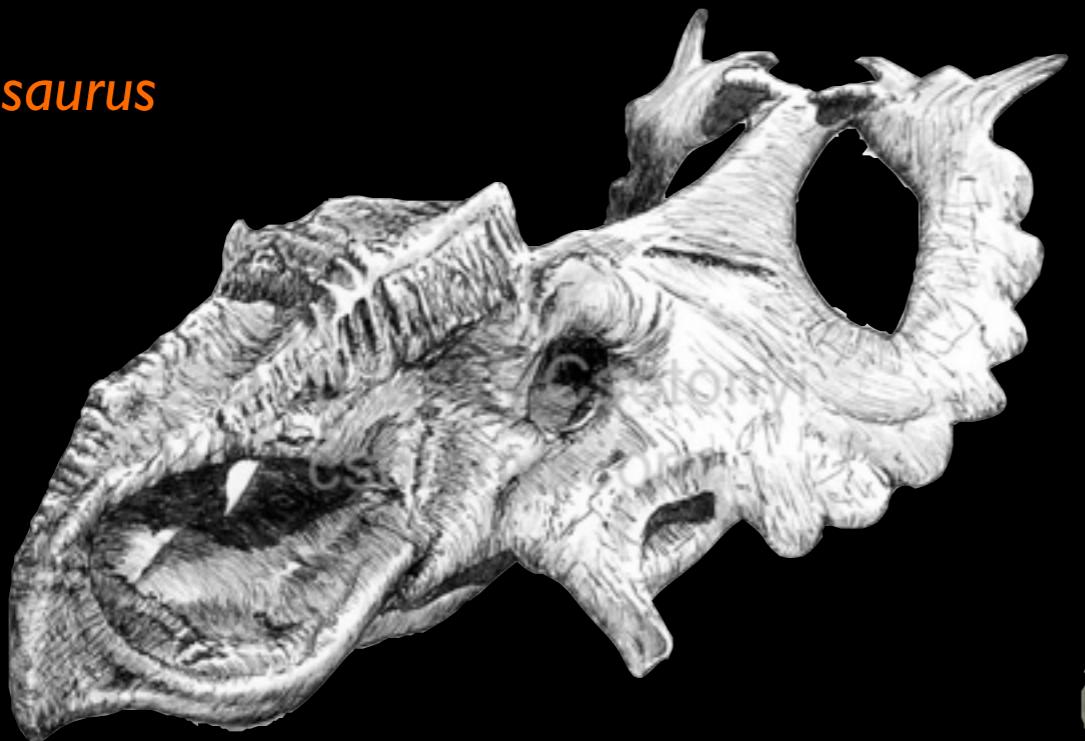


G

Pachyrhinosaurus



Pachyrhinosaurus



Boney pads

Pitted and grooved surface

Potentially an attachment site for a keratinous horn?



