

Notes and Observations on Specimens of *Torosaurus* at the Yale Peabody Museum of Natural History

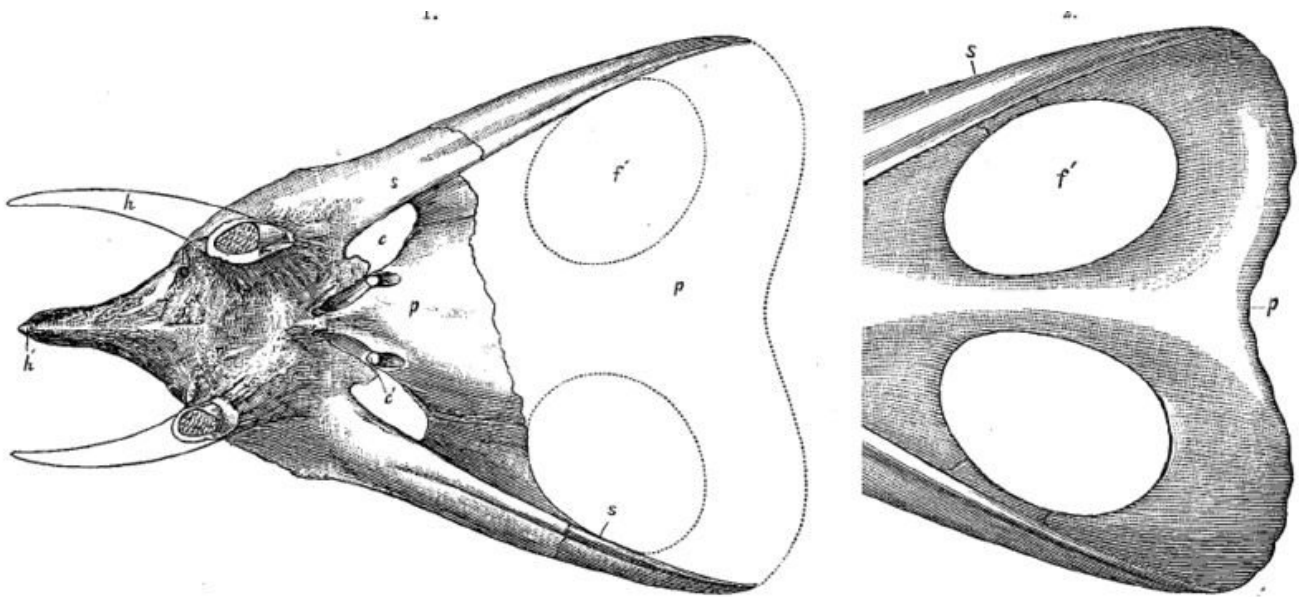


Image after Marsh

Andrew A. Farke, Ph.D.
Raymond M. Alf Museum of Paleontology
1175 West Baseline Road
Claremont, CA 91711

email: afarke@webb.org

Introduction and Overview

Torosaurus – the “pierced lizard” – has been the target of several investigations at the dawn of the 21st century (see key citations below for a few of the relevant papers as well as some important previous descriptions of *Torosaurus*). The holotype specimens for *Torosaurus latus* (YPM 1830) and its junior synonym *Torosaurus gladius* (YPM 1831) are both housed at the Yale Peabody Museum of Natural History (YPM) in New Haven, Connecticut, USA, and have been integral to many discussions about this animal.

In March 2000, I spent several days at the YPM taking detailed notes on the Yale specimens. This file contains scans of the original notes, which I am releasing as a service to the community. My hope is that the data will be of at least some use to others interested in these enigmatic horned dinosaurs, as well as an encouragement for other paleontologists to distribute their own museum notes.

Disclaimer

The sketches, measurements, and notes are all my personal work and interpretations. These data are thus presented “as is”, and users should be appropriately cautious when relying upon my notes for their own research. Although I strive to be accurate, inadvertent mistakes or inaccuracies are possible. In the end, there is no substitute for personal examination of a specimen in order to answer some questions.

Acknowledgments

Thank you to Mary Ann Turner (YPM) for facilitating access to the specimens, and to Museum of the Rockies for support of the original research trip.

Key Citations

- Colbert EH, Bump JD (1947) A skull of *Torosaurus* from South Dakota and a revision of the genus. Proc Acad Nat Sci Phila 99: 93–106.
- Farke AA (2006) Cranial osteology and phylogenetic relationships of the chamosaurine ceratopsid, *Torosaurus latus*. In: Carpenter K, editor. Horns and Beaks: Ceratopsian and Ornithopod Dinosaurs. Bloomington: Indiana University Press. pp. 235–257.
- Farke AA (2011) Anatomy and taxonomic status of the chamosaurine ceratopsid *Nedoceratops hatcheri* from the Upper Cretaceous Lance Formation of Wyoming, U.S.A. PLoS ONE 6: e16196.
- Hatcher JB, Marsh OC, Lull RS (1907) The Ceratopsia. US Geol Surv Monogr 49: 1–300.
- Longrich NR, Field DJ (2012) *Torosaurus* is not *Triceratops*: ontogeny in chamosaurine ceratopsids as a case study in dinosaur taxonomy. PLoS ONE 7(2): e32623.
- Lull RS (1933) A revision of the Ceratopsia or horned dinosaurs. Yale Peabody Mus Memoir 3: 1–175.
- Marsh OC (1891) Notice of new vertebrate fossils. American Journal of Science, Series 3 42: 265–269.
- Scannella J, Horner JR (2010) *Torosaurus* Marsh, 1891 is *Triceratops*, Marsh, 1889 (Ceratopsidae: Chamosaurinae): synonymy through ontogeny. Journal of Vertebrate Paleontology 30: 1157–1168.
- Scannella JB, Horner JR (2011) ‘*Nedoceratops*’: an example of a transitional morphology. PLoS ONE 6: e28705.

How to Cite This

Some aspects of these notes were incorporated into a previous publication (Farke, 2006), and you may wish to cite that if the data were included there. Otherwise, I do request that you cite these notes through reference to the appropriate page on figshare.com, or another appropriate link if figshare.com is not available at some point in the future.

License:



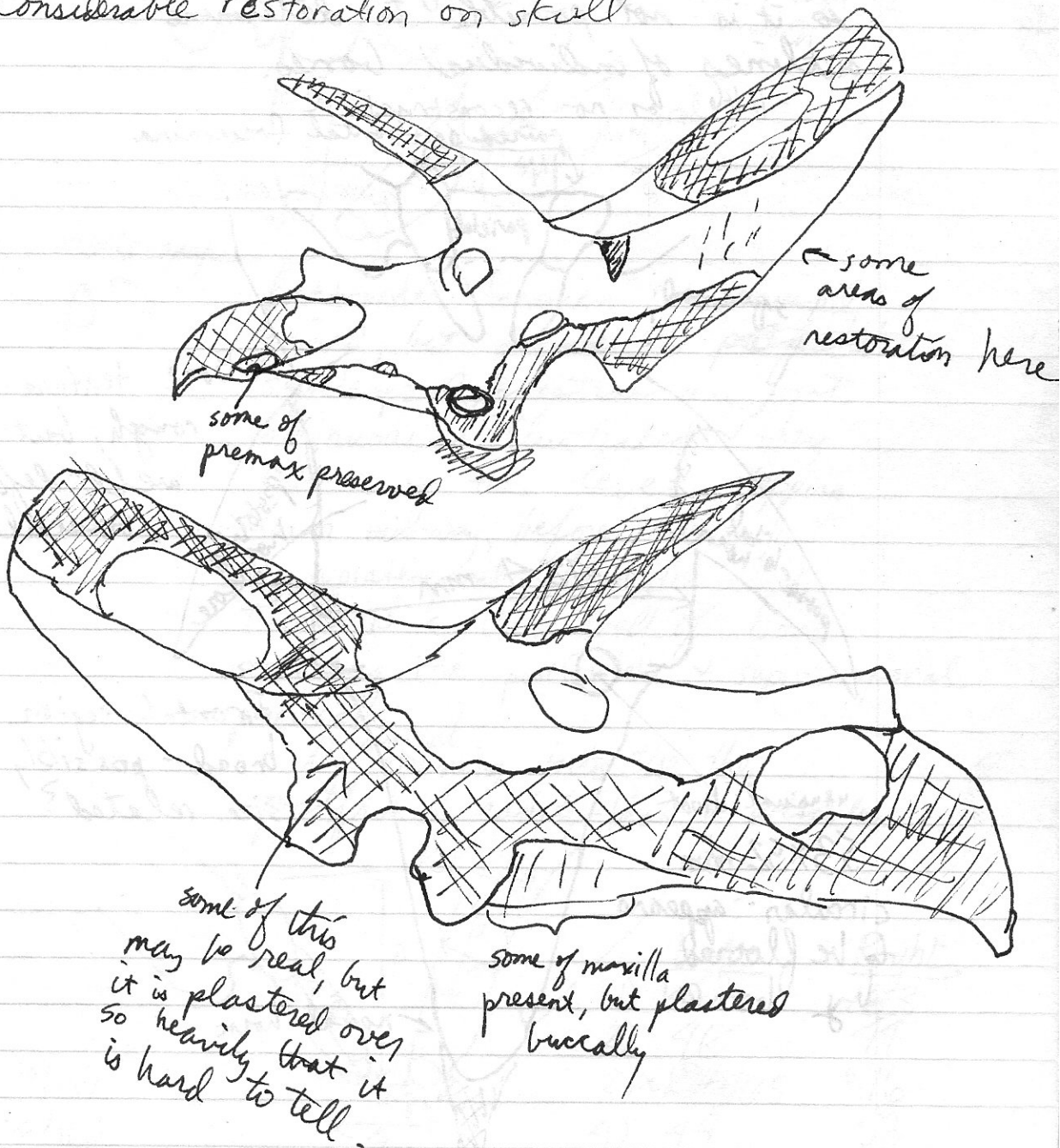
This work is licensed under the Creative Commons Attribution 3.0 Unported License. To view a copy of this license, visit <http://creativecommons.org/licenses/by/3.0/> or send a letter to Creative Commons, 444 Castro Street, Suite 900, Mountain View, California, 94041, USA.

