Spring 5-9-2022

Reconstructing the Ecological Relationships of Late Cretaceous Antarctic Dinosaurs and How Functional Tooth Morphology Influenced These Relationships

Ian D. Broxson
Eastern Washington University

Recommended Citation

Broxson, Ian D., "Reconstructing the Ecological Relationships of Late Cretaceous Antarctic Dinosaurs and How Functional Tooth Morphology Influenced These Relationships" (2022). *2022 Symposium*. 4.
https://dc.ewu.edu/srcw_2022/4

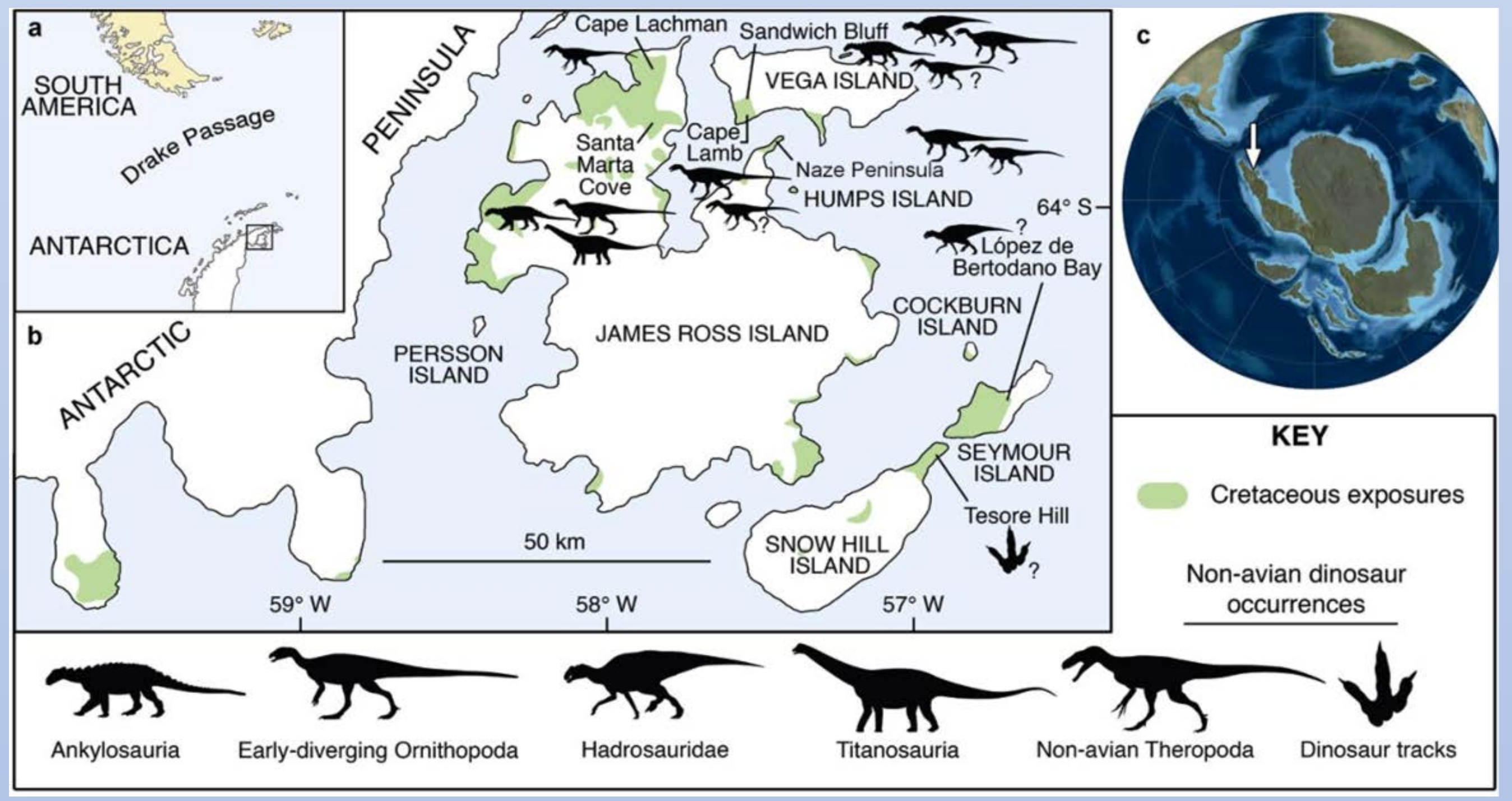
Reconstructing the Ecological Relationships of Late Cretaceous Antarctic Dinosaurs and How Functional Tooth Morphology Influenced These Relationships

Ian Broxson; Graduate Student, Department of Biology Eastern Washington University. Advisor: Dr. Judd Case

Abstract

The Sandwich Bluff Formation of the James Ross Basin of Antarctica has recently yielded a group of five late Cretaceous dinosaurs that lived contemporaneously with each other, a first for Antarctica. These five dinosaurs include fragmentary remains of two differently sized elasmarian ornithopods, a possible megaraptor, a hadrosaur, and a nodosaur. In this study we will construct a model of the ecological relationships of late Cretaceous Antarctica. Additionally, we will look at what specific factors allowed this group of four herbivores and a carnivore to coexist in a restricted locality and what niches were filled by each species. Methods to determine this will include a size estimation of these dinosaurs and a paleobotanical assessment of the Sandwich Bluff locality. A comparative analysis between these Sandwich Bluff dinosaurs and related species from other Gondwanan landmasses will help us in our analysis. Finally, we will perform an in depth analysis of functional tooth morphology and how that relates to diet, size and niche, which will be important for future study of other herbivorous dinosaurs.