Some nasal horns had alternate uses



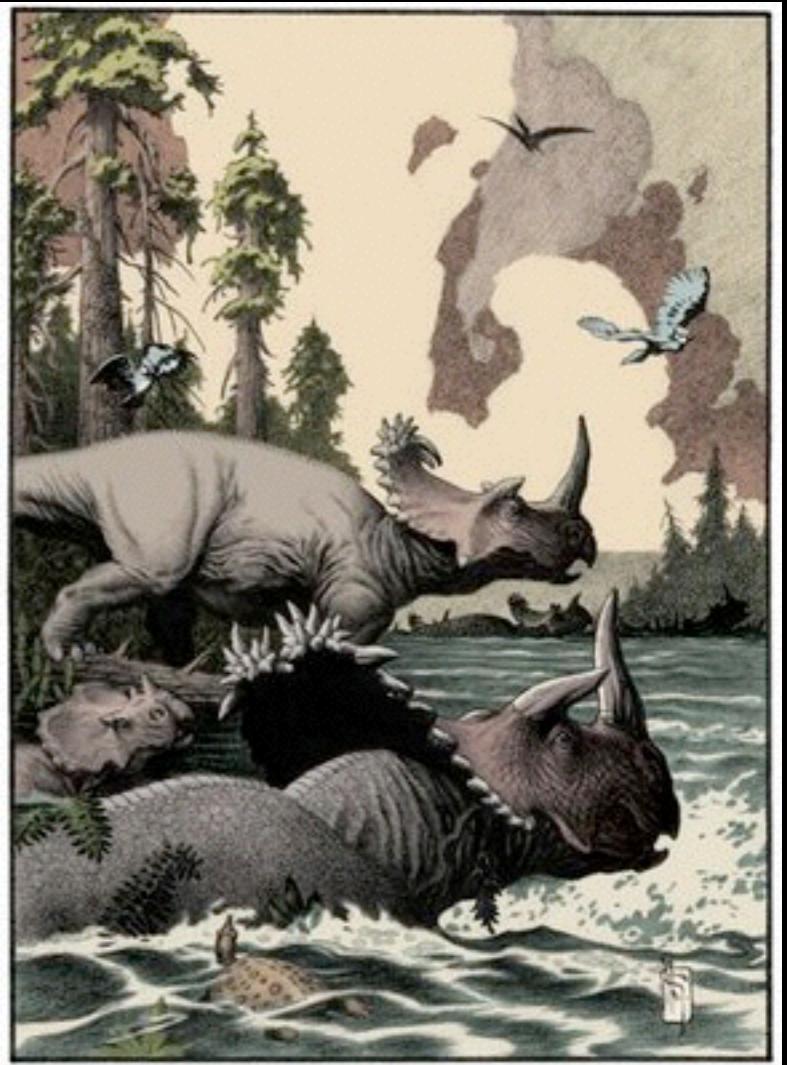
Einiosaurus

Some nasal horns had alternate uses



Einiosaurus

Centrosaurs: Bone Beds



Monotypic: Single species

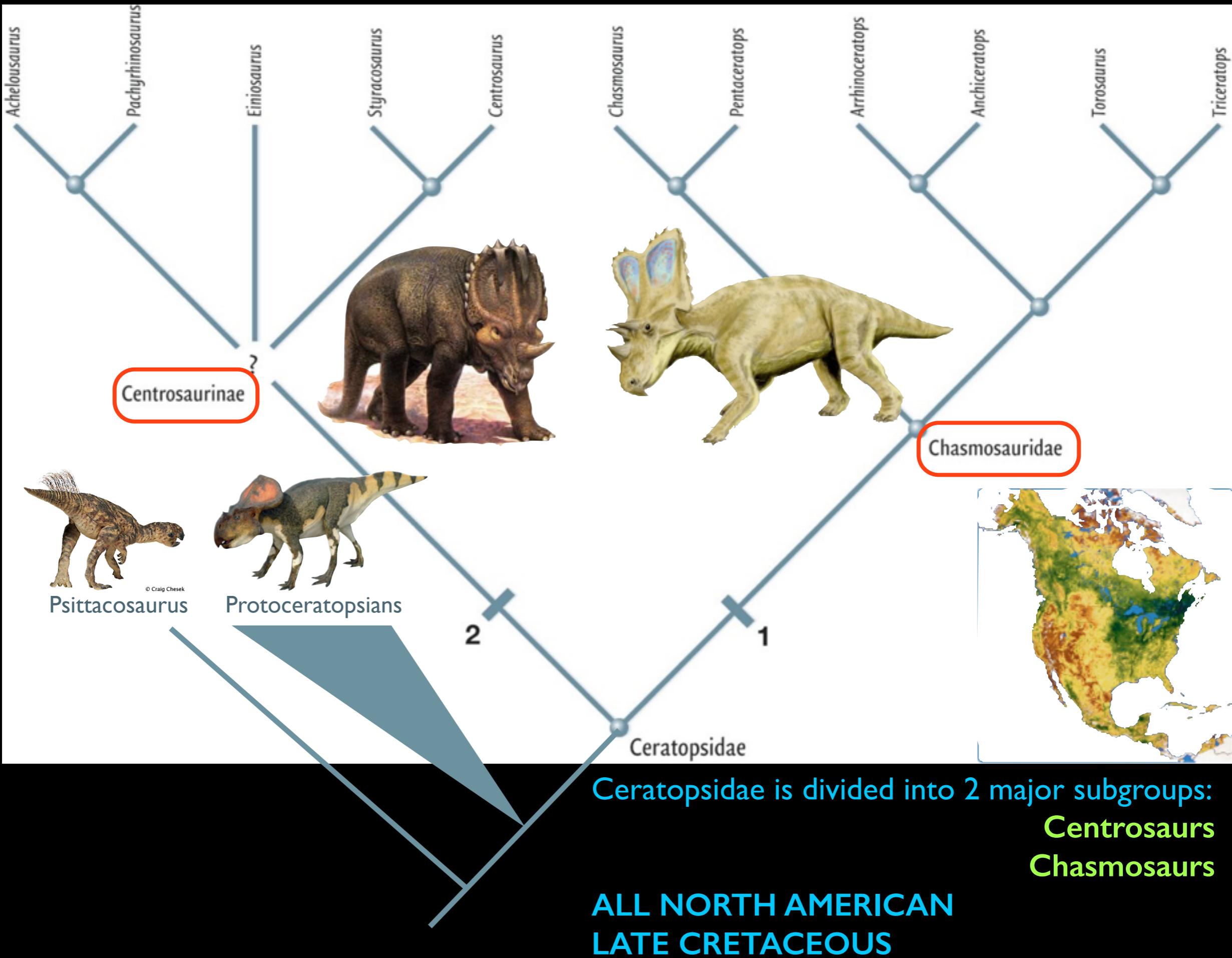
Herding behavior or mass grouping

Did they nest? Less well known...

But: Juveniles, subadults, adults aggregated in bonebeds

Implies family units, herds





Chasmosaurs (long-frilled)

