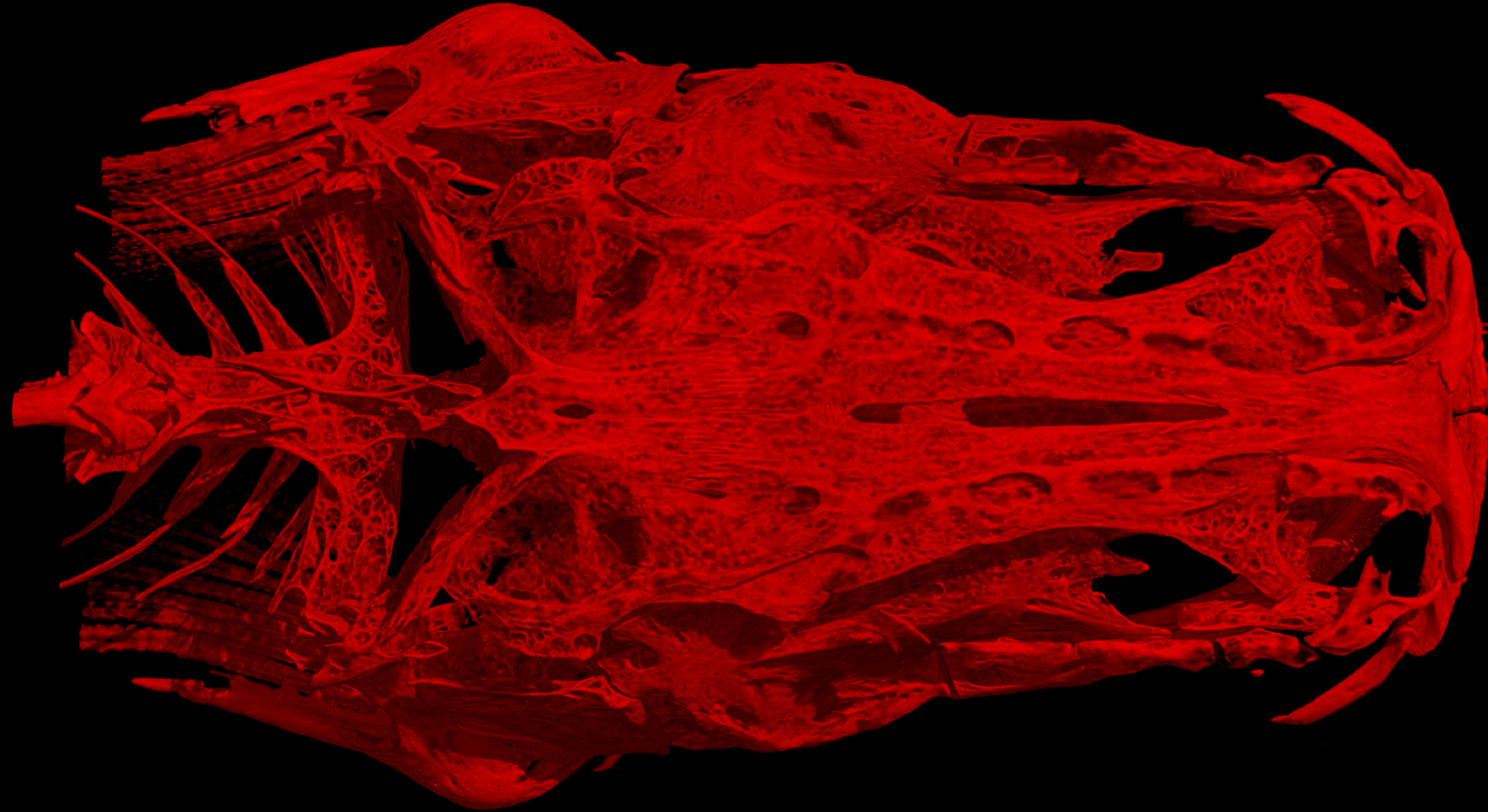


SATAN'S SKELETON REVEALED

JOHN G. LUNDBERG, DEAN A. HENDRICKSON, KYLE LUCKENBILL, MARIANGELES ARCE-H.



The Academy of
Natural Sciences
of DREXEL UNIVERSITY

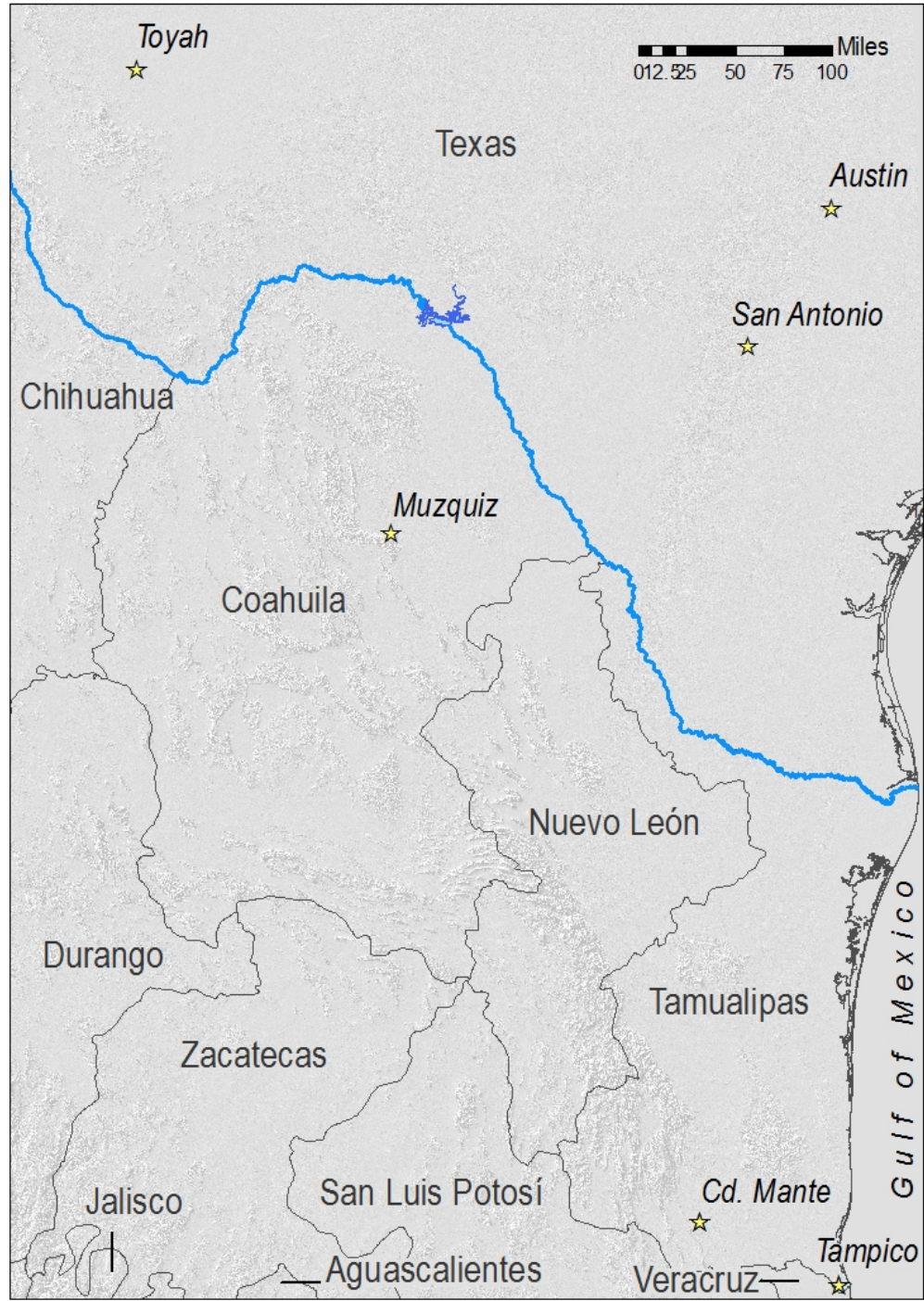


TEXAS
The University of Texas at Austin

SATAN'S SKELETON REVEALED

JOHN G. LUNDBERG, DEAN A. HENDRICKSON, KYLE LUCKENBILL, MARIANGELES ARCE-H.

- FAMILY ICTALURIDAE
- WHY SATAN?
- METHODOLOGY
- UNIQUE CHARACTERS OF *SATAN*
- CURRENT PHYLOGENETIC HYPOTHESIS
- *SATAN* AND *PYLODICTIS*
- *SATAN* AND OTHER TROGLOBITE ICTALURIDS
- CONCLUSIONS