This version of the document was assembled and uploaded on March 2, 2012

7 March 2000

YPM 1830 - Torosaurus latus holotype

Considerable restoration on skull

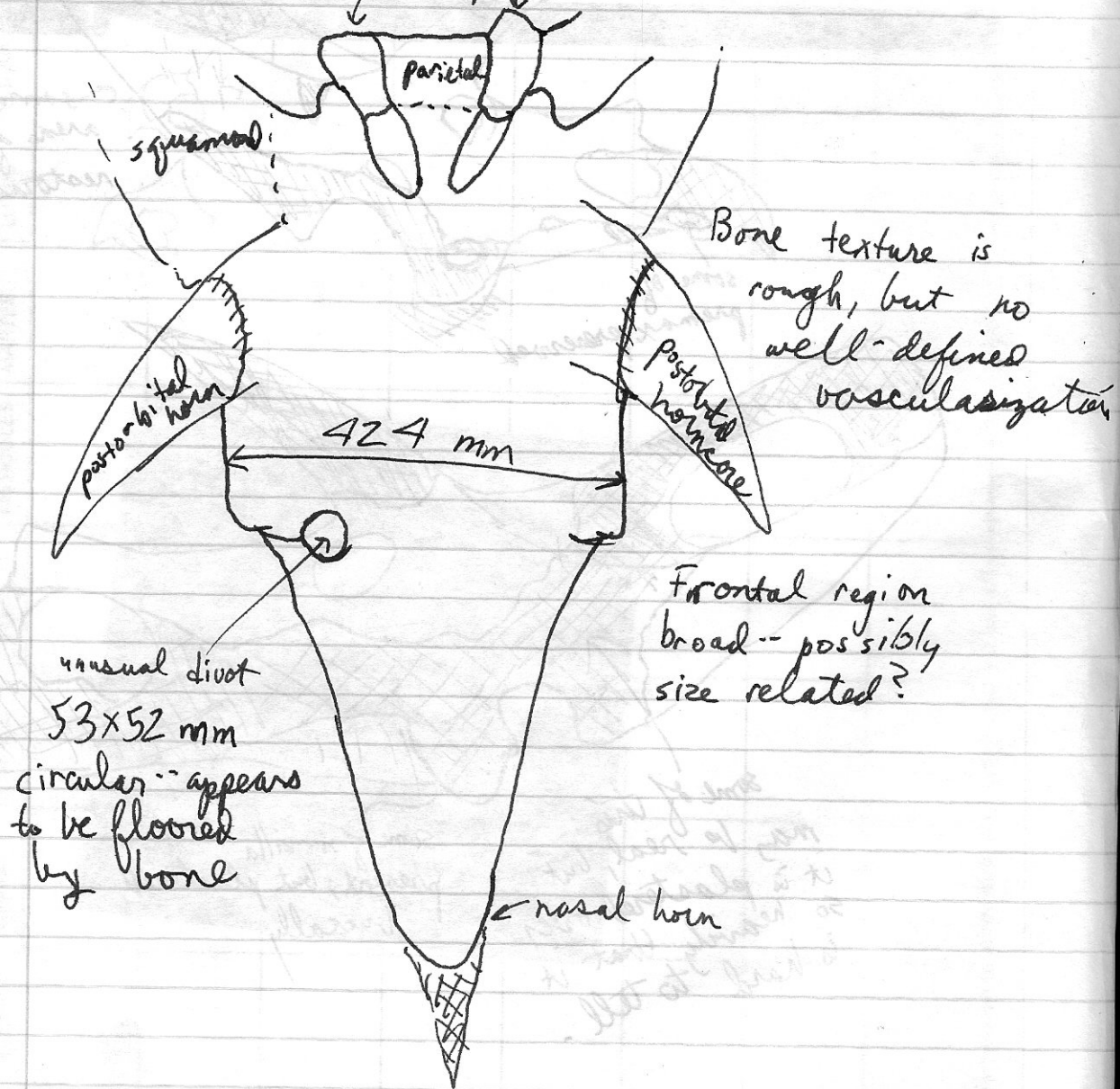


YPM 1830

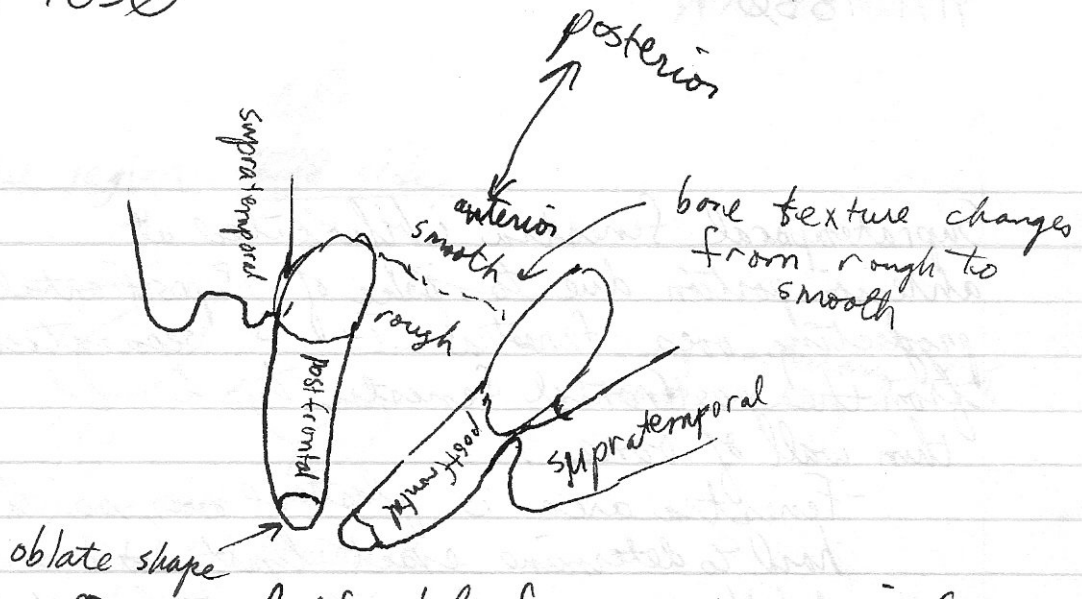
Frontal Region

- well-preserved, but fused,
so it is not possible to determine
outlines of individual bones.

- little or no reconstruction
paired postfrontal foramina



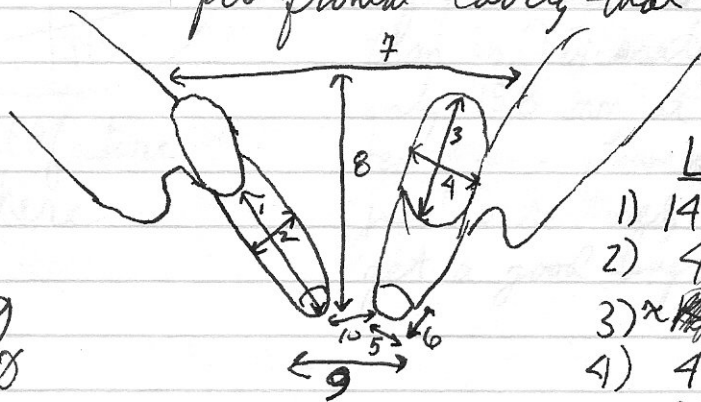
YPM 1830



postfrontal foramen is generally paired, but grooves to ~~postfrontal~~ supratemporal fenestrae are not continuous as illustrated -- they occur on two levels, stepping down mid-way, before connecting to supratemporal fenestra.