Long orbital horns

Short nasal horns

Complex sinus cavities in skull

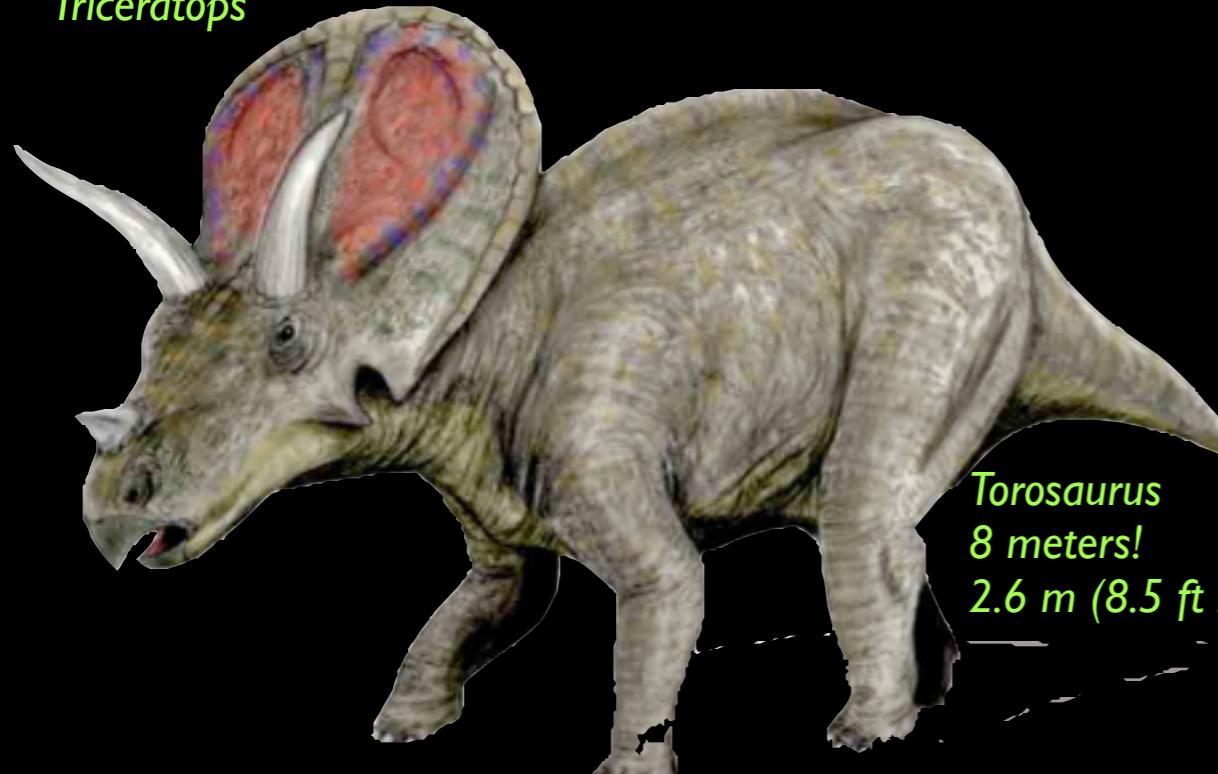
Not found in Bone Beds



Triceratops



Pentaceratops



Torosaurus
8 meters!
2.6 m (8.5 ft long skull)