ICTALURIDAE

EPIGEAN



NOTURUS



AMEIURUS



ICTALURUS



PYLODICTIS OLIVARIS

HYPOGEAN



TROGLOGLANIS PATTERSONI

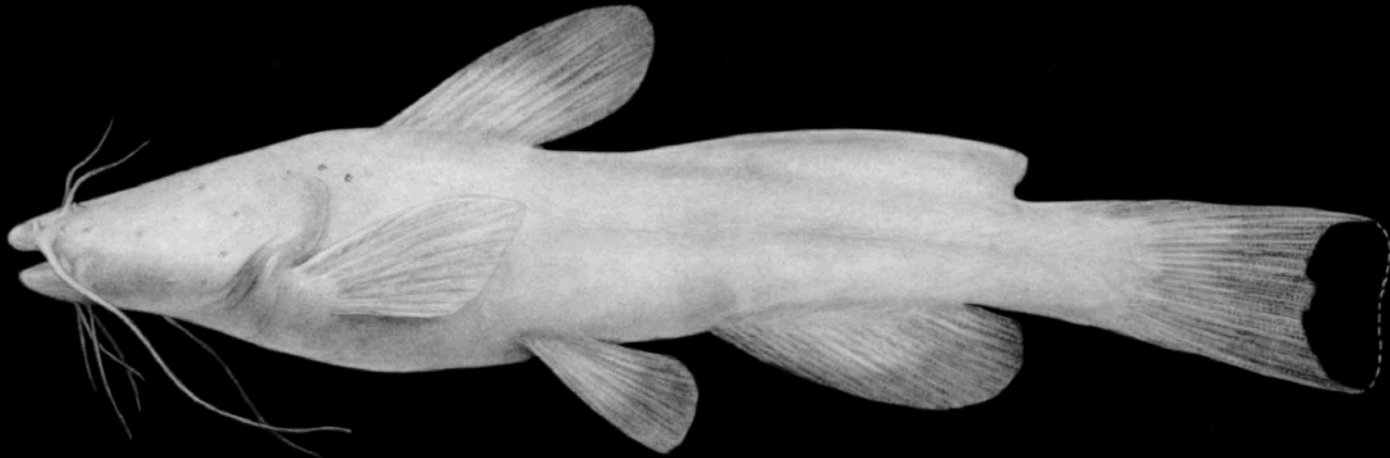


PRIETELLA LUNDBERGI

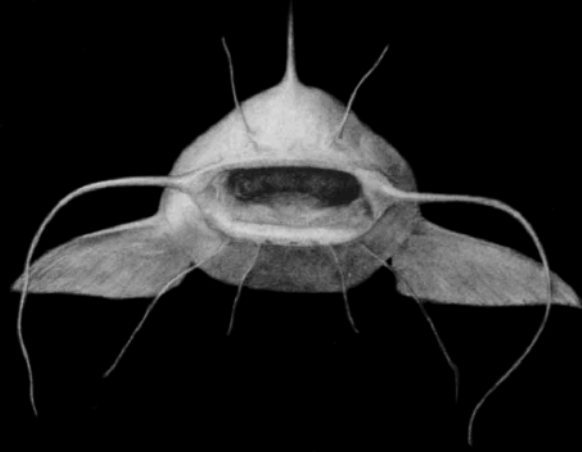


SATAN EURYSTOMUS

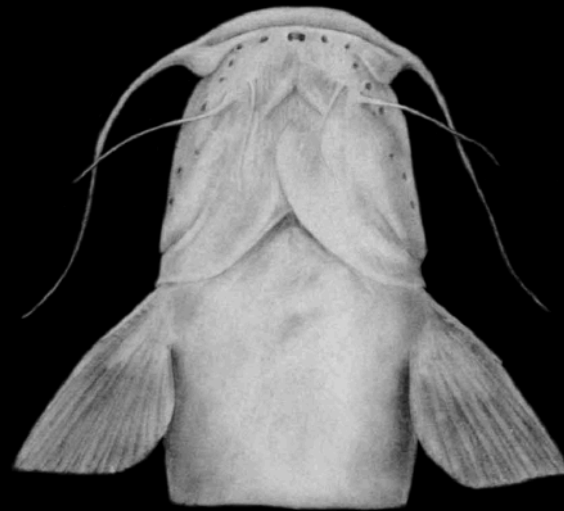
SATAN EURYSTOMUS HUBBS AND BAILEY 1947 WIDEMOUTH BLINDCAT



Satan eurystomus



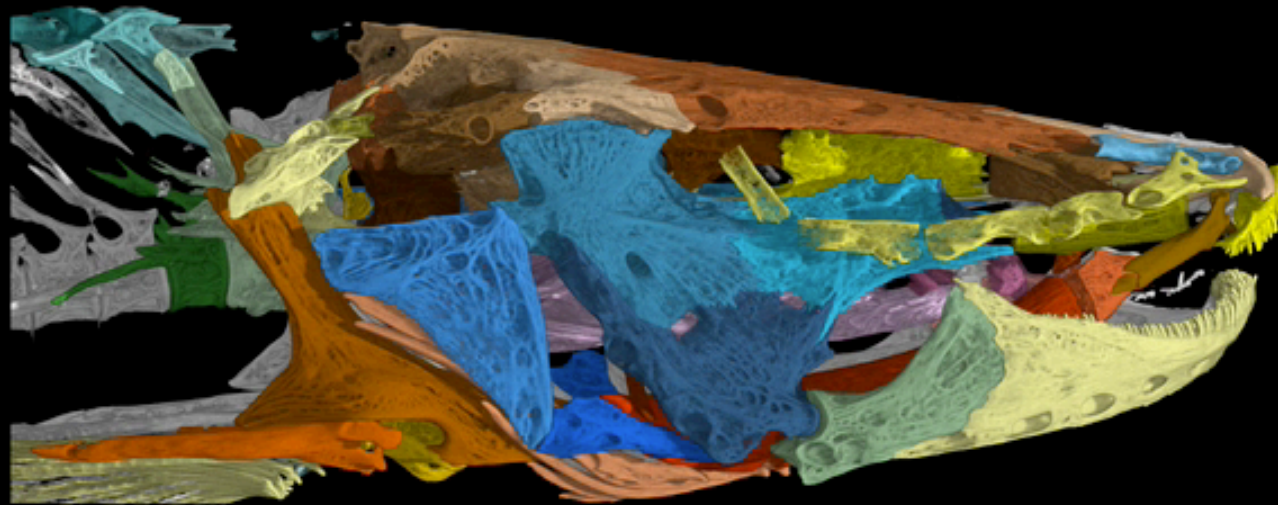
Grace Eager



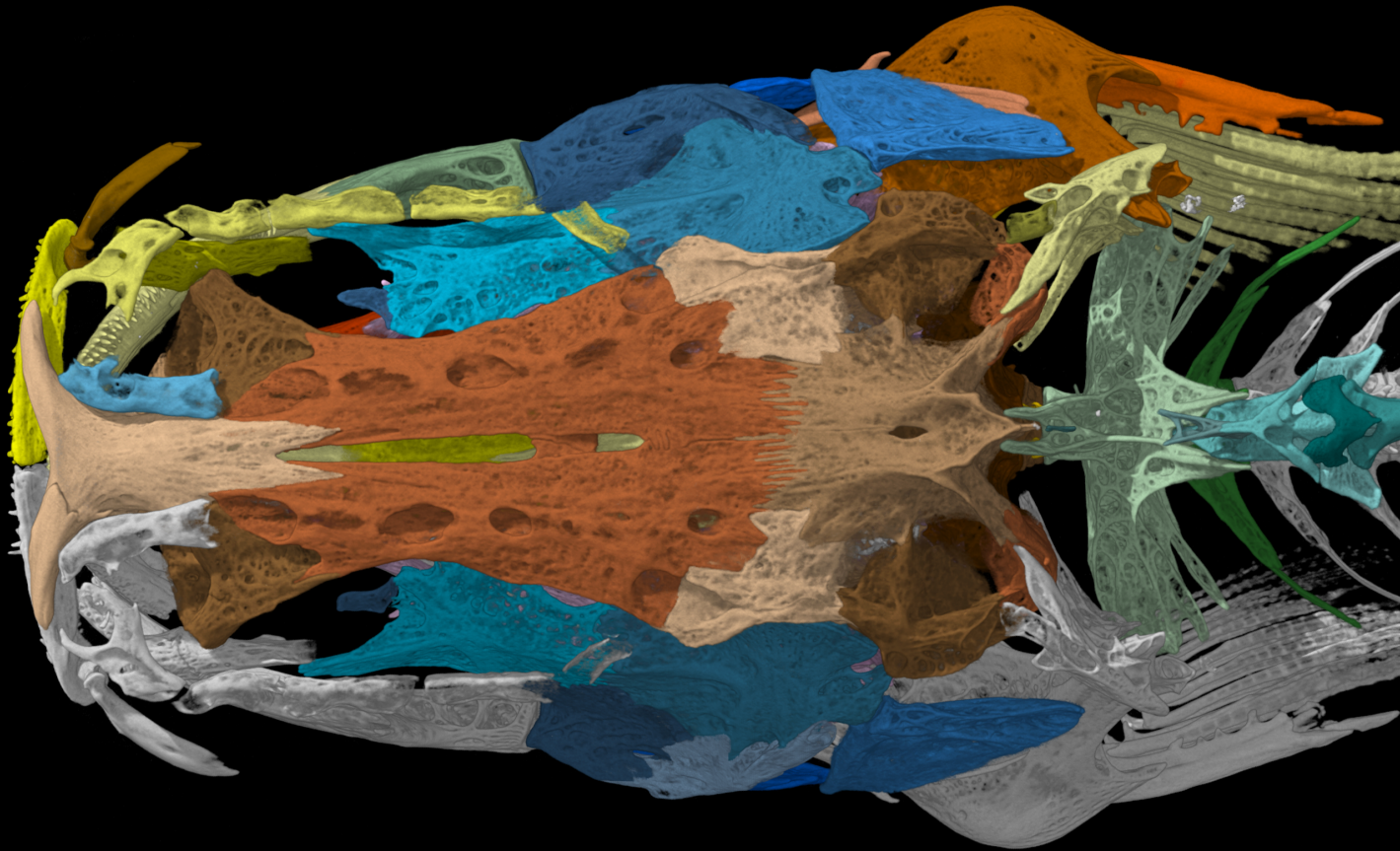
- DISCOVERED IN THE SUBTERRANEAN WATERS OF TEXAS, IN THE EDWARDS AQUIFER UNDER THE SAN ANTONIO AREA.
- 13 PRESERVED INDIVIDUALS KNOWN TO BE IN NATURAL HISTORY COLLECTIONS .
- THE LAST SPECIMENS OF SATAN WERE COLLECTED IN 1984.
- THERE IS NO TISSUE SAMPLES AVAILABLE

METHODS

Satan eurystomus USNM 195830



SATAN'S UNIQUE CHARACTERS



WE FOUND TWELVE UNIQUE CHARACTERS

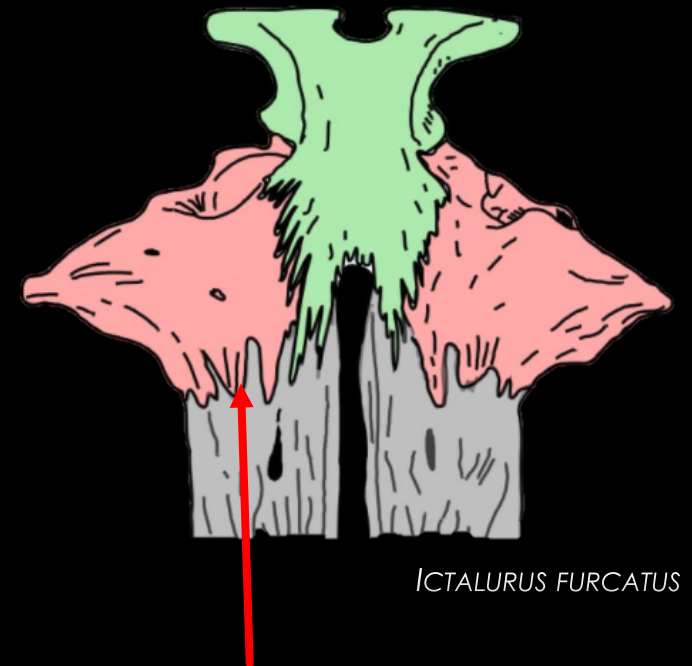
1. FRONTAL-LATERAL ETHMOID JOINT
2. POSTERIOR CRANIAL FONTANEL CLOSURE
3. SUPRAOCCIPITAL MEDIAN SULCUS
4. TEMPORAL FOSSA WIDE AND DEEP
5. POSITION OF THE INFRAORBITAL SENSORY CANAL
6. INFRAORBITAL BONE NUMBER
7. PTEROTIC-POSTTEMPORO-SUPRACLEITHRUM ARTICULATION
8. BRANCHIOSTEGAL MEMBRANES
9. INTERHYAL
10. INTEROPERCLE-POSTERIOR CERATOHYAL JOINT
11. DORSAL-FIN SPINELET
12. ANTERIOR MARGIN OF CLEITHRUM

SATAN'S UNIQUE CHARACTERS



- FRONTAL-LATERAL ETHMOID JOINT

VS.