There is a thin wall of bone separating the postfrontal & supratemporal fenestrae.

No ^{central} opening into the the postfrontal cavity that is visible



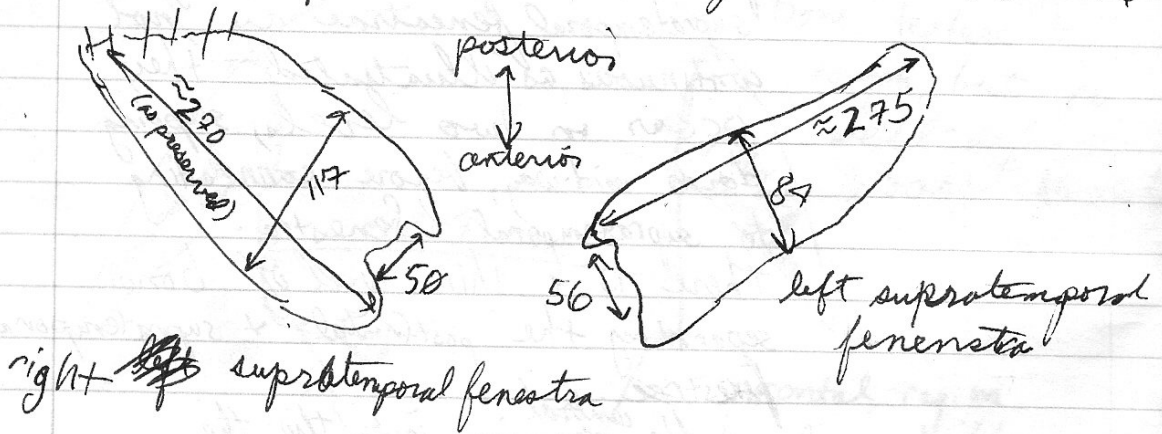
- 7) ≈ 159
- 8) ≈ 260
- 9) 80
- 10) 31

	Left	Right
1)	146	163
2)	40	44
3)	105 105	≈ 76
4)	44	53
5)	23	21
6)	30	27

YPM 1830

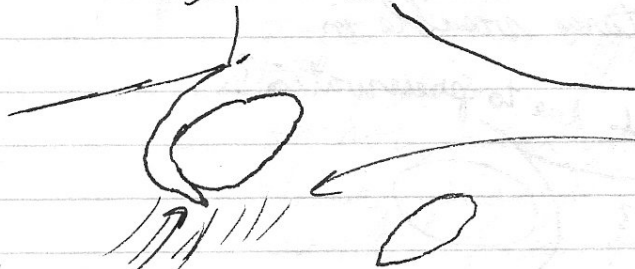
Supratemporal fenestra is bifurcated at anterior portion due to piece of ? postfrontal projecting over fenestra. It is separated from the postfrontal fenestra by a thin wall of bone.

- Fenestra area is plastered over, so it's hard to determine exact limits or depths; appears to grade smoothly onto the parietal -- exact length not determinable



VPM 1830

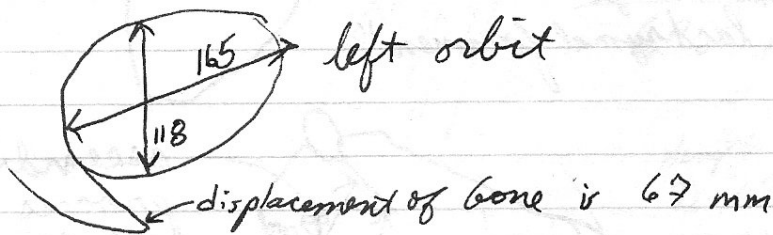
Orbital region ~~Left~~ ^{Left} side



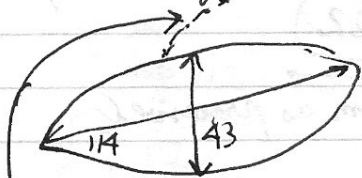
some vascularization,
unbranching

some displacement
of preorbital? crushing?

orbit is elongated ~~posterior~~ on its horizontal axis --
possibly due to crushing?



Left infratemporal fenestra

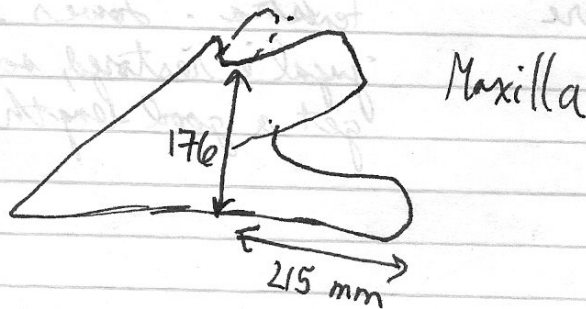
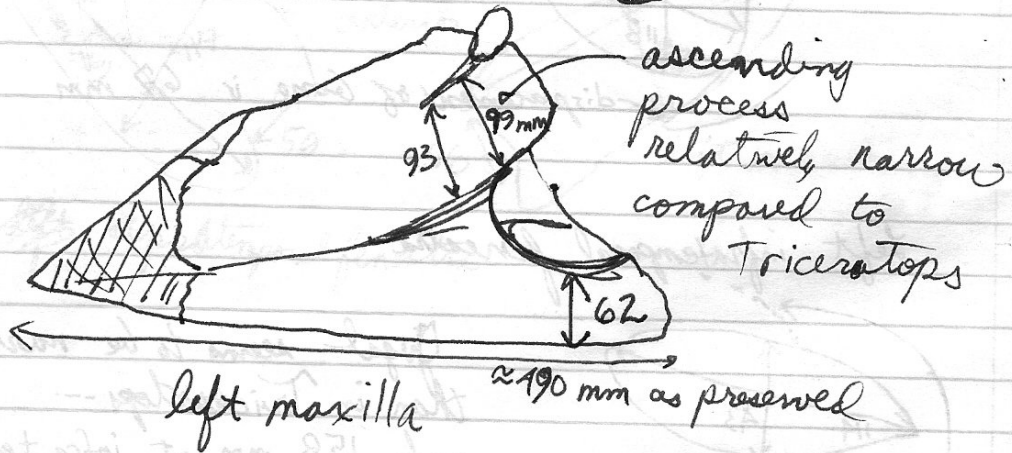
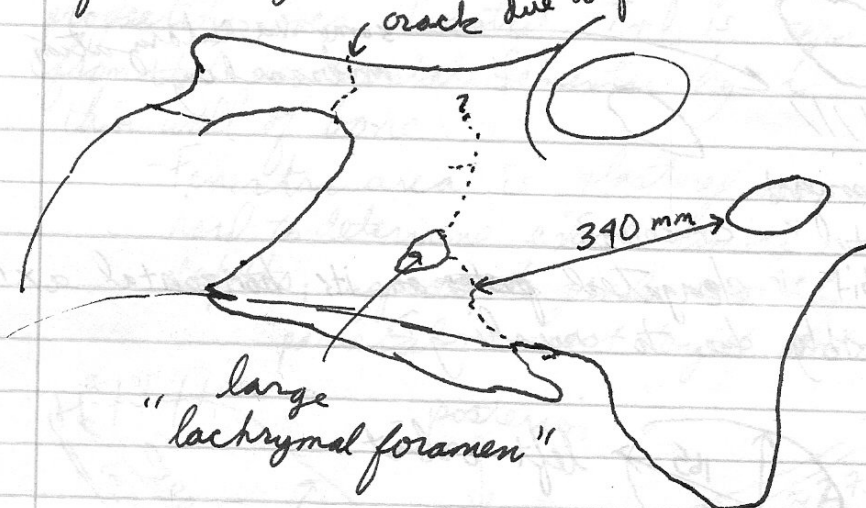


slight bit of suture
visible here

Jugal seems to be narrower
than in *Triceratops* ---
only 158 mm at infratemporal
fenestra. Lower end of
jugal is restored, so I cannot
get a good length measurement