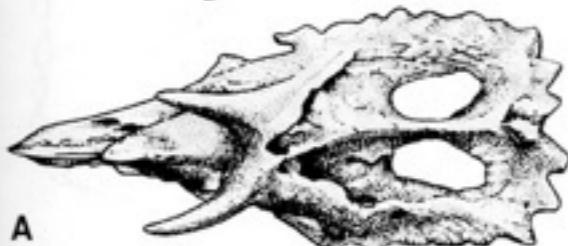


Arrhinoceratops

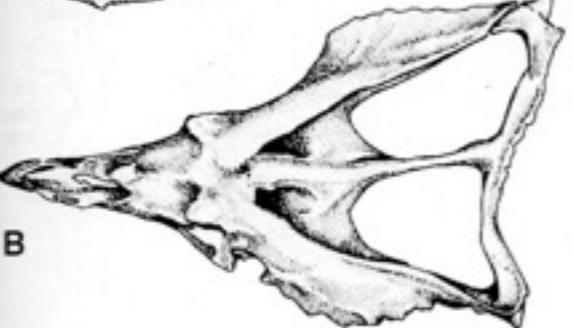


Chasmosaurus
Kind of a badass

Chasmosaurs



A Anchiceratops



B Chasmosaurus



C Chasmosaurus



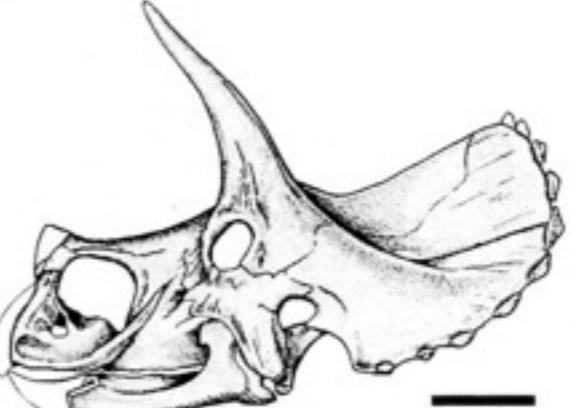
D Chasmosaurus



E Arrhinoceratops



F Torosaurus



G Triceratops

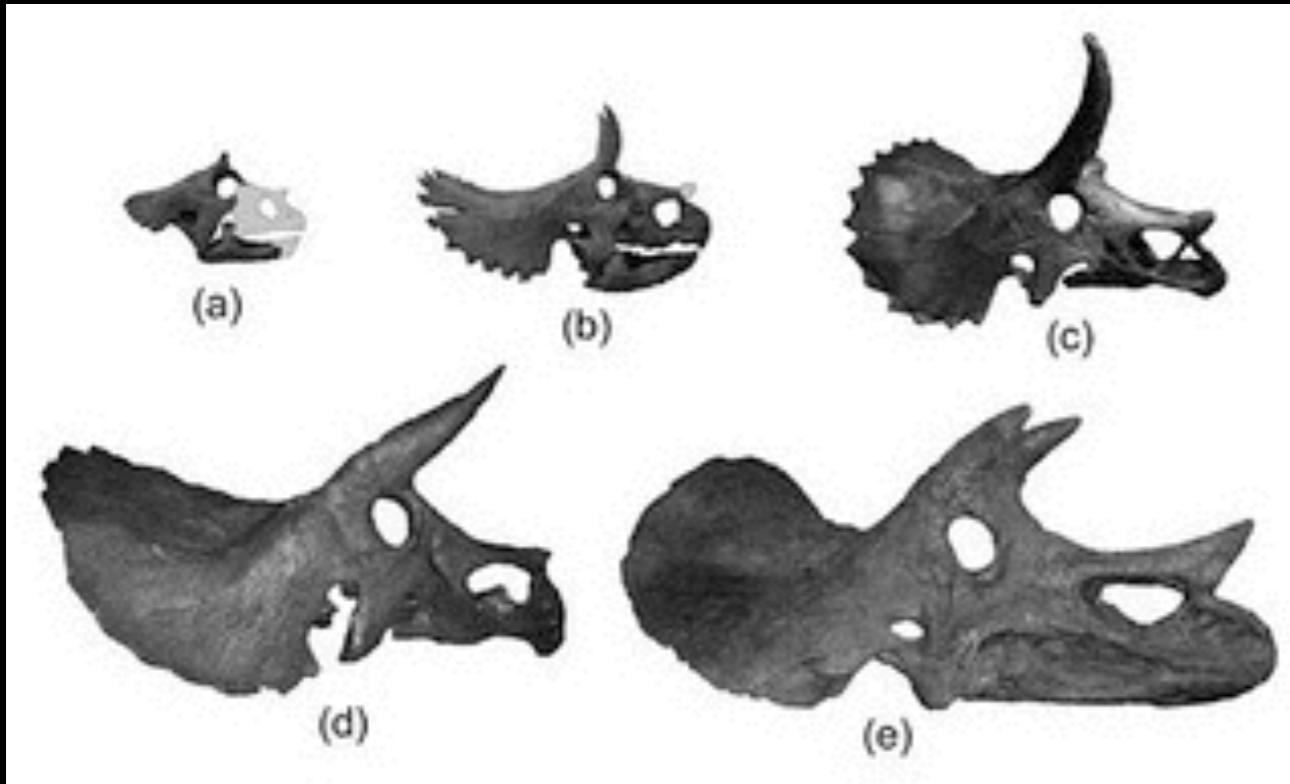


H Triceratops

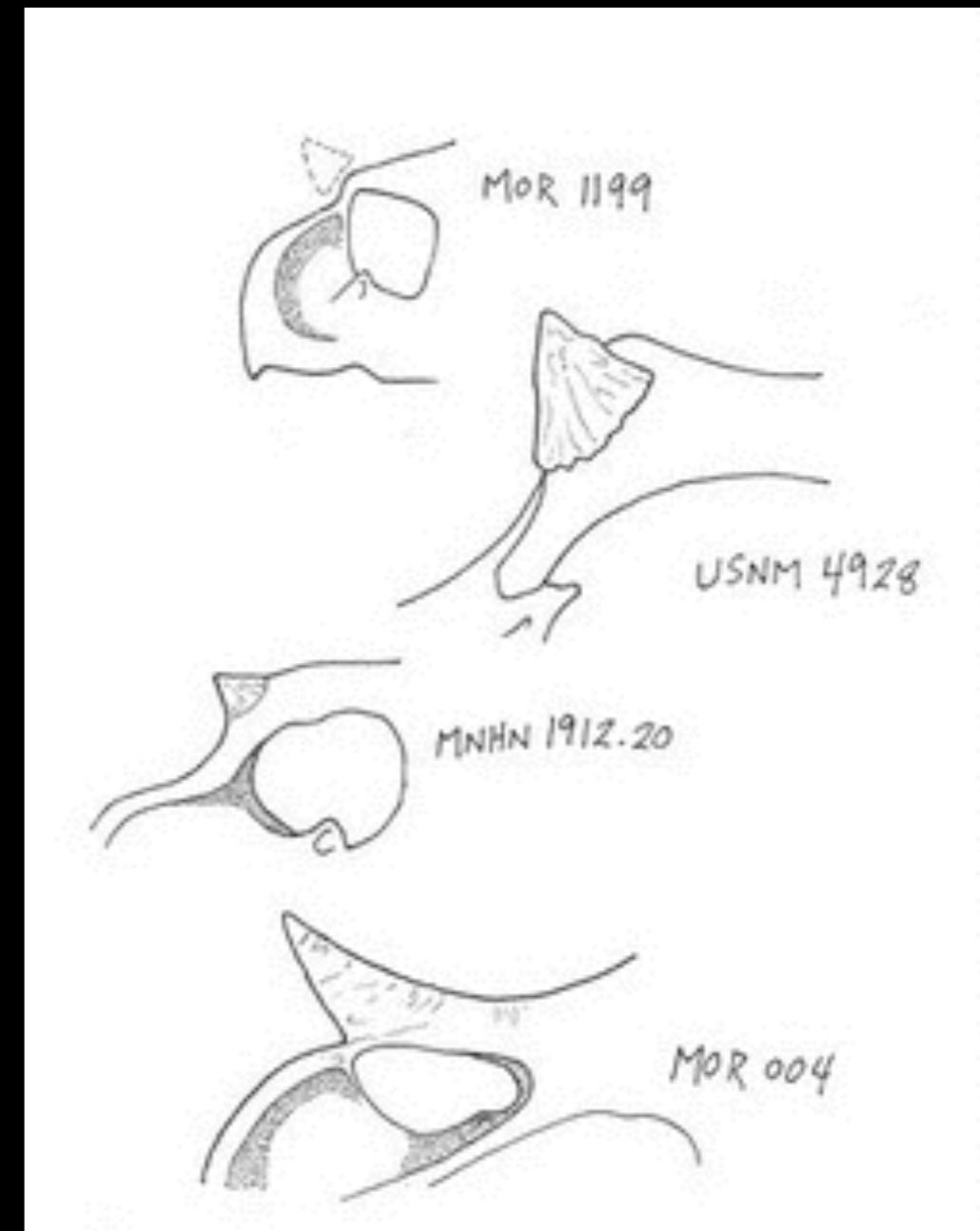


I Pentaceratops