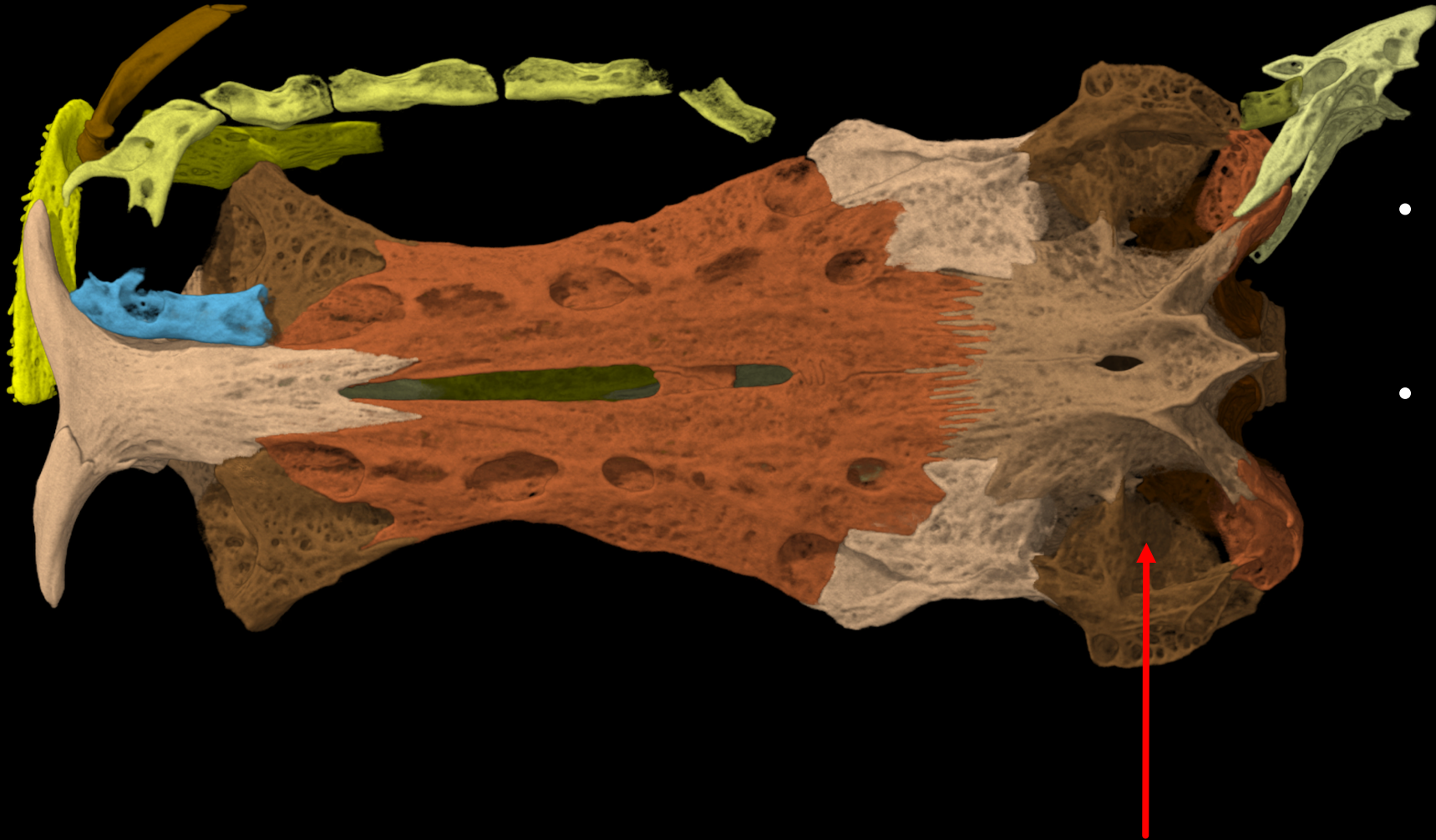
ICTALURUS FURCATUS

SATAN'S UNIQUE CHARACTERS



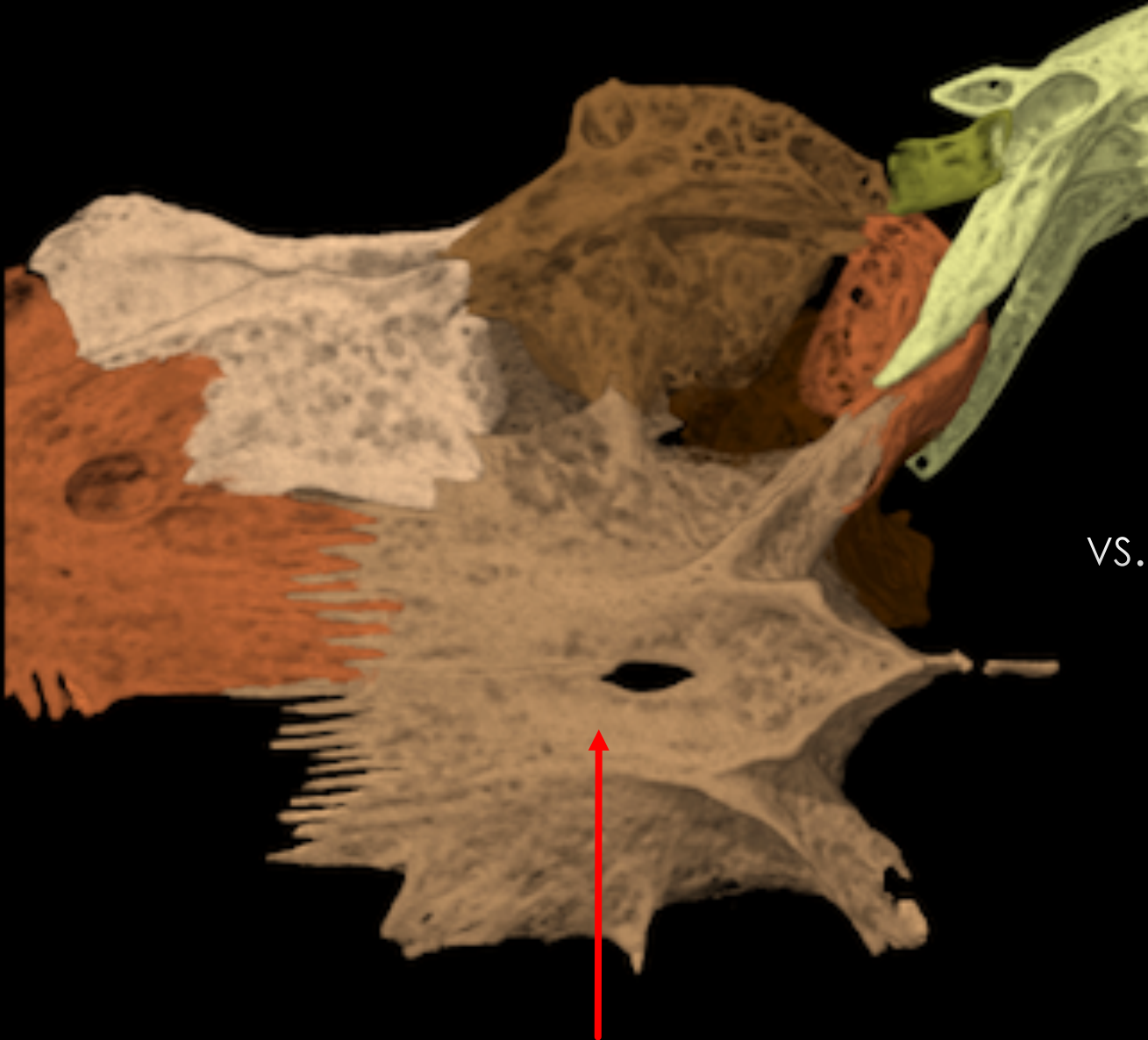
- POSTERIOR CRANIAL FONTANEL CLOSURE

SATAN'S UNIQUE CHARACTERS



- POSTERIOR CRANIAL FONTANEL CLOSURE
- TEMPORAL FOSSA WIDE AND DEEP

SATAN'S UNIQUE CHARACTERS