YPM 1830

Some possible sutures visible in facial region



YPM 1830

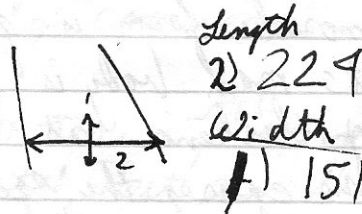
Left orbital horn

most broken off, but base still exists. Very elongated on horizontal axis
- base placed behind the center of the orbit

lateral surface flat --
medial surface concave

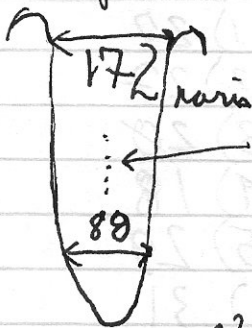


Basal Circumference
620 mm

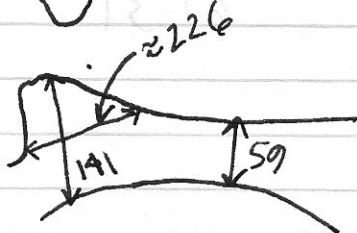


Nasals

Very similar to Triceratops
top view



slight ridge along midline extends back 190 mm from apex of nasal horn



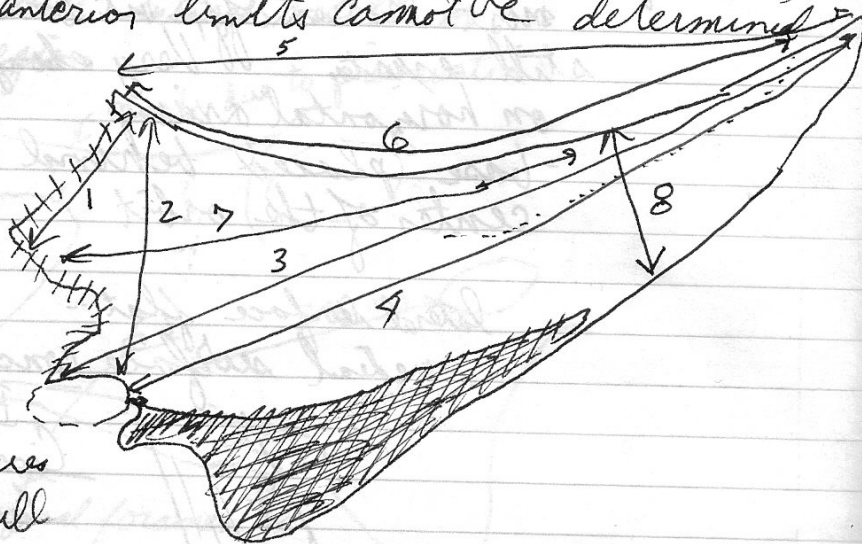
Nasal horn is short, low and directed forward
- some of suture visible on underside as faint groove

KYPM 1830

Left Squamosal

- exact anterior limits cannot be determined

- *1) 264
- *2) 329
- 3) 1,309
- 4) 1,243
- *5) 1,100
- *6) 1,176
- *7) 1,278

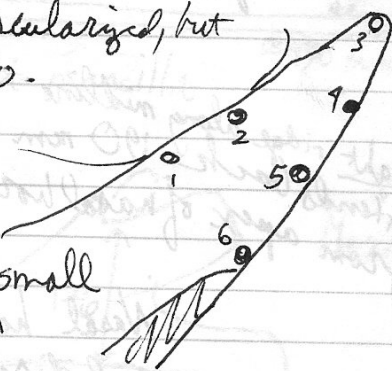


* estimates; exact measures obscured due to skull fusion

Squamosals form is quite elongate.

It's main body is flat, except it curves up & thickens at the contact with the parietal. This causes the squamosal form to be "trough shaped" (concave); much more than in Chasmosaurus.

Surface is vascularized, but not heavily so.

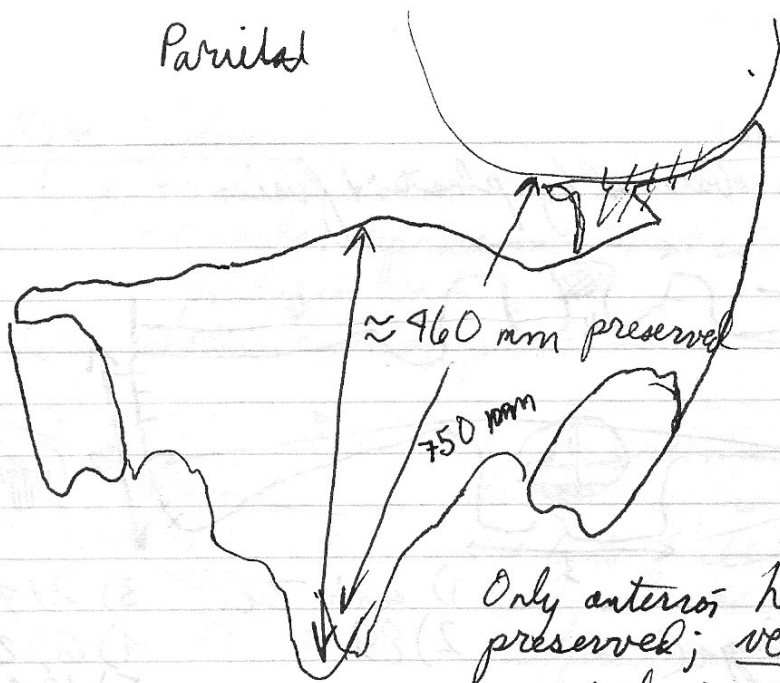


- Thickness
- 1) 27
 - 2) 27
 - 3) 20
 - 4) 18
 - 5) 29
 - 6) 31

Underside is flat, only slightly convex, with small dish-shaped depression at anterior end

YPM 1830

Parietal



Only anterior half is preserved; very lightly vascularized

Medially, no bumps are present; overall form is smooth, broad, & convex.

Part of left ^{anterior} parietal fenestra is ~~not~~ preserved
~~Thickness~~ ~~in~~ ~~the~~ scratch-test revealed it to be plaster! (or else plastered over)
Underside, where not plastered over, has no visible texture.

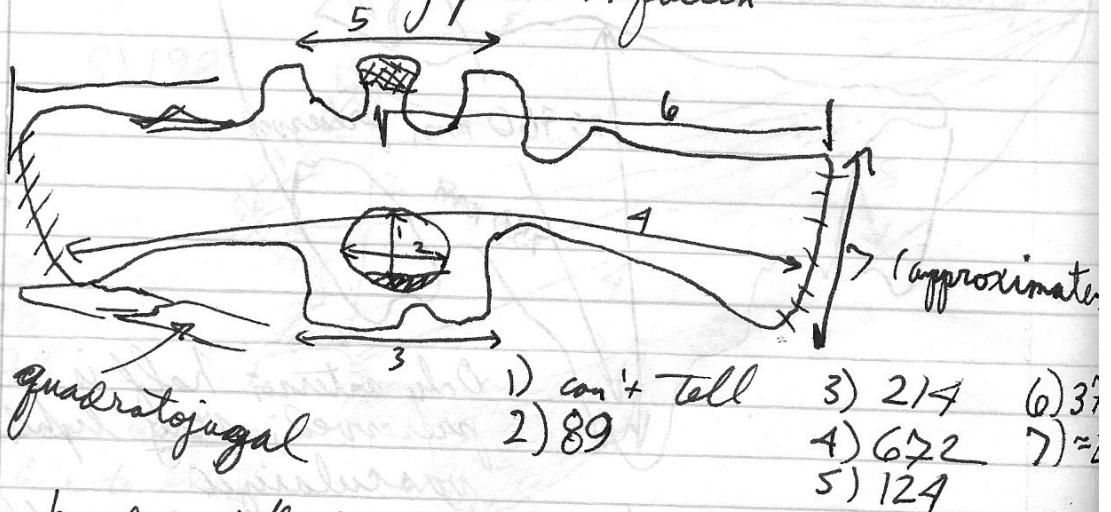
UPM 1830

0501 1014

lateral

Braincase

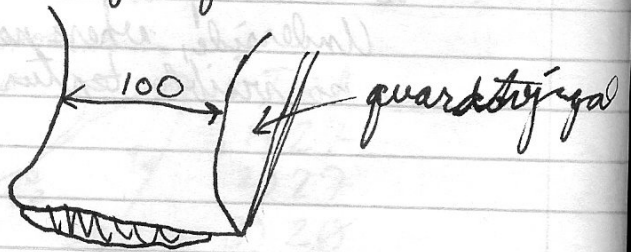
limits obscured by plaster & fusion --



hard to tell due to plaster, but the exoccipital processes seem unusually wide compared to others. ≈ 672 mm wide
214 mm across basioccipitals

*exoccipital "fan" narrower, perhaps?

Right quadrate

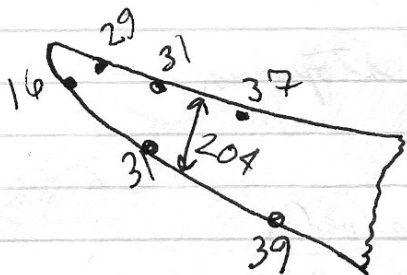


Can't tell in at how much of an angle the quadrate is directed forward, because it is obscured by plaster & reconstructed on proximal end

Right Squamosal

Several "divots" on rear side
 - circular depressions towards the posterior end

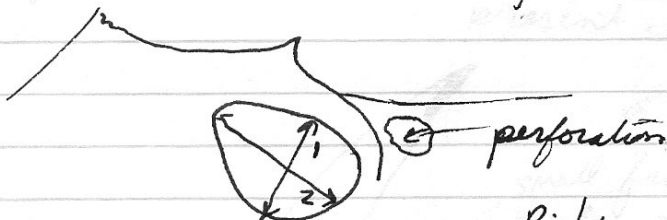
Little vascularization present.