Chasmosaurs: babies all look the same



Triceratops horn growth stages





Sexual dimorphism?
Late frill development

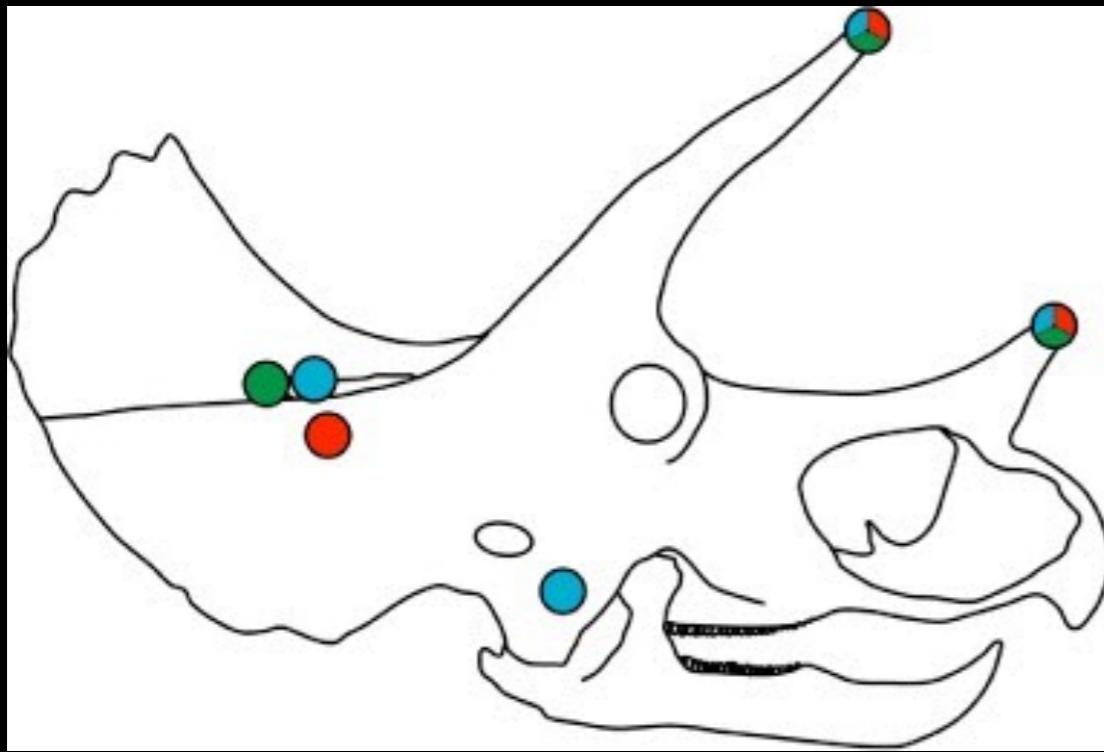
Horns and Frills: Defense or competition?