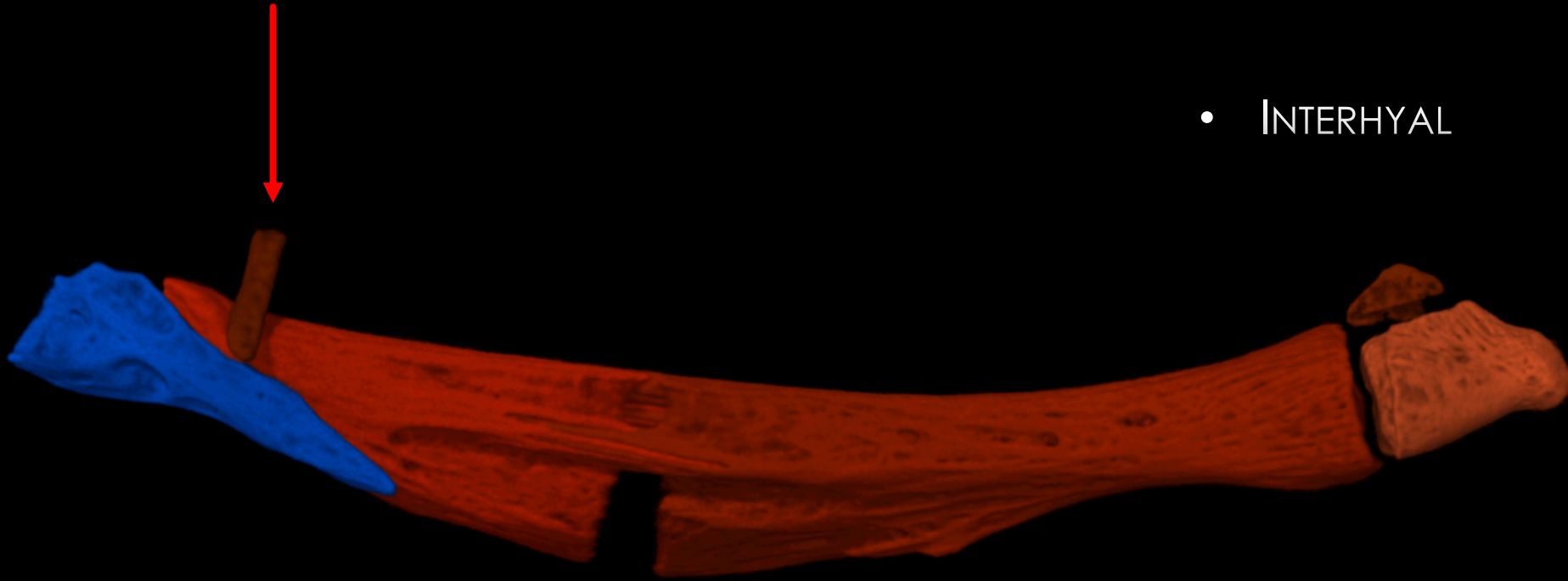
- SUPRAOCCIPITAL MEDIAN SULCUS

vs.



SATAN'S UNIQUE CHARACTERS

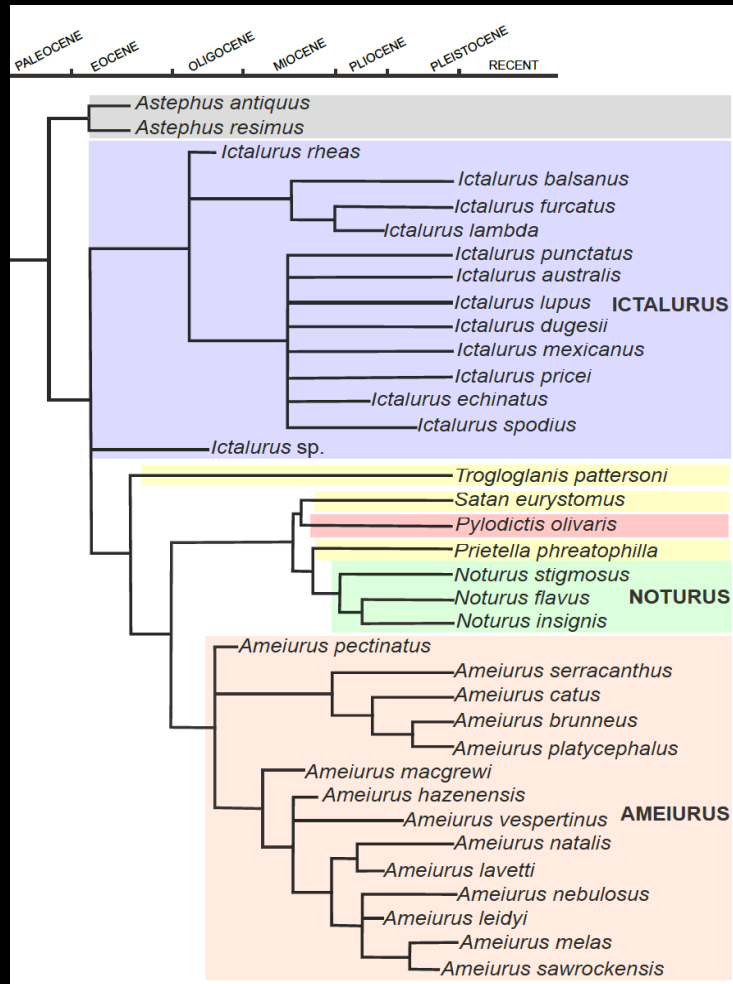
- INTERHYAL



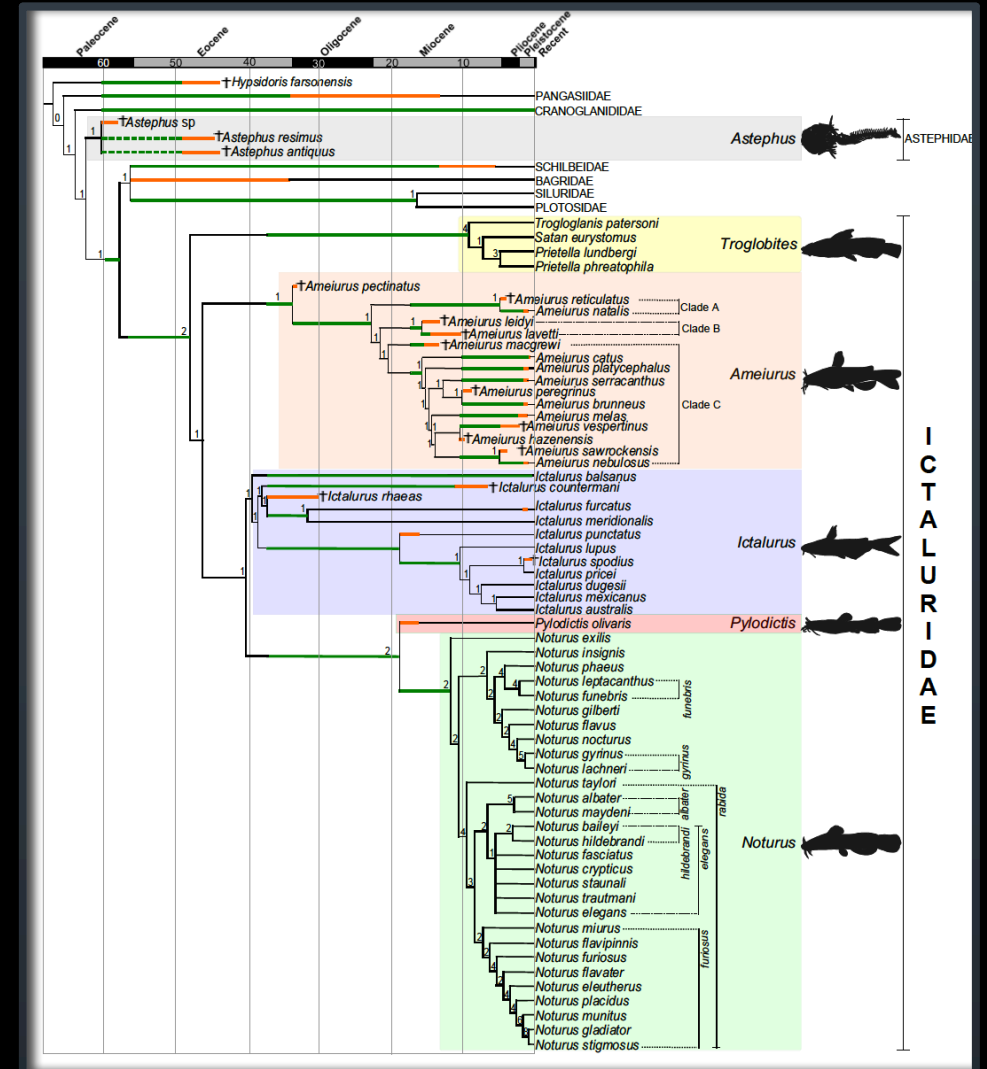
vs.



PHYLOGENETIC HYPOTHESIS



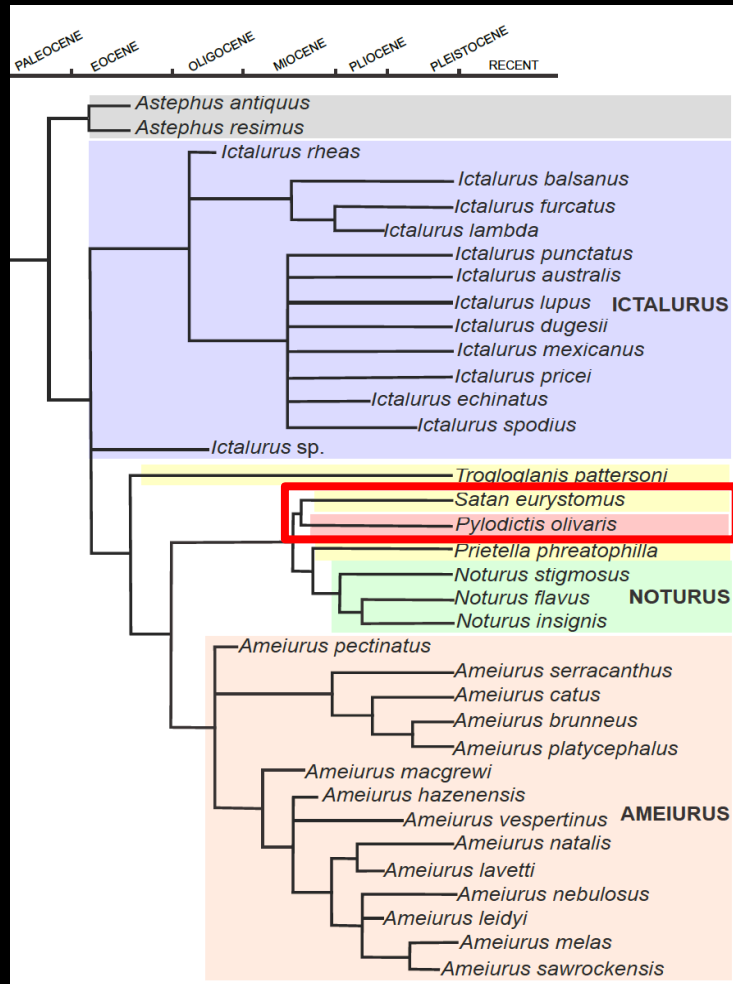
vs.