Only posterior portion of the bone is present; some bits of the anterior end, so measurements are difficult

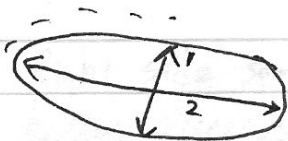
Right orbital area

- 1) 130
- 2) 164



Right orbit not subjected to crushing of left orbit
 Egg-shaped

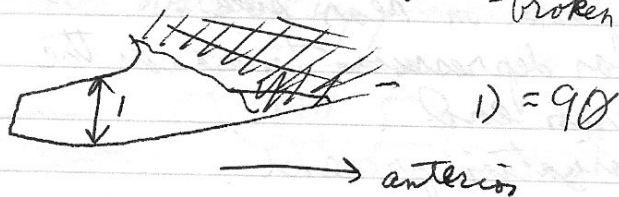
Right Orbital horn broken off @ base
 Measurements are



- 1) (width) 146
- 2) (length) 261
- Circumference = 656

4PM 1830

Right maxilla not nearly as well preserved
- broken off anteriorly



Teeth seem typical for ceratopsians;
no special features

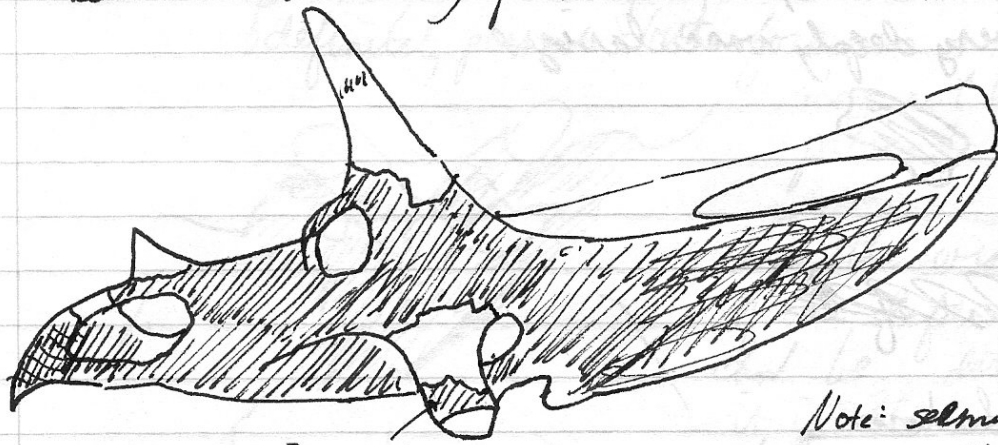
Number of alveoli, as preserved;
several of anterior positions are missing

Left
21+
(maybe 5-6 more)

Right
too difficult to count

7 March 2000

YPM 1831 -- Torosaurus gladius holotype
- considerable restoration on this skull also,
but not as thickly painted as YPM 1830.



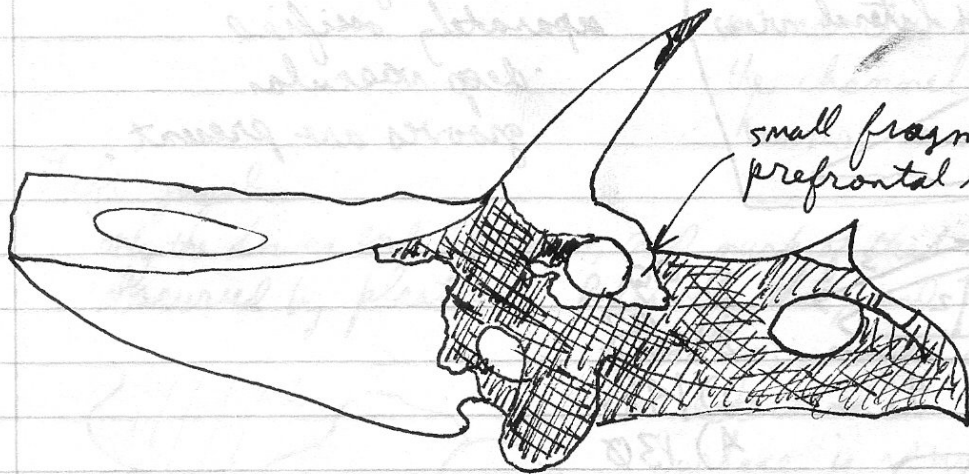
? bone plastered over?

Most of left side
of skull is gone

Note: seemingly

contra Hatcher et al. 1907,

only right squamosal is preserved
and both orbital horns are
present.



small fragment of
prefrontal region present

Right side somewhat
better preserved, but still most of face is gone.

- occipital condyle mentioned by Hatcher is
not mounted with specimen -- will search collections
for info

YPM 1831

Fragment of ? premaxilla? preserved

(or ? rostrum)

42 mm wide, 47 mm tall
very deeply vascularized



~~Fragment of~~

Nasal horn

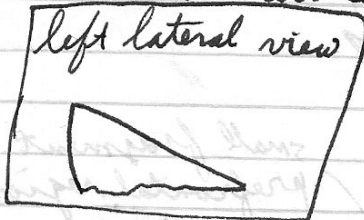
- detached from specimen according to Hatcher; I can confirm this.

- small, slight & slightly recurved.

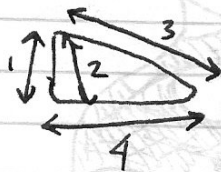
- no sutures visible to determine if it was

separately ossified

deep vascular grooves are present.



Lateral

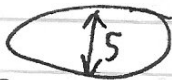


1) 99

2) 93

3) 142

4) 130



~~5) 77~~ 5) 77

Dorsal

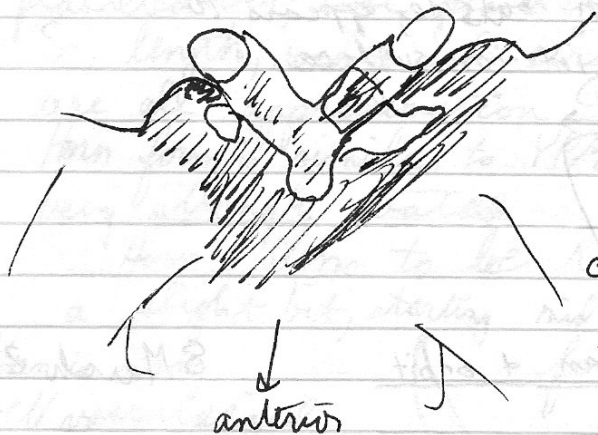
YPM 1831

Postfrontal region very poorly preserved

most of area plastered over

- restored as having small, single postfrontal foramen with channels branching away from it. branching channels are

definitely present, but foramen may or may not have been present.



Only the width of the left channel can be determined -- it is 36 mm.

The channel is shallow, perhaps only 5 mm deep or so.

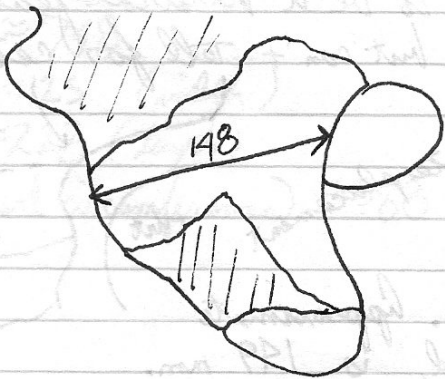
The bone around it is vascularized, but the channel itself has no vascularization.

Left jugal

only the lower end is present, and much of that probably obscured by plaster. Relatively thin, and typical

of ceratopsians as can be determined.

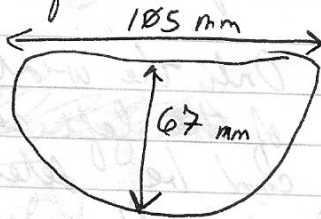
Surface is very lightly vascularized.



YPM 1831

Left epijugal

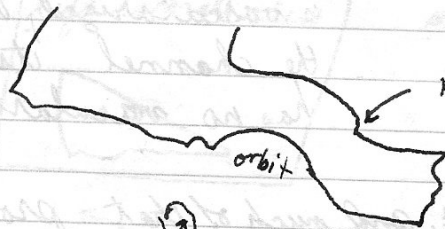
- Complete, but articulation with jugal and ventral side are obscured by plaster.
- deeply vascularized.
 - strongly convex on outside, appears to be flattened on interior surface.



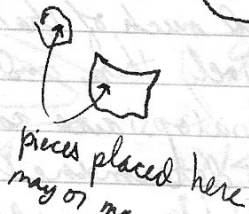
Right supraorbital horn + orbit

8 March 2000

Right orbit is half-reconstructed



orbit border is not smooth, but appears to have a raised ridge here. Seems to be a natural feature, but can't tell for certain.



pieces placed here may or may not be accurate placement



Too much restoration to get good measurements. Approximate width of orbit, as preserved, is 149 mm.

