Skull remains of the British Early Cretaceous ankylosaurian dinosaur *Hylaeosaurus armatus*: description and phylogenetic implications

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Introduction & Methods

Hylaeosaurus armatus is a species of ankylosaur from the Early Cretaceous of southern England. First described in 1833 by the famous anatomist Gideon Mantell, it made up one of three fossil reptile taxa from which Richard Owen used to coin the term 'Dinosaur' in 1842. However, *Hylaeosaurus* is still only known from a single partially preserved specimen that was only very recently found to contain skull material. This project aimed to manually segment and describe X-ray micro-Computed Tomography data gained from the 'skull block' of the holotype of *Hylaeosaurus*. Manual segmentation, using a 'brush tool', was performed using the software VGStudio MAX 3.2. at the Natural History Museum, London.
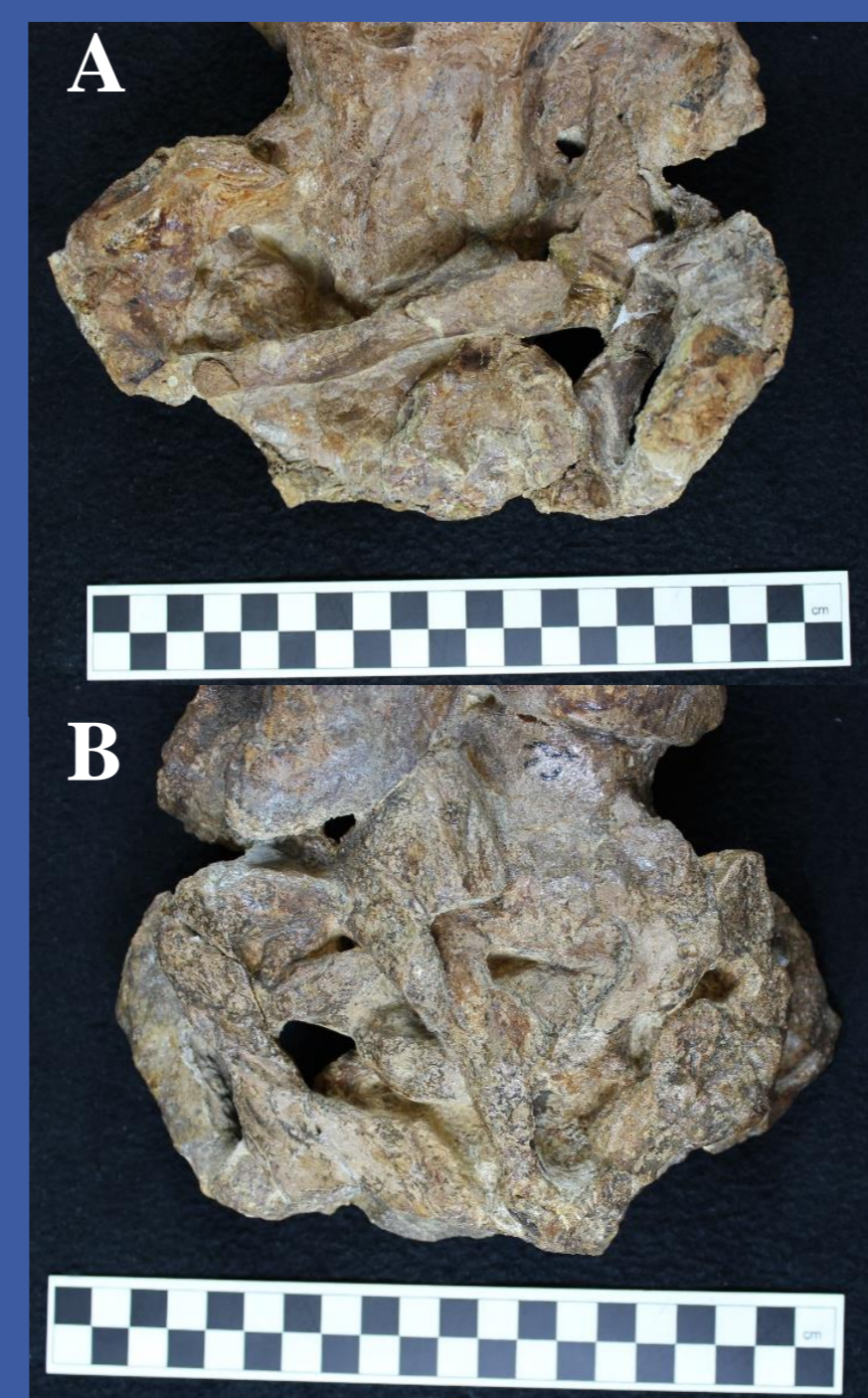