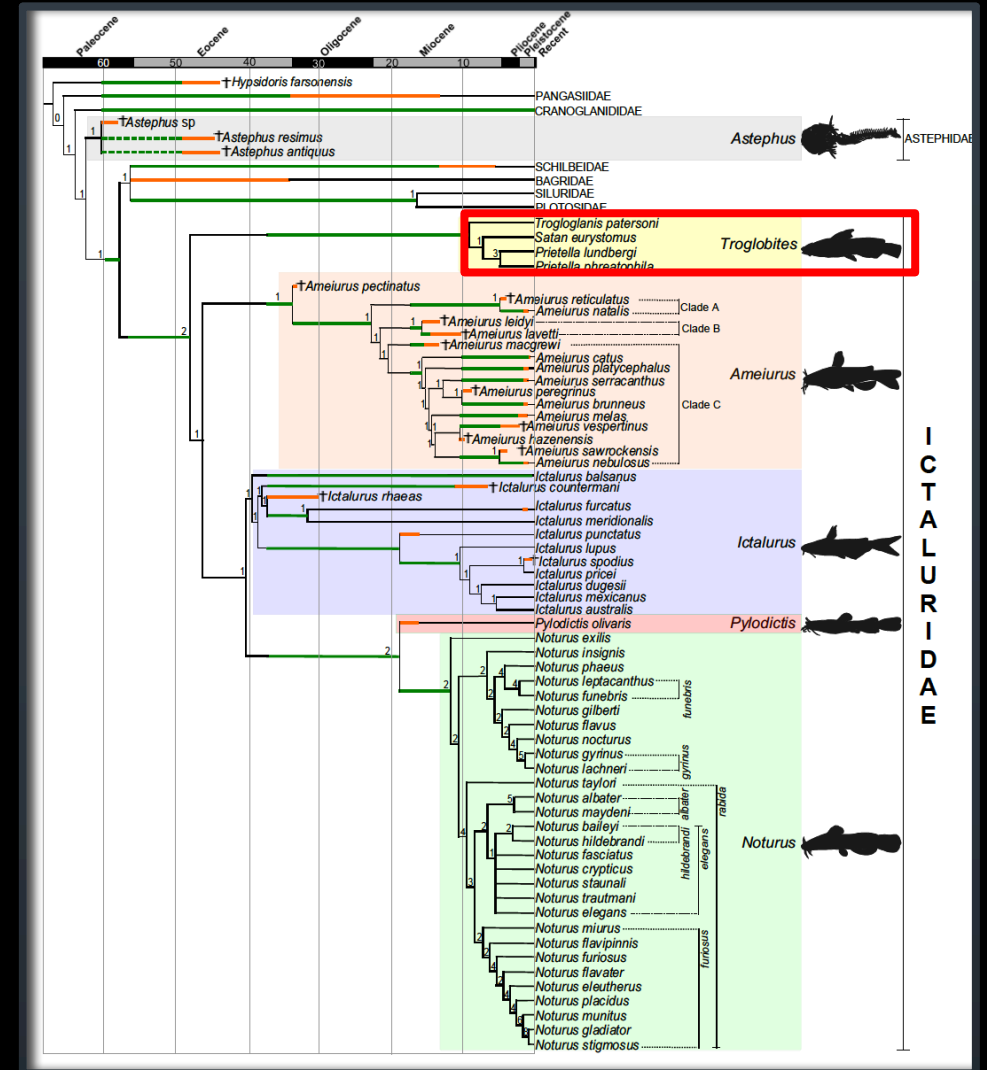
MORPHOLOGY BASED, LUNDBERG 1992

TOTAL EVIDENCE, ARCE ET AL., 2016

PHYLOGENETIC HYPOTHESIS



vs.



MORPHOLOGY BASED, LUNDBERG 1992

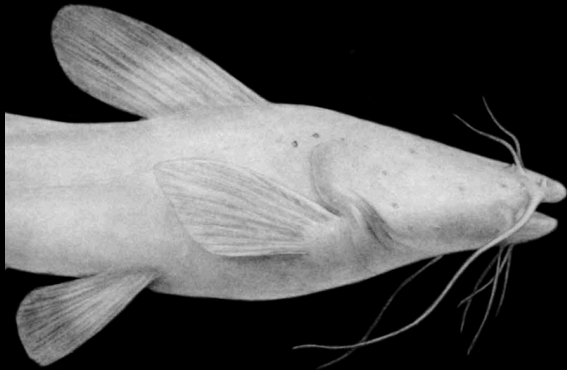
TOTAL EVIDENCE, ARCE ET AL., 2016

SATAN + PYLODICTIS

HUBBS & BAILEY, 1947

TAYLOR, 1969

LUNDBERG, 1992



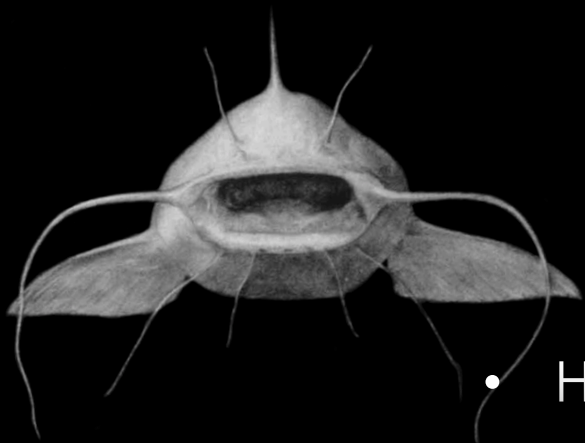
10 SYNAPOMORPHIES

1. HEAD SHAPE AND MOUTH POSITION
2. MESETHMOID BONE SHAPE
3. LATERAL ETHMOID POSTERIOR PROCESS*
4. SUPRAOCCIPITAL POSTERIOR PROCESS
5. PARASAGITTAL AND OCCIPITAL CRESTS
6. OPERCULAR FRAME AND PANEL
7. FIRST MANDIBULAR SENSORY CANAL PORE
8. PREOPERCULO-MANDIBULAR SENSORY CANAL FORAMINA AND PORES
9. POSTERIOR CERATOHYAL
10. 4TH SUPRANEURAL AND ANTERIOR NUCHAL PLATE