YPM 1831/99

Right orbital horn

Fairly well preserved along its length, with some minor areas of the apex missing.

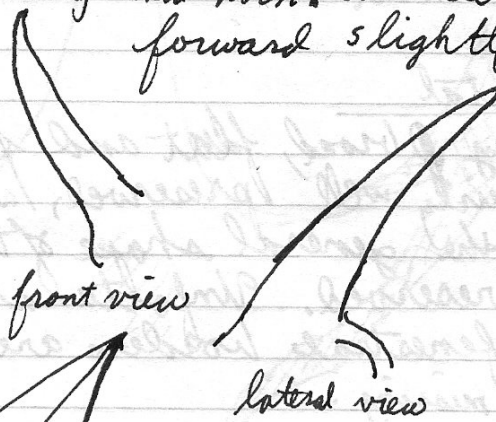
The medial portion of the base seems to be plastered over; some plaster laterally, also.

So, length, width and circumference measurements are all approximation (\pm some mm).

Horn form is similar to YPM 1830 in being strongly ovated

Horn seems to be recurved inward a slight bit, starting mid-horn. Also curves forward slightly

Horn is very well vascularized along its entire length.



Measurements

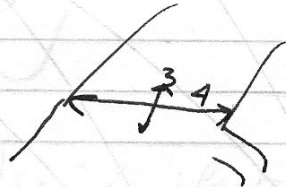
1) ≈ 721

2) ≈ 748

3) ≈ 125 (width)

4) ≈ 223 (length)

Basal circumference) ≈ 588



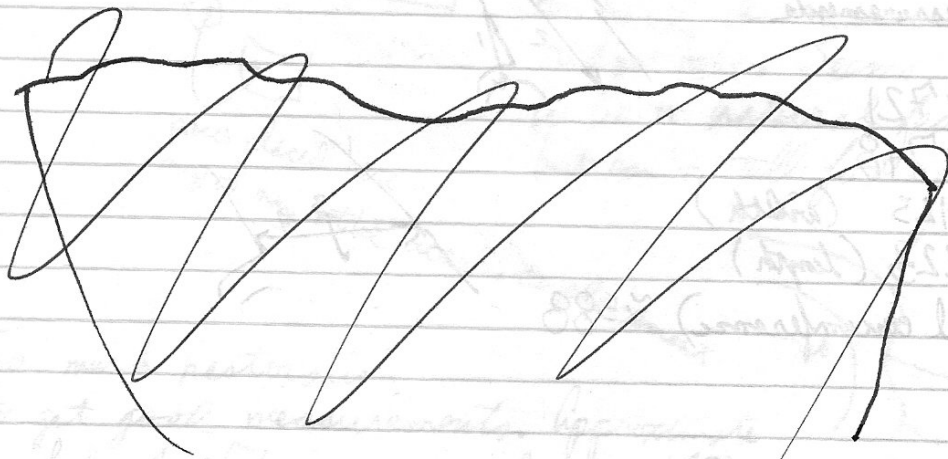
YPM 1831

Left orbital horn

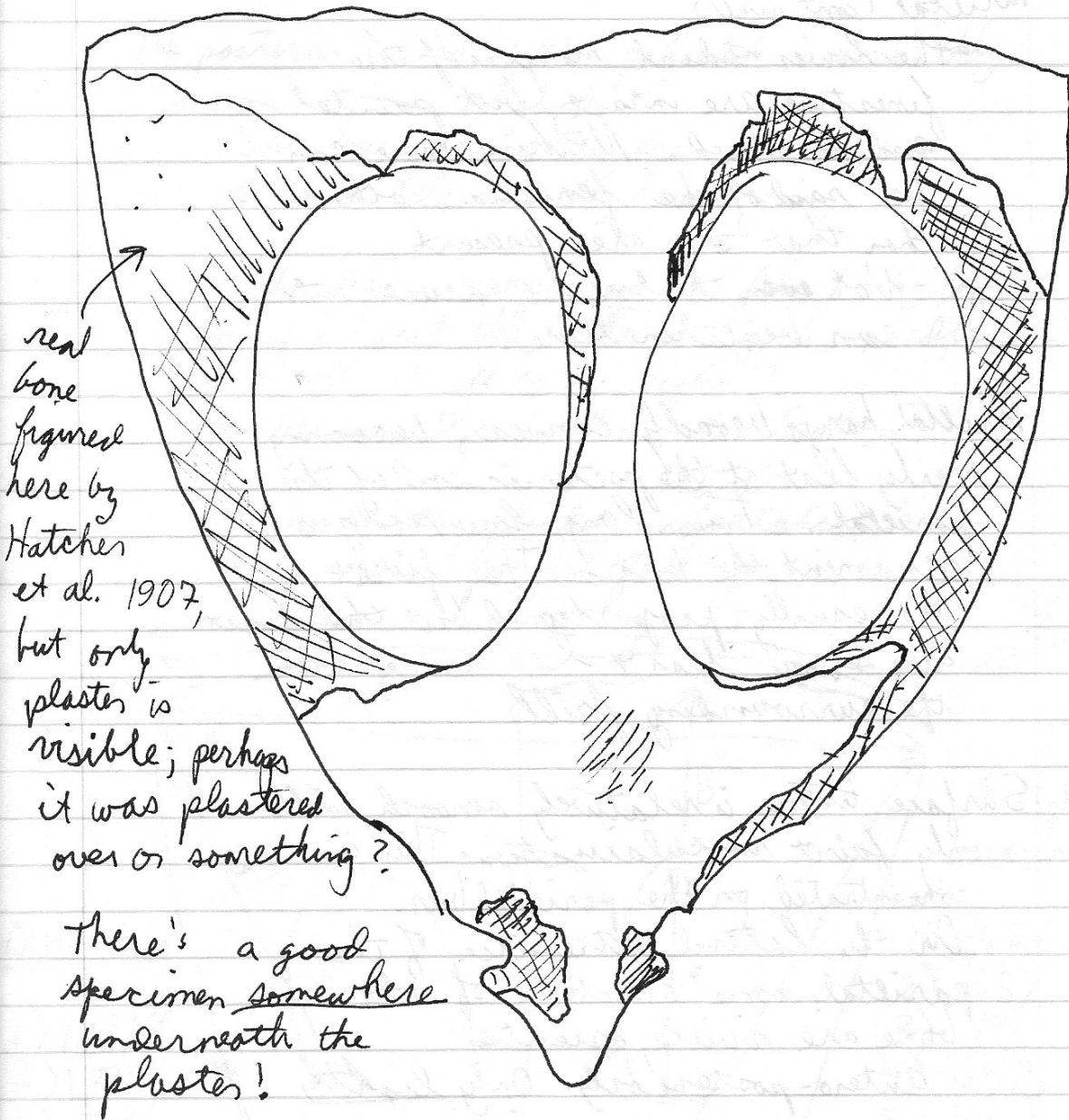
- similar form to right horn.
- base appears to be gone, so I won't attempt any measurements. However, the horn appears to be missing only the last few cm of the apex of the horn.
- very deeply incised vascular grooves.
- horn changes from ovate to circular in outline several ~~cm~~ cm from the summit.

Parietal

Very broad, flat and featureless. Fairly well preserved, with most of the general shape of the parietal preserved. Unfortunately, the fenestral borders are largely missing.



YPM 1831 31 1997



real bone figured here by Hatcher et al. 1907, but only plaster is visible; perhaps it was plastered over or something?

There's a good specimen somewhere underneath the plaster!

Most of parietal is heavily plastered & painted; so, most of bone texture & detail is lost. The whole of the underside of the parietal has been reinforced with plaster, so I cannot determine any of its structures.

YPM 1831

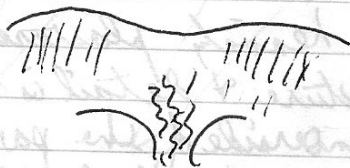
Parietal (continued)

- the lower medial margins of the fenestrae are intact but painted and plastered. Nothing more can be said of the fenestrae, other than that they are present.
- Not even thickness measurements can be taken here.

Parietal bar is broadly convex, becoming nearly flat at the posterior end of the parietal. Four long, low ridges ornament the bar. The first two are equally proportioned, but the last two show less & less relief from the surrounding frill.

Surface texture is relatively smooth, with only faint vascularization. This is concentrated on the parietal bar.

On the lateral extremities of the parietal, some striations of the bone are visible, oriented antero-posteriorly. Only lightly incised on the bone.