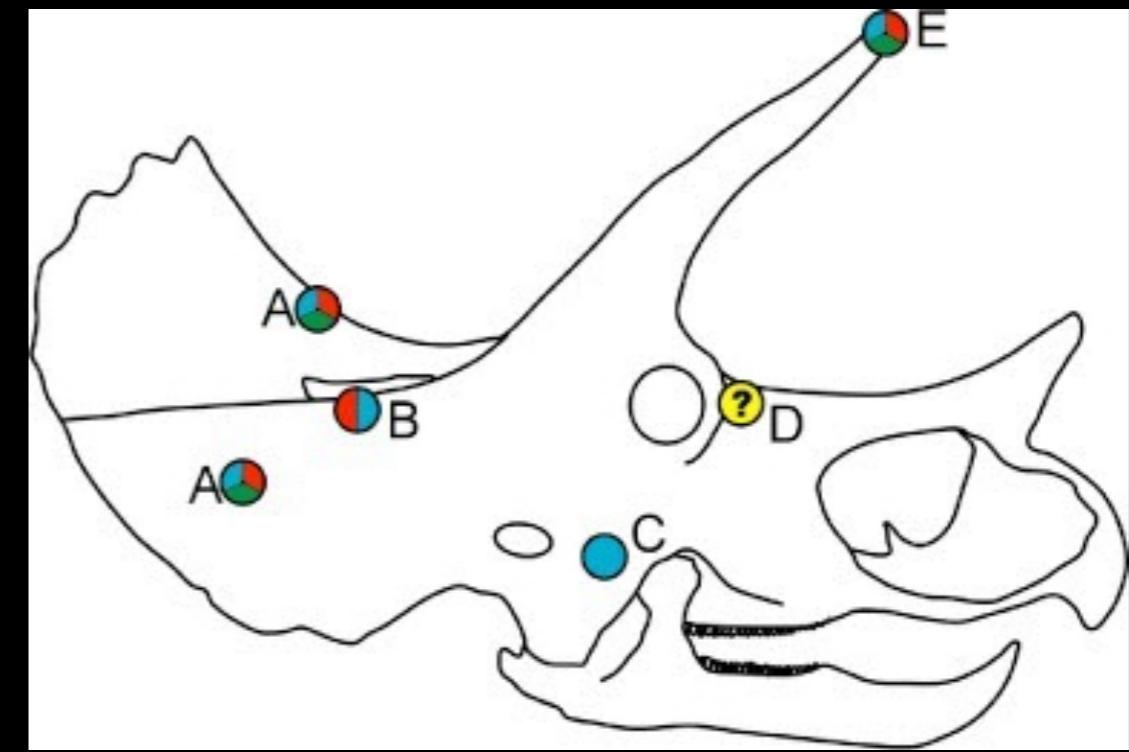
All Ceratopsians have: long horns, short horns or thickened pads of bone near nares or orbitals
Frill: Very thin- not adequate defense; indications of high vasculature

This suggests head to head sparing among males and display
Display: to females, to other males, and to distinguish among species