SATAN + PYLODICTIS



M. Thomas



G. Sneegas

- HEAD SHAPE AND MOUTH POSITION

SATAN + PYLODICTIS



SATAN + PYLODICTIS



SATAN



PYLODICTIS

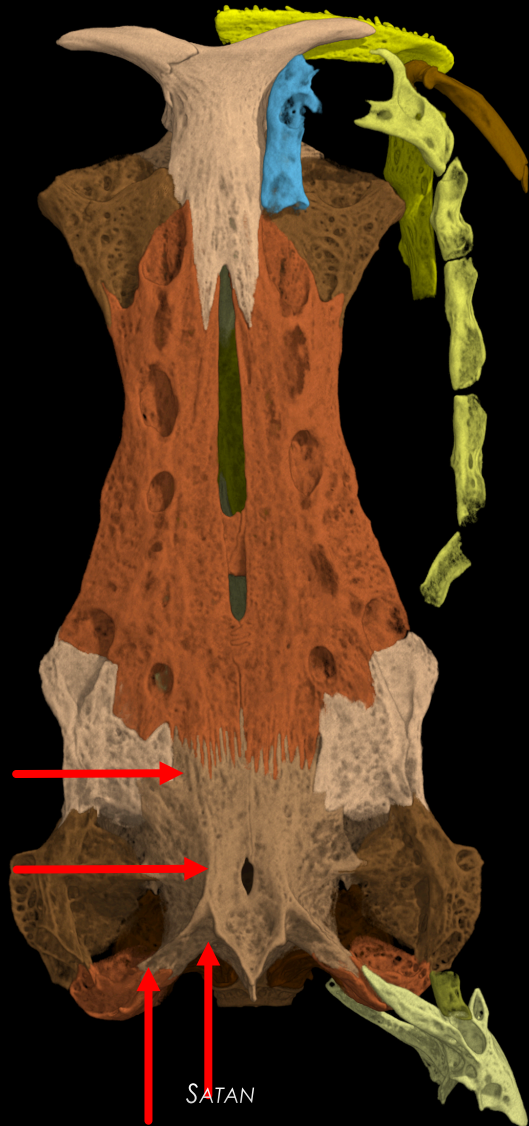
- MESETHMOID BONE SHAPE

SATAN + PYLODICTIS



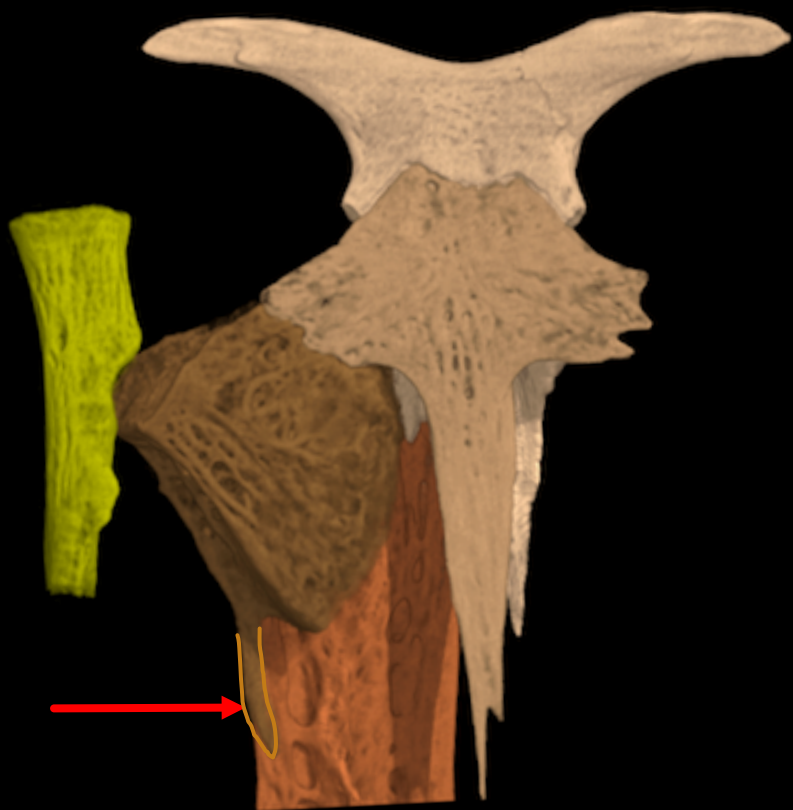
- MESETHMOID BONE SHAPE
- SUPRAOCCIPITAL POSTERIOR PROCESS

SATAN + PYLODICTIS



- MESETHMOID BONE SHAPE
- SUPRAOCCIPITAL POSTERIOR PROCESS
- PARASAGITTAL AND OCCIPITAL CRESTS

SATAN + PYLODICTIS



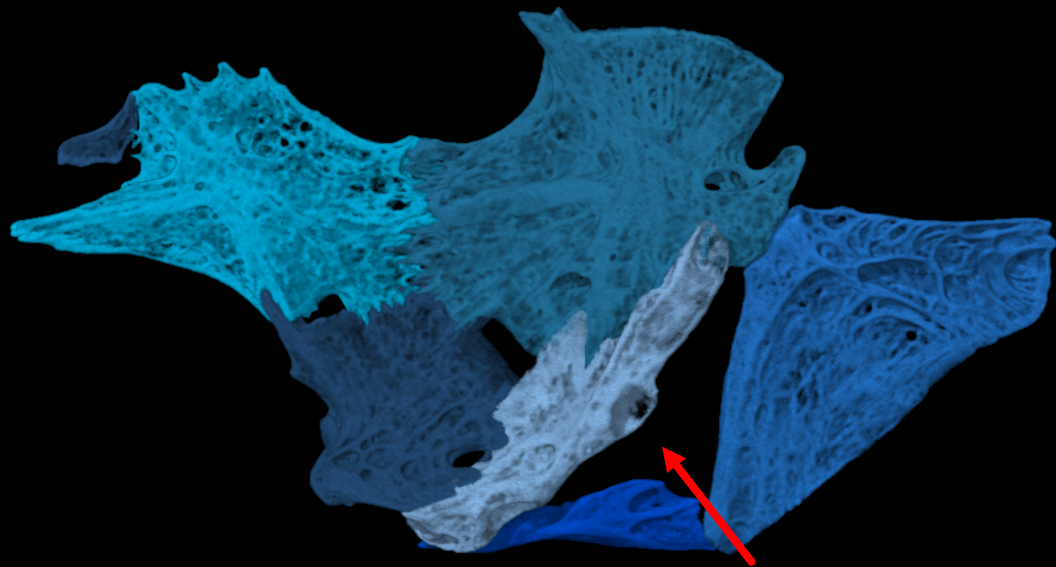
SATAN



PYLODICTIS

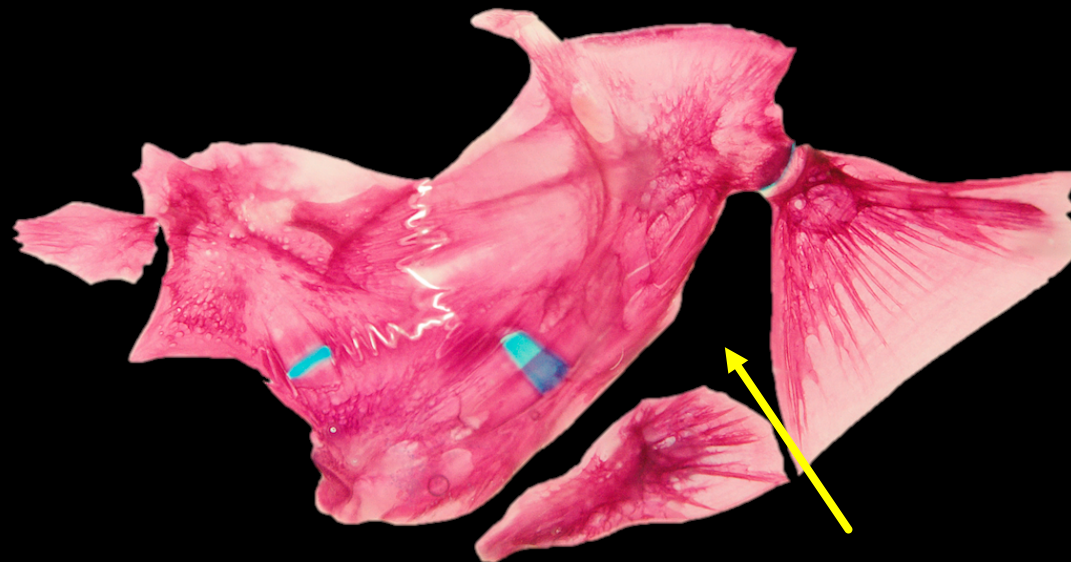
- LATERAL ETHMOID POSTERIOR PROCESS

SATAN + PYLODICTIS



SATAN

VS.



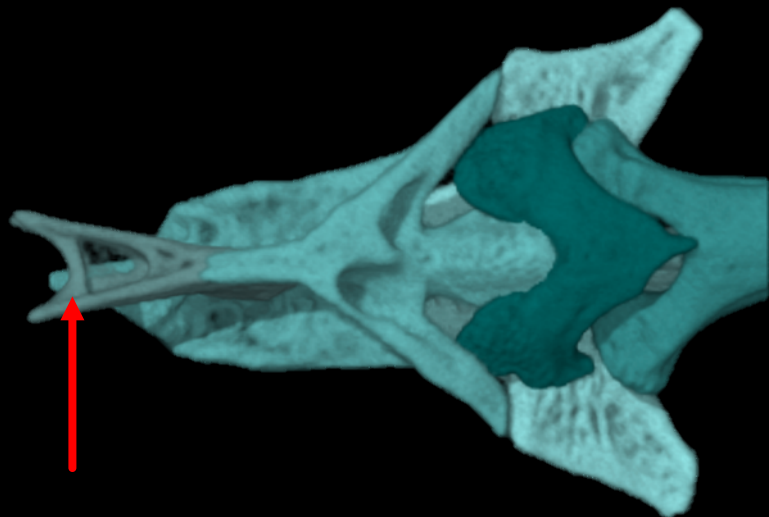
PYLODICTIS



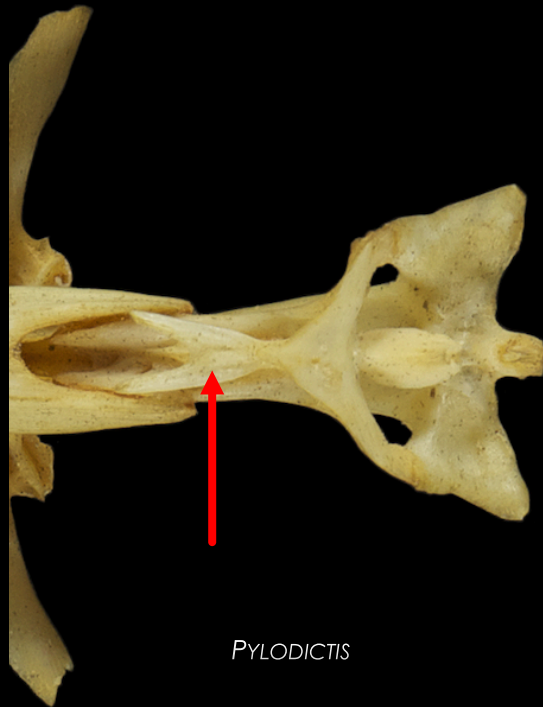
ICTALURUS

- OPERCULAR FRAME AND PANEL

SATAN + PYLODICTIS



SATAN



PYLODICTIS

- 4TH SUPRANEURAL AND ANTERIOR NUCHAL PLATE

(TROGLOGLANIS (SATAN (PRIETELLA)))

ARCE ET AL., 2016



TROGLOGLANIS PATTERSONI



Satan euryostomus



Prietella lundbergi



PRIETELLA PHREATOPHILA

15 SYNAPOMORPHIES

1. LACK OF EYES
2. LACK OF PIGMENTATION
3. LATERAL LINE EXTEND
4. 5TH VERTEBRA LACKING STRONGLY OVERLAPPING SUTURAL ARTICULATIONS WITH THE POSTERIOR FACE OF WEBERIAN COMPOUND
5. MESETHMOID CORNUA
6. ANTERIOR CRANIAL FONTANEL LOCATION
7. SHALLOW DESCENDING WING OF FRONTAL
8. SHORT SUPRAOCCIPITAL POSTERIOR PROCESS
9. ROUNDED PTEROTIC WING
10. WIDTH OF PARASPHENOID AND ORBITOSPHENOID
11. ORIGIN OF ADDUCTOR ARCUS PALATINI SCAR PYLODICTIS
12. ANTERIOR CERATOHYAL-VENTRAL HYPOHYAL JOINT
13. DORSAL HYPOHYAL SIZE
14. FUSED UPPER HYPURALS
15. TRANSCAPULAR LIGAMENT OSSIFICATION

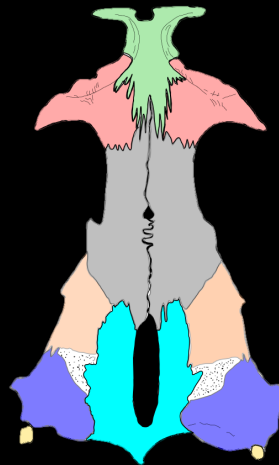
(TROGLOGLANIS (SATAN (PRIETELLA)))



SATAN



TROGLOGLANIS



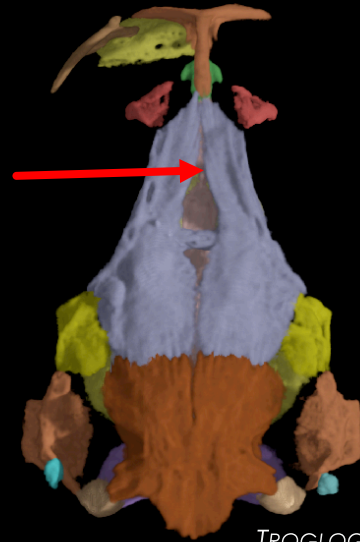
PRIETELLA PHREATOPHILA DIFFERS FROM THE OTHER THREE TROGLOBITES

- MESETHMOID CORNUA

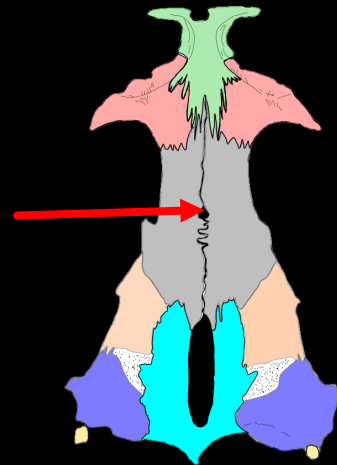
(TROGLOGLANIS (SATAN (PRIETELLA)))