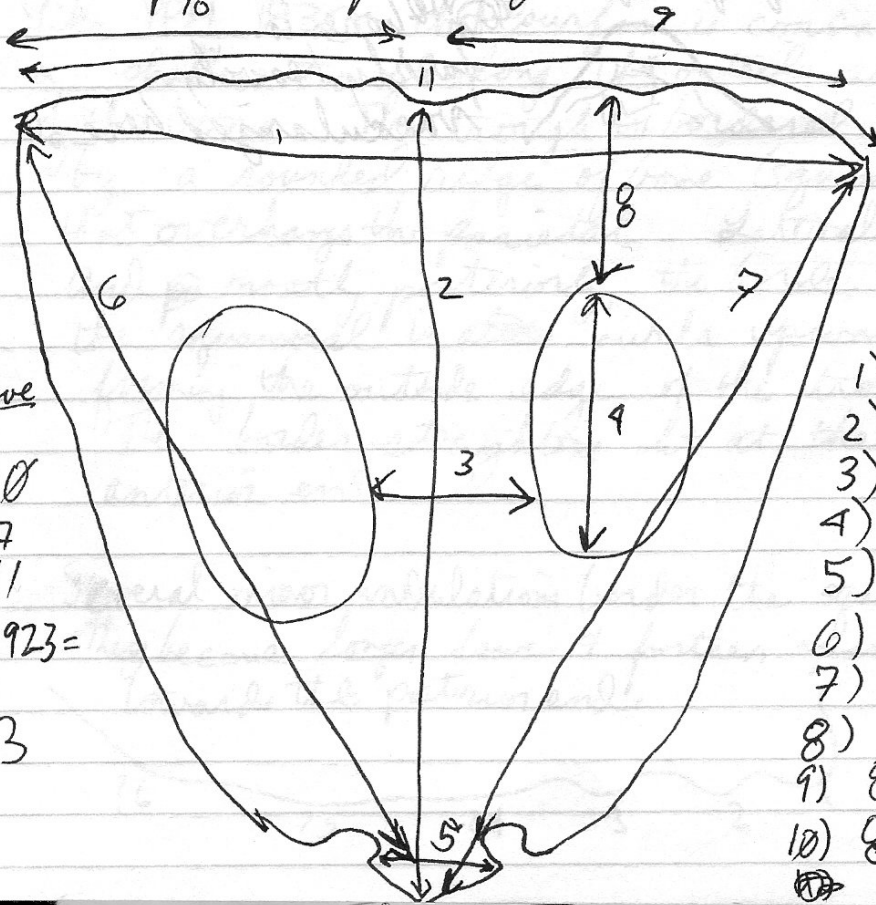


The posterior border of the parietal is smoothly shaped.

Some low sinuities are present, but I can't tell exactly how many.

On the left side, perhaps four & maybe five if I count the little one in the midline. Can't tell at all on the right side, because the border is too broken.

There is a very slight ^{medial} indentation in the posterior border of the parietal.



Straight-line measurements

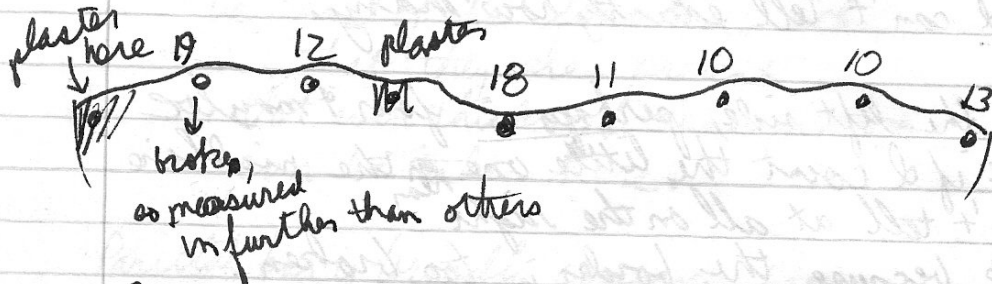
On the curve

- 1) 1,710
- 2) 1,337
- 3) 241
- 11) 944 + 923 =
- 9) 944
- 10) 923

- 1) 1,664
- 2) 1,332
- 3) 191
- 4) 652
- 5) 141 (as preserved)
- 6) 1468
- 7) 1,512
- 8) 285
- 9) 880
- 10) 856

YPM 1831

Some thickness measurements are possible on the rear margin of the parietal



Anterior of parietal ends in a wedge shaped process, apparently bordered by the ~~post~~ postfrontal fossa.

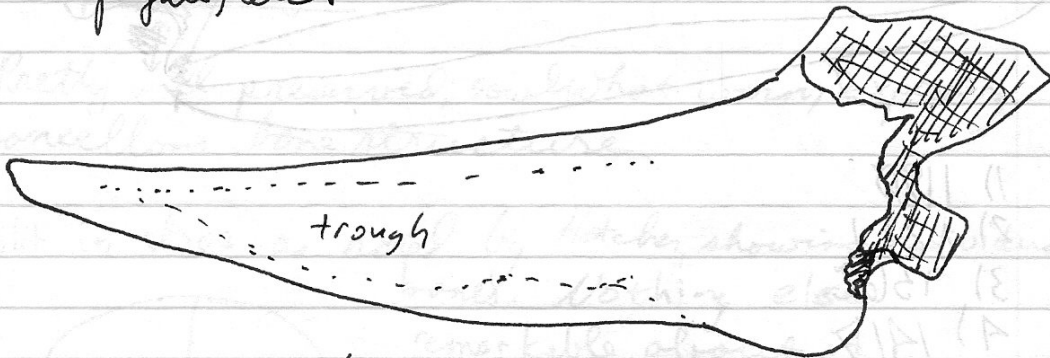


The bone is fairly heavily vascularized here.

YPM 1831 M99

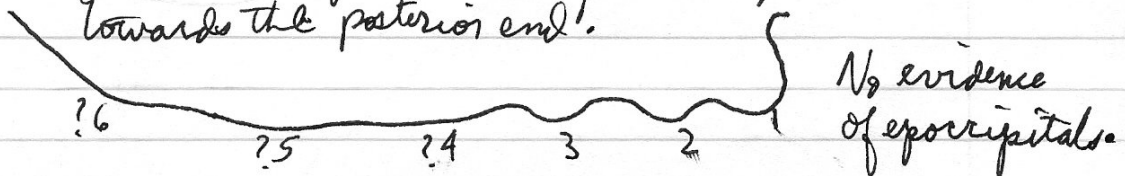
Right squamosal

Very well preserved, missing only the anterior end where it articulates with the jugals, etc.



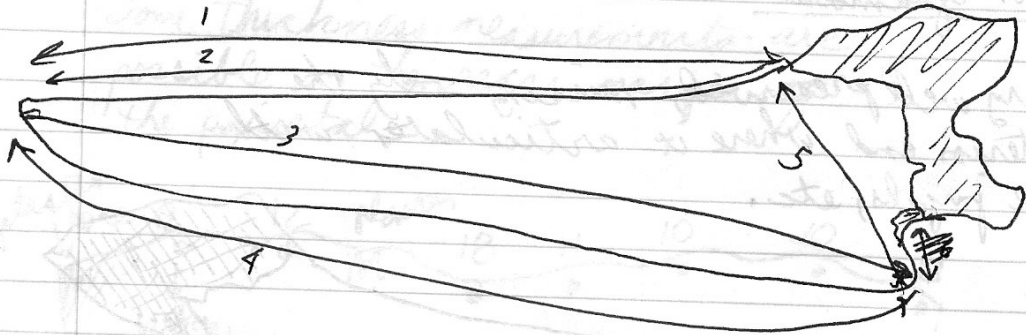
The medial border is quite straight. Like YPM 1830 the surface is concave, forming a shallow trough along the outside surface of the bone. The trough is bordered medially by a rounded ridge of bone (squamosal bar) that overhangs the parietal. Laterally, and ~~at~~ mostly posteriorly, the border of the squamosal is ~~also~~ curls upwards, forming the outside edge of the trough. The border straightens out at the anterior end.

Several minor undulations border the squamosal. They become longer, lower & further apart towards the posterior end.