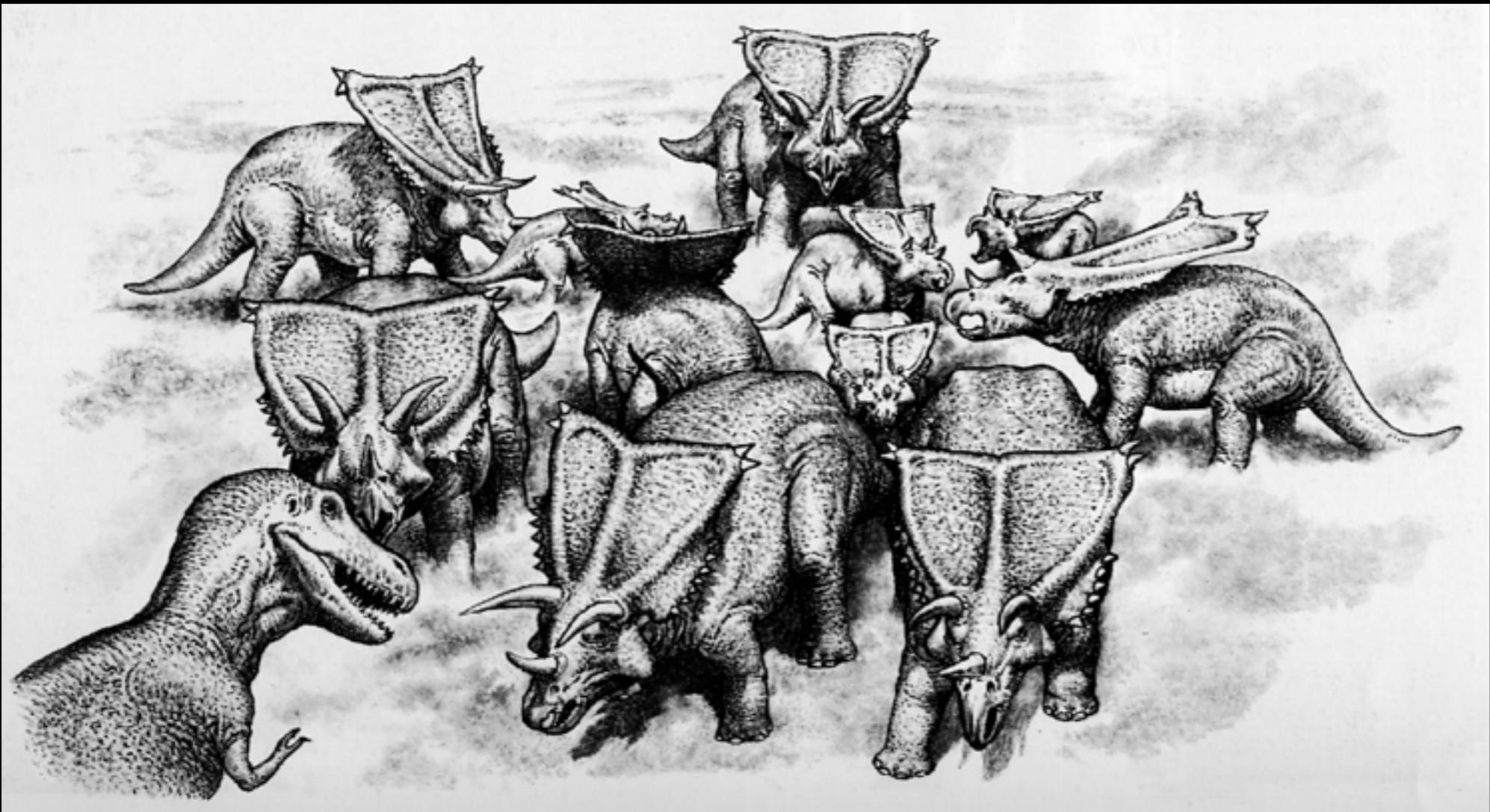
BUT: also defense... similar to antelope horns (remember the Oryx)



Where you predict to find damage if they
were horn-locking



Where you find damage





Avaceratops lammersi
Campanian, Montana



Albertaceratops nesmoi
Campanian, Alberta & Montana



Centrosaurus apertus
Campanian, Alberta



Brachyceratops montanensis
Campanian, Montana



Styracosaurus albertensis
Campanian, Alberta



Einiosaurus procurvicornis
Campanian, Montana



Pachyrhinosaurus canadensis
Maastrichtian, Alberta, Alaska



Achelosaurus horneri
Campanian, Montana

1 m