SATAN



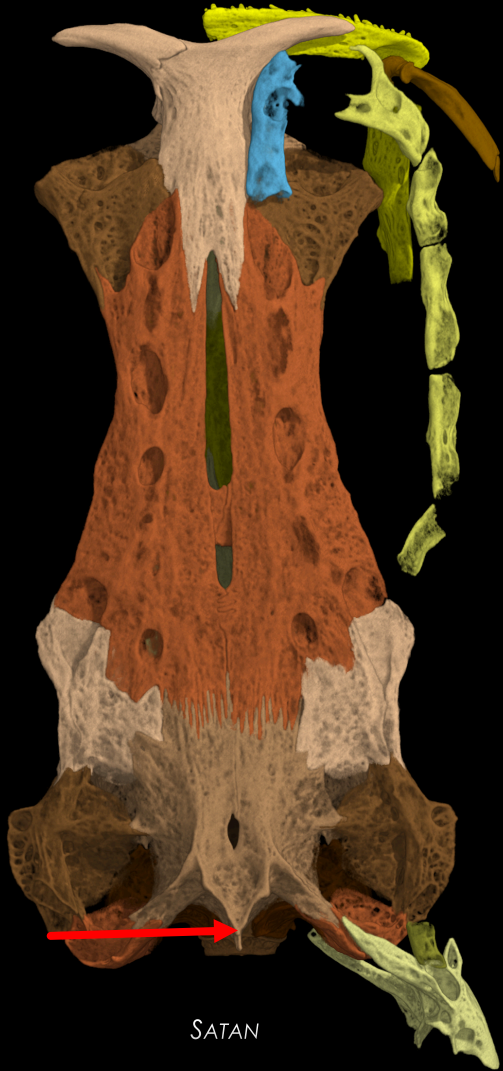
TROGLOGLANIS



PRIETELLA

- MESETHMOID CORNUA
- ANTERIOR CRANIAL FONTANEL

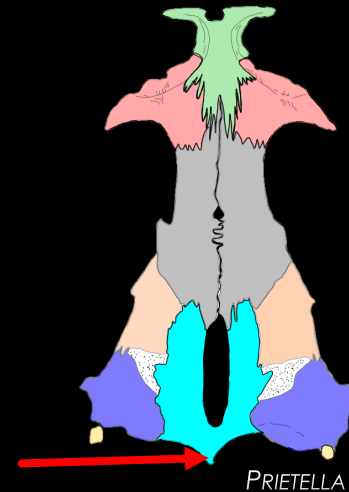
(TROGLOGLANIS (SATAN (PRIETELLA)))



SATAN



TROGLOGLANIS



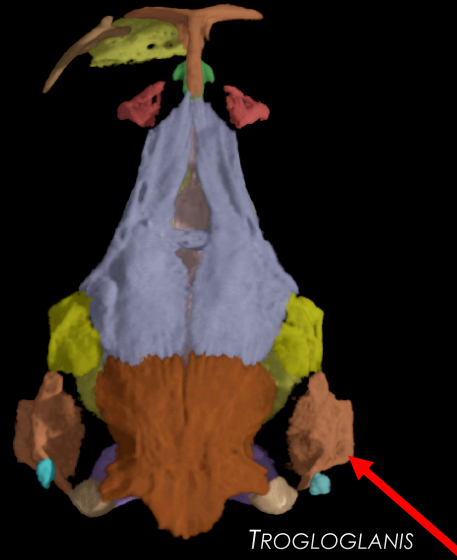
PRIETELLA

- MESETHMOID CORNUA
- ANTERIOR CRANIAL FONTANEL
- SUPRAOCCIPITAL POSTERIOR PROCESS

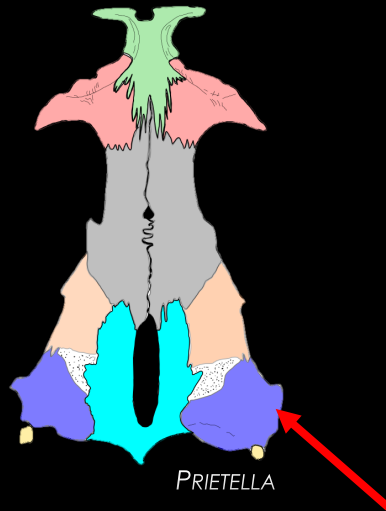
(TROGLOGLANIS (SATAN (PRIETELLA)))



SATAN



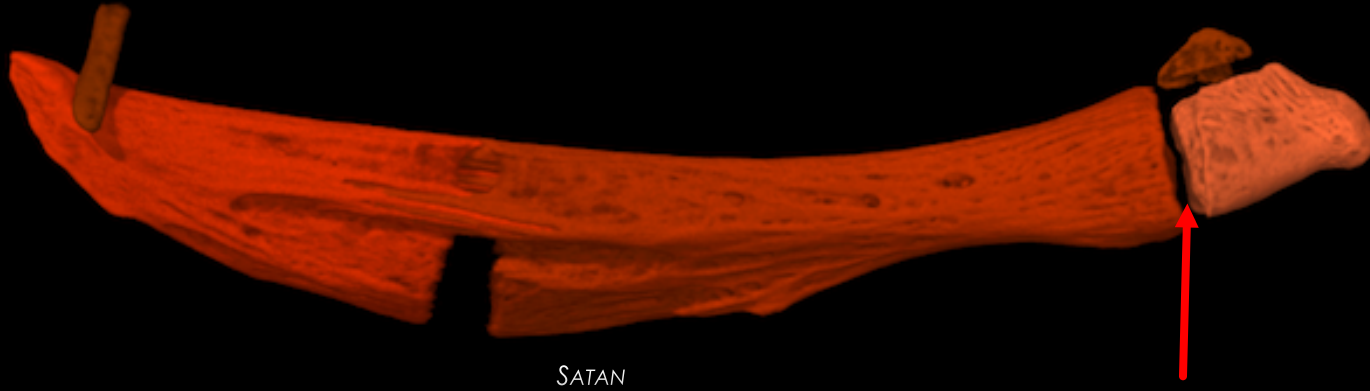
TROGLOGLANIS



PRIETELLA

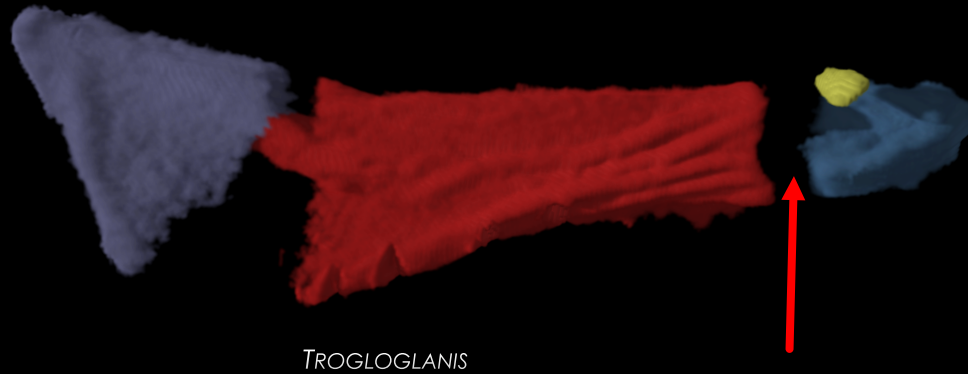
- MESETHMOID CORNUA
- ANTERIOR CRANIAL FONTANEL
- SUPRAOCCIPITAL POSTERIOR PROCESS
- PTEROTIC WING

(TROGLOGLANIS (SATAN (PRIETELLA)))



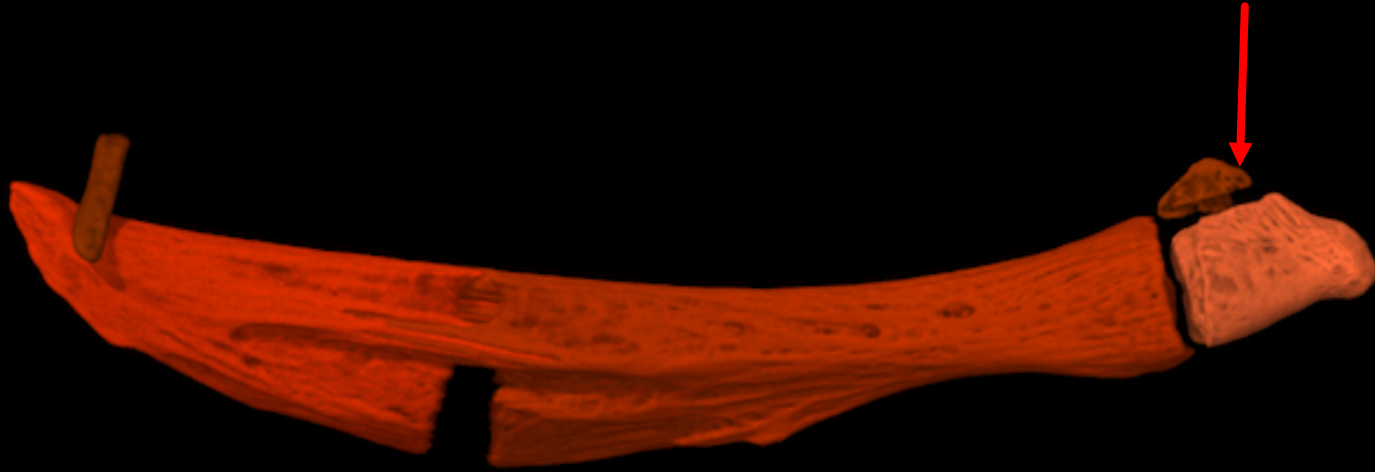
SATAN

- ANTERIOR CERATOHYAL-VENTRAL HYOHYAL JOINT



TROGLOGLANIS

(TROGLOGLANIS (SATAN (PRIETELLA)))