4PM 1831

Measurements



1) 1190

2) 1,221

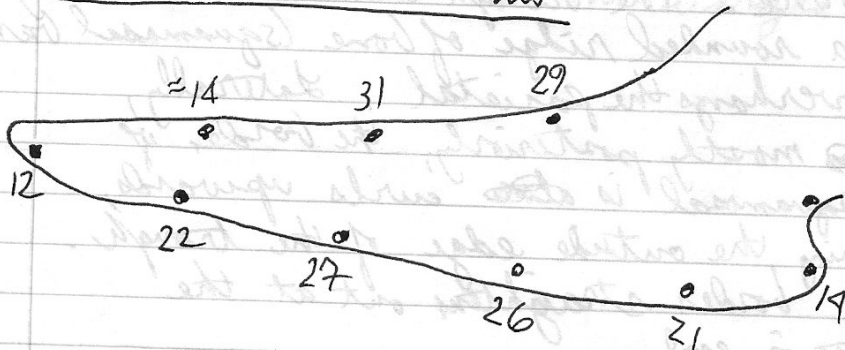
3) 1362

4) 1417

5) 426

~~1190~~ - plaster

Thickness measurements



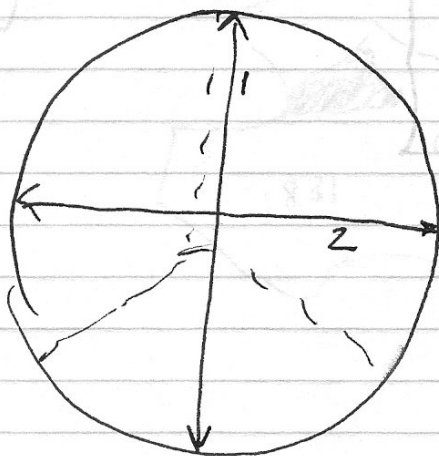
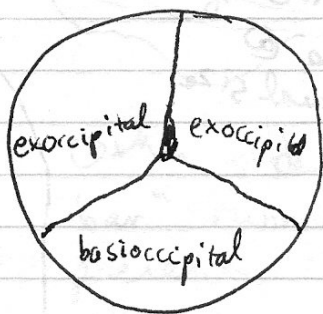
YPM 1831

YPM 1831 -- some material not mounted on skull
Mostly fragments that are unrecognizable
- appear to be all from the skull

Occipital condyle

Pretty well preserved; somewhat worn, exposing cancellous bone structure.

Split in three as noted by Hatcher, showing individual bones. Nothing else remarkable about it.



Measurements

- 1) 83
- 2) 86

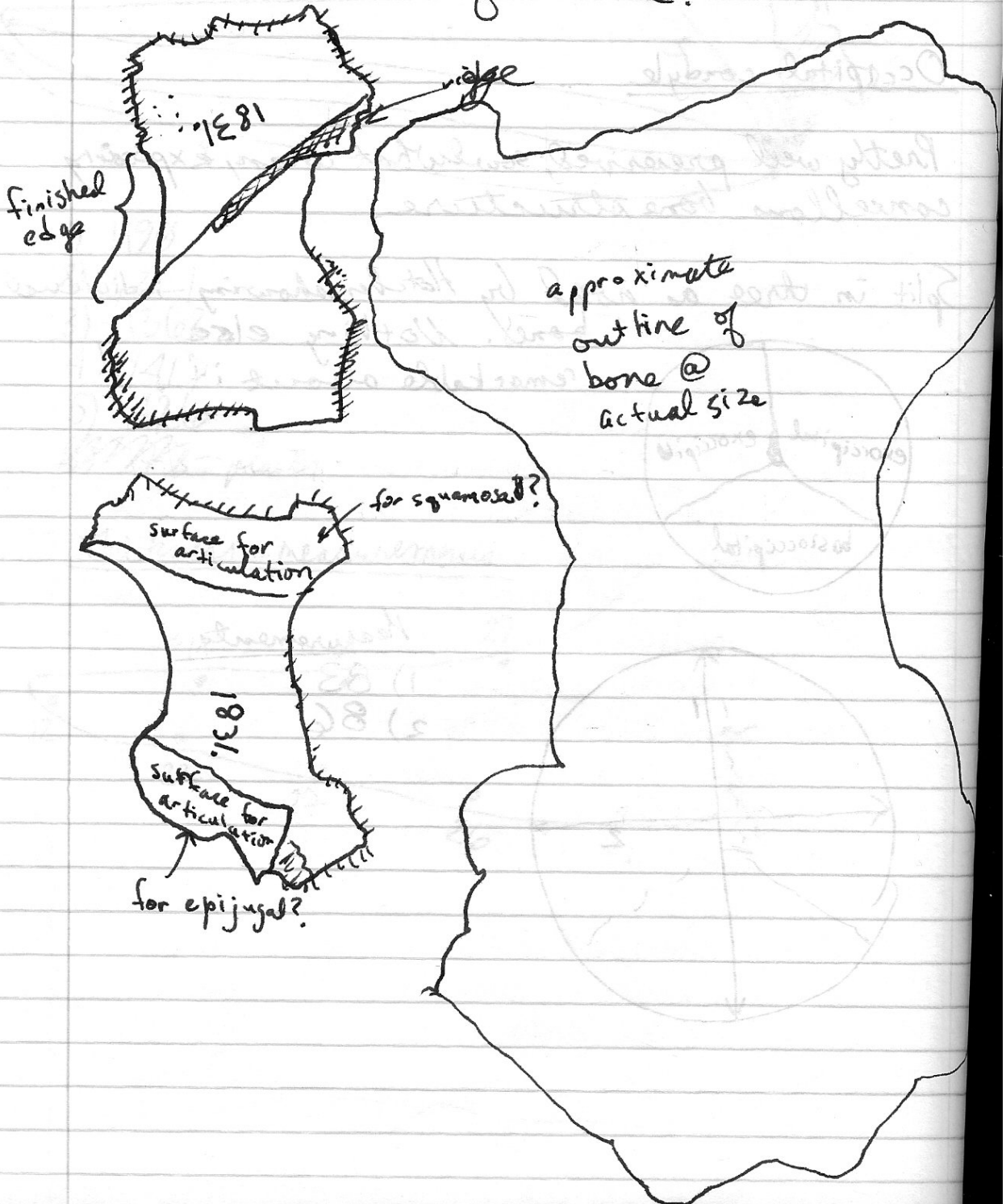
YPM 1831

M94

right jugal, perhaps?

YPM 1831 -- loose, unidentified bone

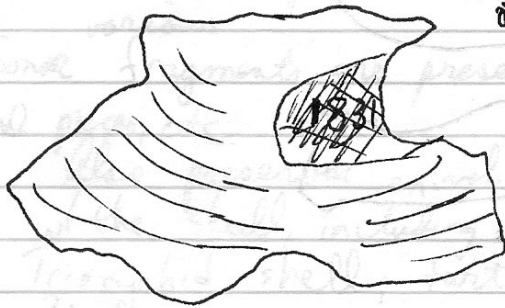
- roughly I-shaped, ridge cutting across the middle of the bone.



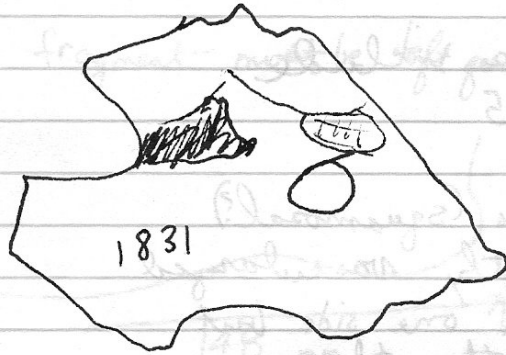
YPM 1831

YPM 1831 -- loose unidentified bone
? piece of base of supraorbital horn
with section of coronal sinus preserved?

Heavy vascular texture on one side, but
in an unusual, V-shaped pattern, converging
on the "midline" of
the bone.

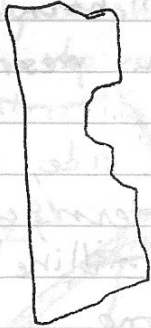


Other side is smooth, with "structural
bar" running across + large indentation
present. No vascularization

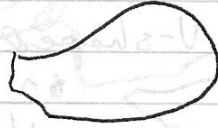


YPM 1831

YPM 1831 -- fragment of squamosal bar



edge on view shows
edge of "trough"



Shows a very light
vascularization texture.



? Parietal fragments

No real texture visible on front
or back side. Some small
striations (mentioned previously)
are visible.

Random thicknesses include
6, 15, 5

Some fragments (squamosal?)
have a lightly vascularized
texture on one side but
nothing on the other.

YPM 1830

YPM 1830 skull & skeleton fragments

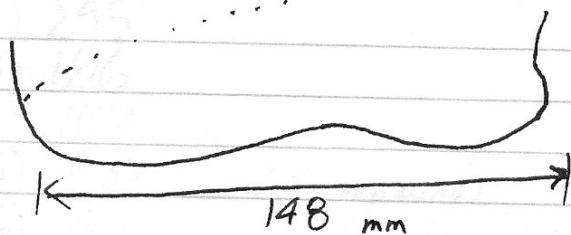
- some of the skeletal fragments mentioned by Marsh in his original description are preserved in their original bur lag wrappings -- can't tell what bones they are, or even if they are ceratopsian. Badly neglected & weathered.

^{various} Some fragments are preserved; pariet bits ~~and~~ and pieces, etc.

Also preserves animal bones found w/ the skull, including large pieces of Trionychid shell; turtle limb bones
? hadrosaur jaw fragments

Only identifiable ^{Torosaurus} bones are orbital horn end and quadrate fragment.

Quadrate fragment -- must be left quadrate -- right is mounted.



- In the box was a note by Lull saying he attempted to mount it, but it was "impossible."

YPM 1830

Orbital horn core fragment

tentatively associated with skull

-- may have been surface float
or something.