Figure 1: Dorsal (A) and ventral (B) views of the skull block of *H. armatus*.
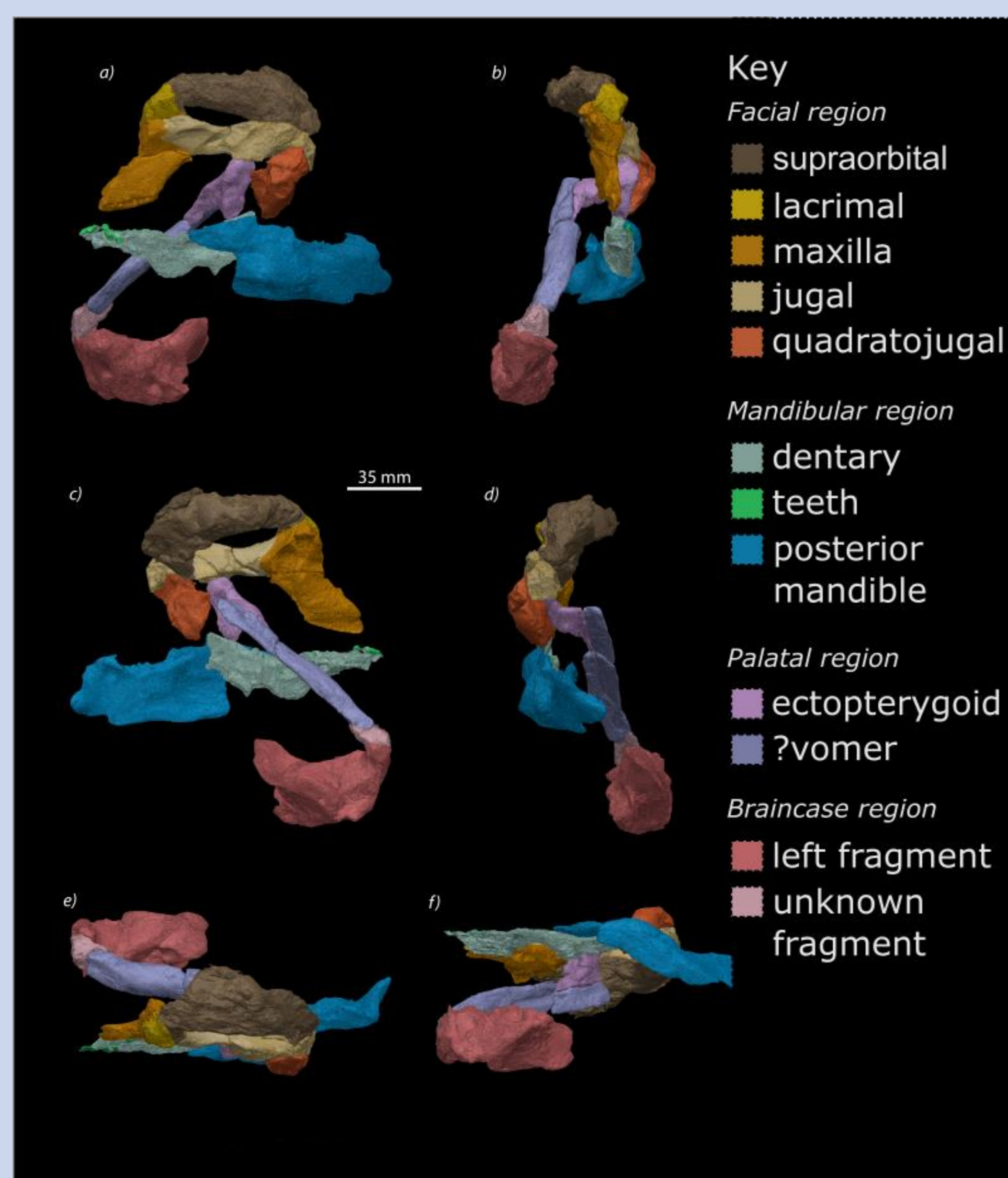
Segmented Skull Material