SATAN

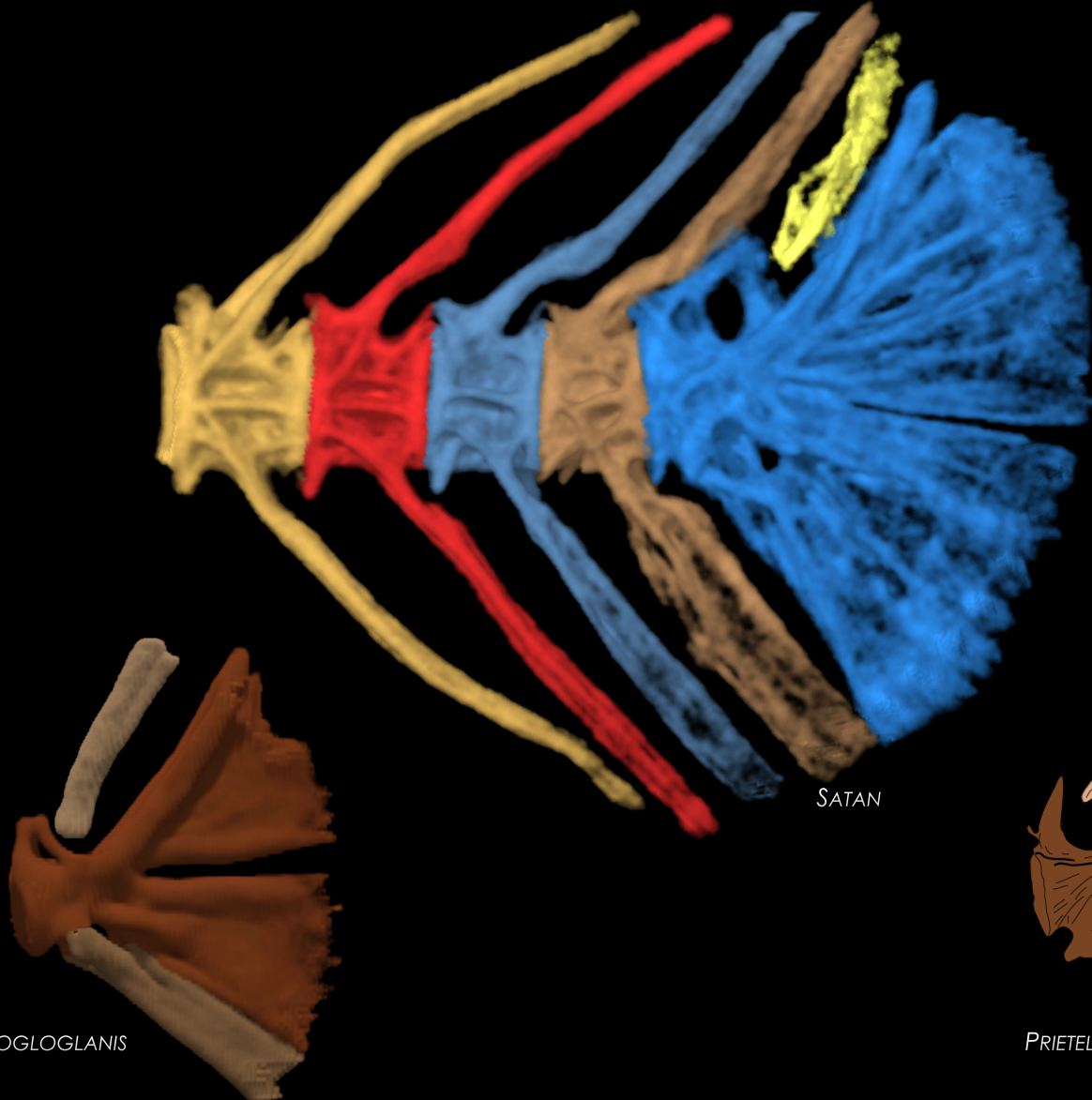
- ANTERIOR CERATOHYAL-VENTRAL HYPOHYAL JOINT



TROGLOGLANIS

- DORSAL HYPOHYAL

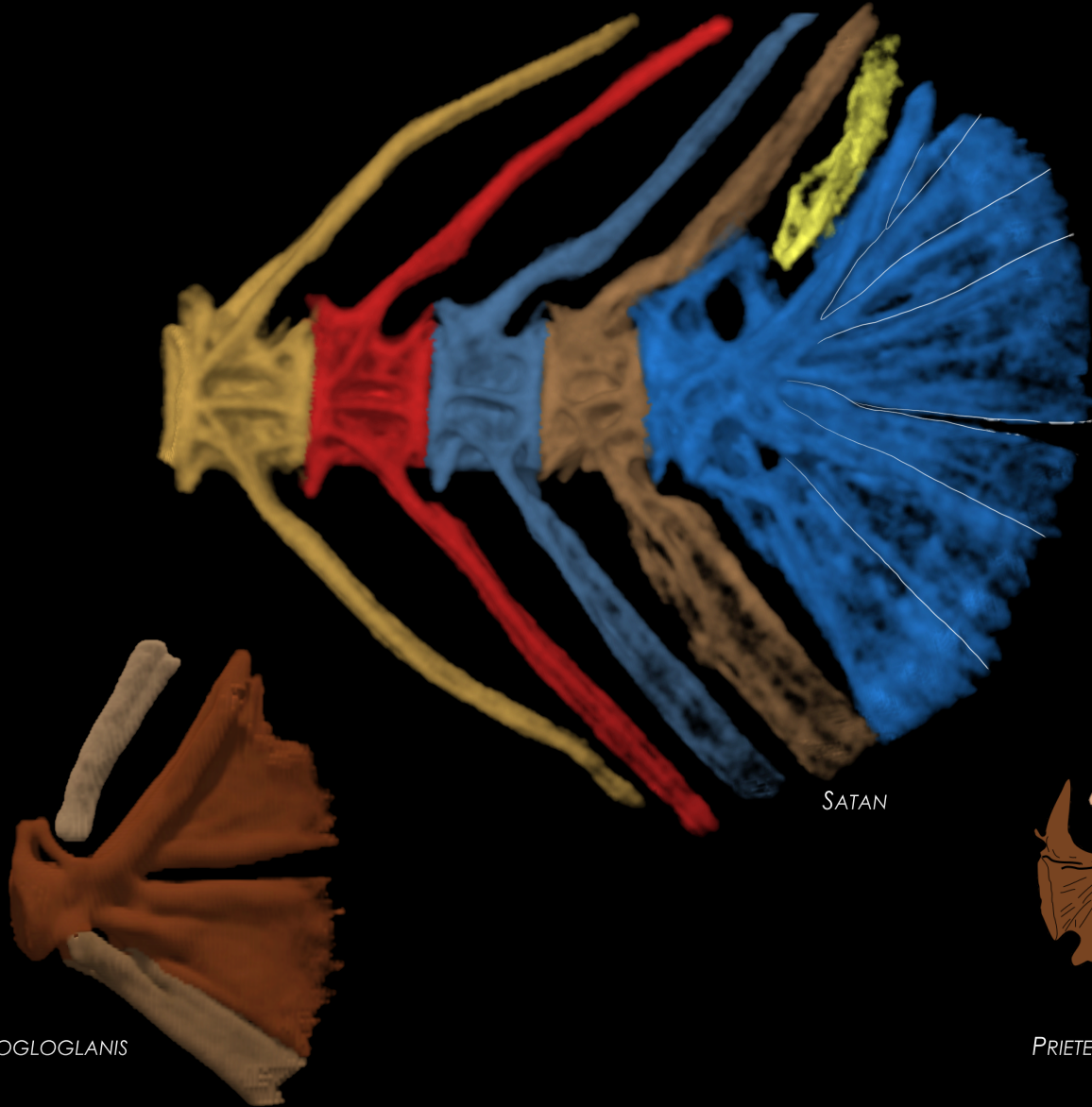
(TROGLOGLANIS (SATAN (PRIETELLA)))



- UPPER HYPURALS



(TROGLOGLANIS (SATAN (PRIETELLA)))



- UPPER HYPURALS

CONCLUSIONS

- CHARACTERS SUPPORTING THE *SATAN-PYLODICTIS* INVOLVE STRUCTURES THAT FUNCTION IN PREY DETECTION AND SUCTION FEEDING ON RELATIVELY LARGE PREY.
- UNDER SATAN + PYLODICTIS HYPOTHESIS: APOMORPHIC SIMILARITIES SHARED AMONG *SATAN*, *TROGLOGLANIS*, *P. PHREATOPHILA* AND *P. LUNDBERGI* ARE RECONSTRUCTED AS STYGOMORPHIC CONVERGENCES.
- UNDER THE TROGLOBITES HYPOTHESIS: APOMORPHIC SIMILARITIES SHARED BY *SATAN* AND *PYLODICTIS* ARE RECONSTRUCTED AS CONVERGENT HOMOPLASIES RELATED TO FEEDING MECHANISMS

CONCLUSIONS

- ADDITIONAL CHARACTER EVIDENCE AND/OR TIGHTER PHYLOGENETIC CONSTRAINTS IN ROBUST PHYLOGENY OF ICTALURIDAE IS NECESSARY
- MOLECULAR DATA ARE DIFFICULT TO OBTAIN DUE MAINLY TO LACK OF SPECIMENS OF *SATAN*, *TROGLOGLANIS* AND *P. LUNDBERGI* FROM THE TYPE LOCALITY.
- IF *PYLODICTIS* AND *SATAN* ARE SISTERS, THEIR SYNAPOMORPHIC CHARACTERISTICS ORIGINATED IN THEIR COMMON EPIGEAN ANCESTOR.
- FOR THE TROGLOBITES CLADE, A HYPOGEAN MOST RECENT COMMON ANCESTOR WITH SYNAPOMORPHIES SUCH AS LOSS OF EYES AND PIGMENTATION, AND SIMPLIFICATION OF THE 5TH VERTEBRA.

ACKNOWLEDGEMENTS

- A. COHEN, M. COLBERT, J. MAISANO - UNIVERSITY OF TEXAS
- K. CONWAY - TEXAS A&M
- A. SUMMERS - UNIVERSITY OF WASHINGTON, FRIDAY HARBOR LABORATORIES
- H. PRESTRIDGE - TAMU
- K. MCDERMID, J. KREJCA, P. SPROUSE & B. LARSEN - ZARA ENVIRONMENTAL LLC, MANCHACA, TX
- J. SULLIVAN - NIH GENBANK

THANK YOU

Satan eurystomus USNM 195830