Key

Facial region
- supraorbital
- lacrimal
- maxilla
- jugal
- quadratojugal

Mandibular region
- dentary
- teeth
- posterior mandible

Palatal region
- ectopterygoid
- ?vomer

Braincase region
- left fragment
- unknown fragment

From all of the material segmented and described, four cranial regions were identified:
1. The 'facial region' comprised of the upper left jaw and orbital region;
2. The 'mandibular region' comprised of the lower dentary (including teeth – Figure 3) and posterior mandible;
3. The 'palatal' region comprised of the upper left side of the roof of the mouth;
4. The 'braincase region' including a large but indeterminate fragment of the left side of the braincase, with partially preserved inner ear canals inside (Figure 4)
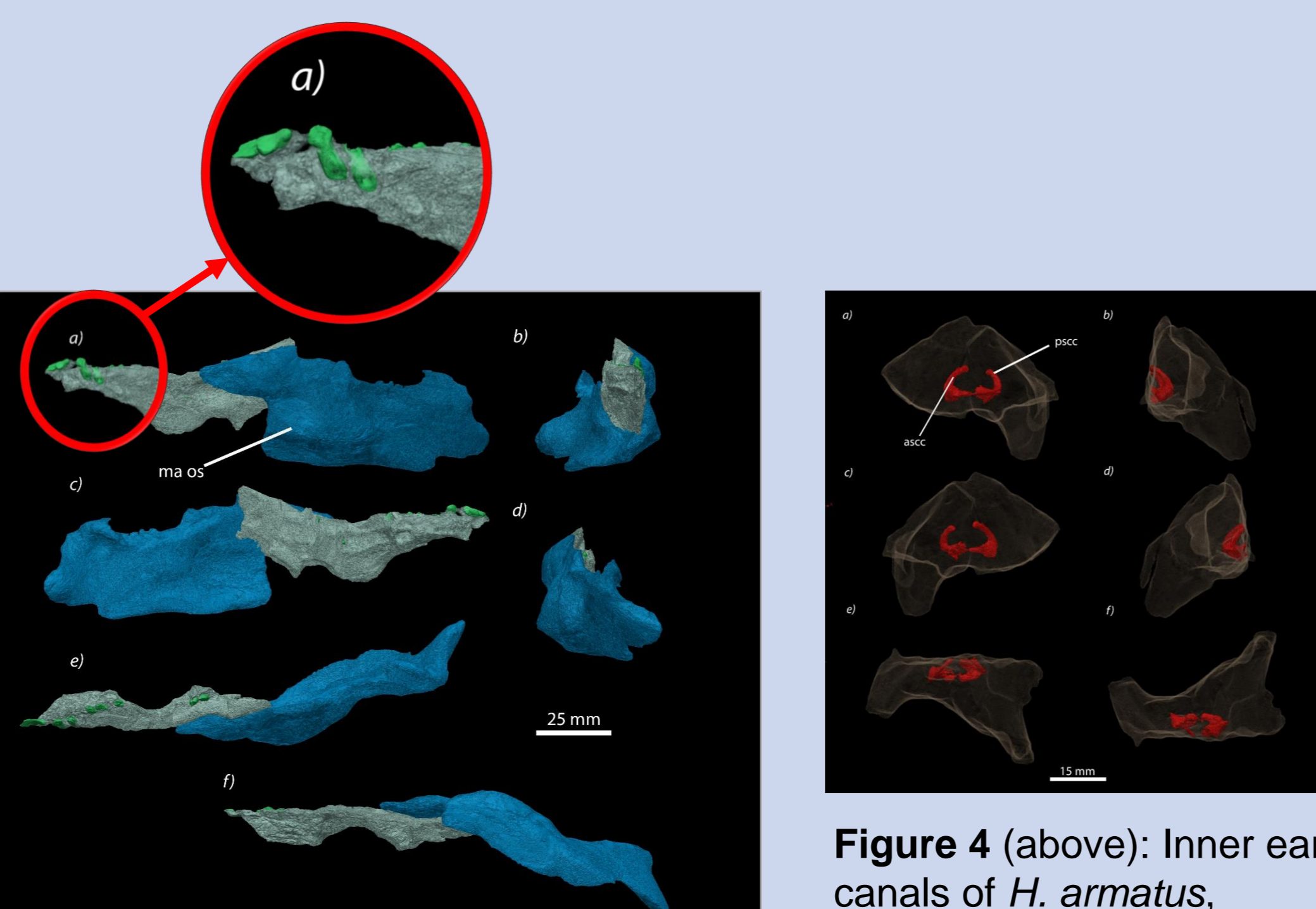

Figure 3 (right): Mandible of *H. armatus* with exposed teeth highlighted in red.

Figure 4 (above): Inner ear canals of *H. armatus*, highlighted in red within the left braincase fragment.

Figure 2: Composite of all segmented elements from the holotype of *H. armatus*.

Revised Phylogenies

Anatomical descriptions of the segmented skull material were used to place new character scores into matrices for two recent phylogenies of Ankylosauria. The two phylogenies were the study of Thompson *et al.* (2012) and the as of yet unpublished PhD thesis of Raven (2021). This was done to improve the character score data for *Hylaeosaurus*, and give further clues as to the placement of the dinosaur within the clade Ankylosauria.

Both analyses run in the software TNT v1.5 recovered *Hylaeosaurus* as an early-diverging member of the clade Nodosauridae. In Thompson *et al.* (2012), Nodosauridae is recovered as a monophyletic family, while in Raven (2021) Nodosauridae is a paraphyletic grouping of three different families and several outgroup taxa.
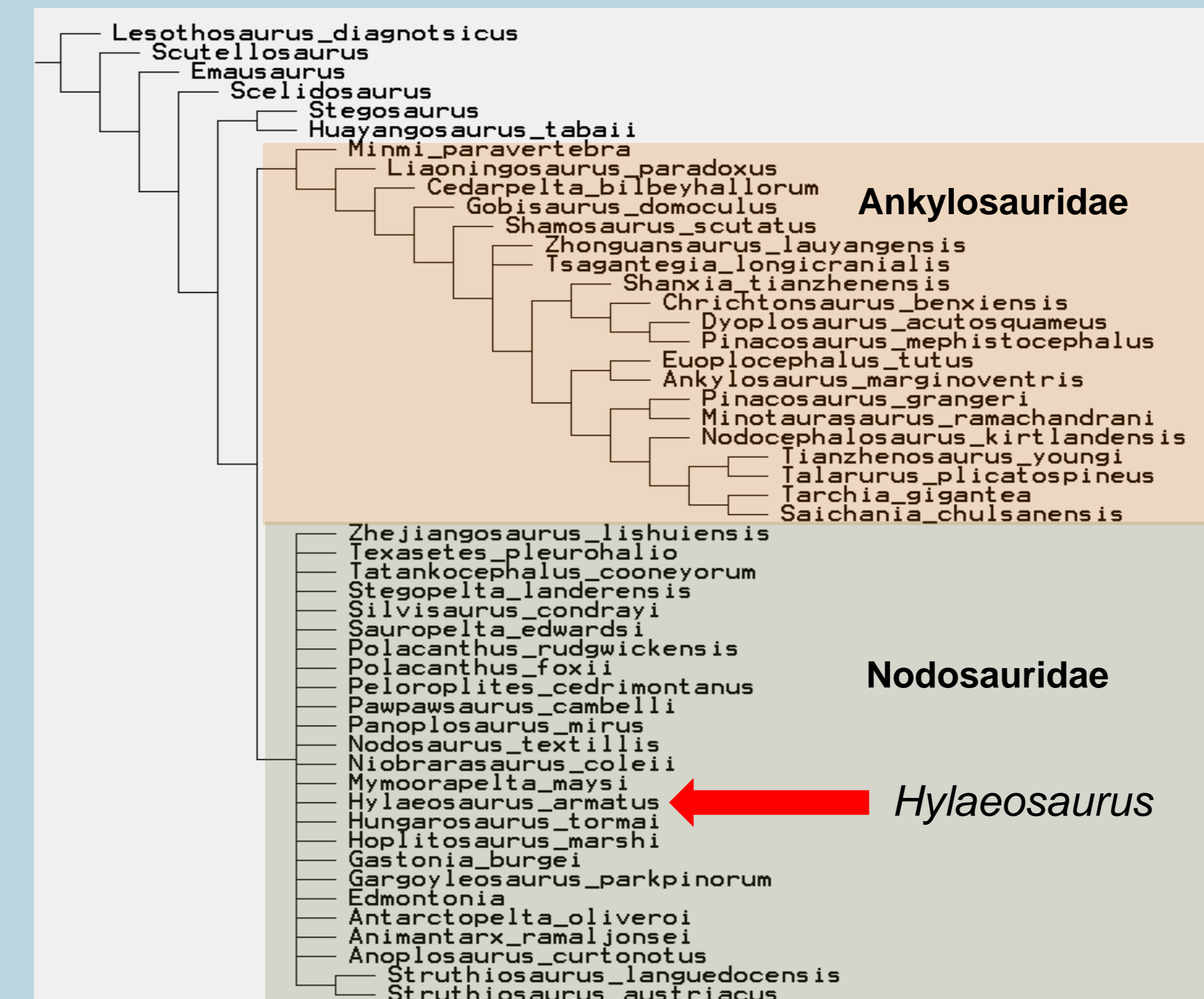
Based on Raven (2021):

Figure 6: Revised phylogeny from Raven (2021) with added character state scores from the cranium of *H. armatus*.

Based on Thompson *et al.* (2012):

Figure 5: Revised phylogeny from Thompson *et al.* (2012) with added character state scores from the cranium of *H. armatus*.
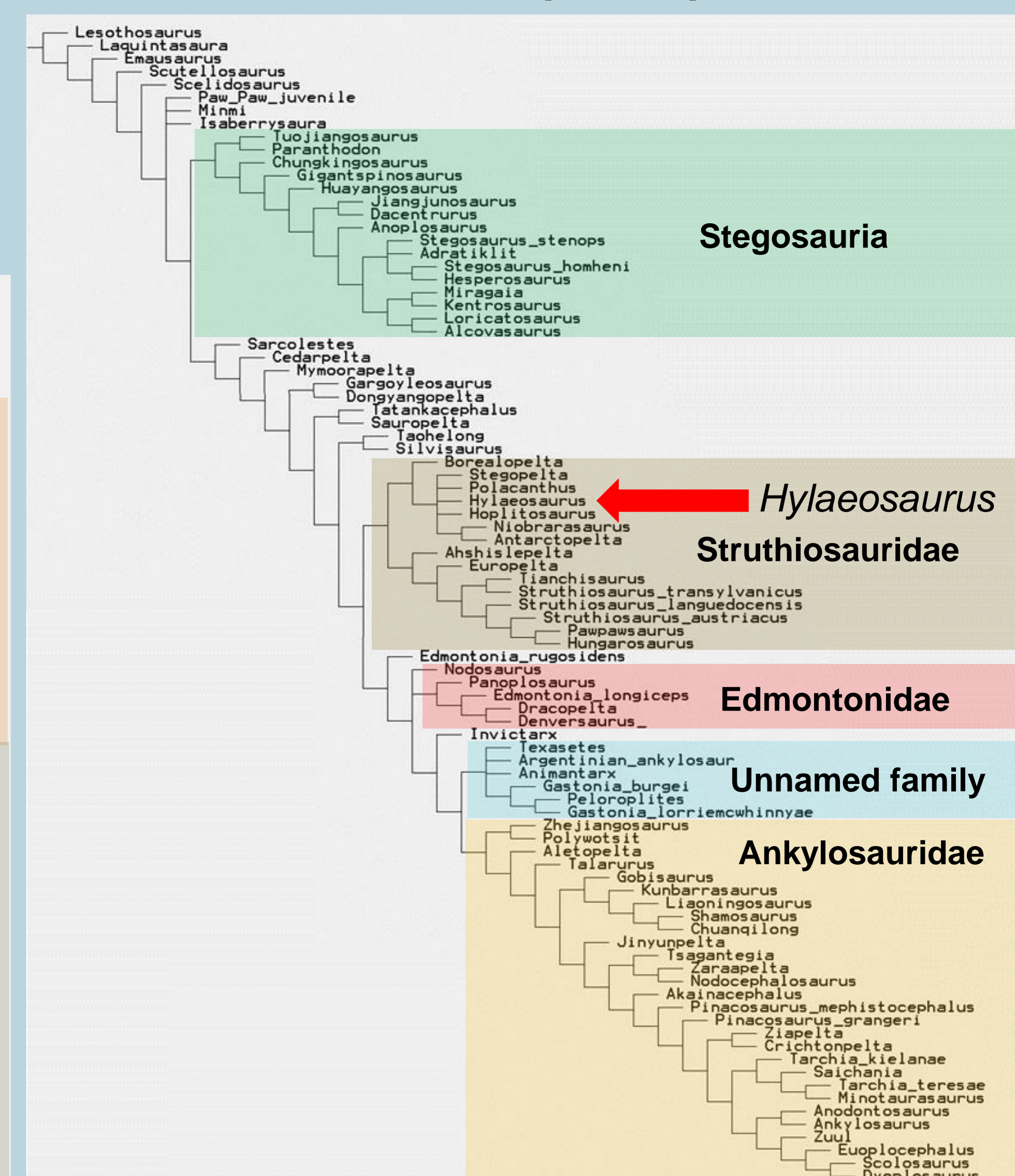
Implications & Conclusions

This project represents the first detailed work on skull material belonging to *Hylaeosaurus*. The cranial elements discovered were unexpectedly numerous and well articulated, and there are likely still undiscovered elements remaining in the skull block. The recovery of *Hylaeosaurus* as a nodosaurid in both phylogenetic analyses strengthens traditional interpretations of the genus and its close relatives, known as 'polacanthids', as being early-diverging nodosaurs, rather than members of the monophyletic family Ankylosauridae.

References

Raven, T. J. (2021). The Taxonomic, Phylogenetic, Biogeographic and Macroevolutionary History of the Armoured Dinosaurs (Ornithischia: Thyreophora) (Doctoral dissertation, University of Brighton).

Thompson, R. S., Parish, J. C., Maidment, S. C., & Barrett, P. M. (2012). Phylogeny of the ankylosaurian dinosaurs (Ornithischia: Thyreophora). *Journal of Systematic Palaeontology*, 10(2), 301-312.

Figure 1 photographed by the author. Figures 2-4 made by author using Adobe Photoshop 2021, with data exported from VGStudio MAX 3.2. and Blender 2.1. Figures 5-6 made using output generated from TNT v1.5. and edited using Microsoft Office.

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