Background



– The Sandwich Bluff Formation of the James Ross Basin of Antarctica has recently yielded a group of five dinosaurs that lived contemporaneously with one another in the late Cretaceous (Maastrichtian) (Lamanna 2019).

– Dinosaurs discovered included two elasmarians, one small and one medium, a hadrosaur, a nodosaur, and a suspected megaraptor.

– Elasmarians are a group of recently classed basal ornithopods that were very prevalent and endemic across Gondwanan landmasses in the Cretaceous (Rozadilla 2016).

– Hadrosaurs were highly derived Ornithopods with a near global distribution by the end of the Cretaceous. This discovery is the first and only known Hadrosaur to live in Antarctica (Case 2000).

– Nodosaurs are members of the *Ankylosauria* clade. An older Nodosaur *Antarctopelta oliveroi,* suggesting a relationship with this new, younger Nodosaur (Salgado 2006).

– Megaraptors are large Theropods found in both South America and Australia. If confirmed, this would be the first megaraptor recorded from Antarctica (White 2020).

Materials + Methods

– Materials

- The smaller elasmarian is represented by a single ungual, (Figure 2).
- The medium sized elasmarian is represented by metatarsal data and the proximal end of the fibula.
- The nodosaur is represented by an osteoderm.
- The hadrosaur is represented by a single tooth.
- The suspected megaraptor is represented by a portion of the maxilla.

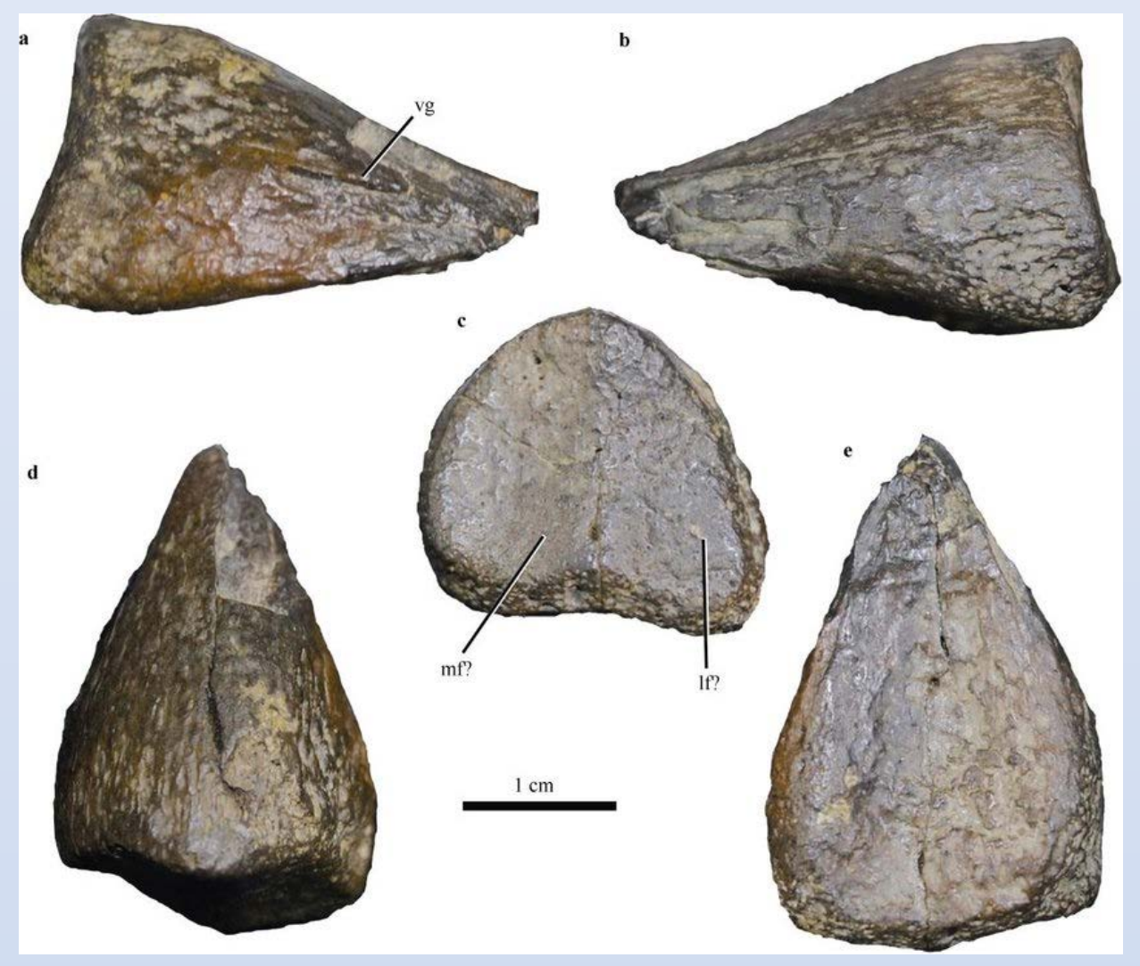


Figure 2 – smaller elasmarian ungual.

– Methods

– In order to make inferences on diet and ecology, we must first create a size estimate of the SBF elasmarians.

– To accomplish this, we performed a comparative analysis between the width of the ungual of the smaller SBF elasmarian to the width of unguals from other elasmarians and how that relates to size.

– We performed a similar analysis with Metatarsal IV and the proximal end of the femur to create more data points for our analysis.

– Functional tooth morphology was analyzed to determine diet and whether size, biogeography, or taxonomy influenced tooth structures.

– This allows us to infer what the dentition of the SBF elasmarians may have been.

– We accomplished this by creating phylogenetic trees in PAUP based on existing character data.

Results

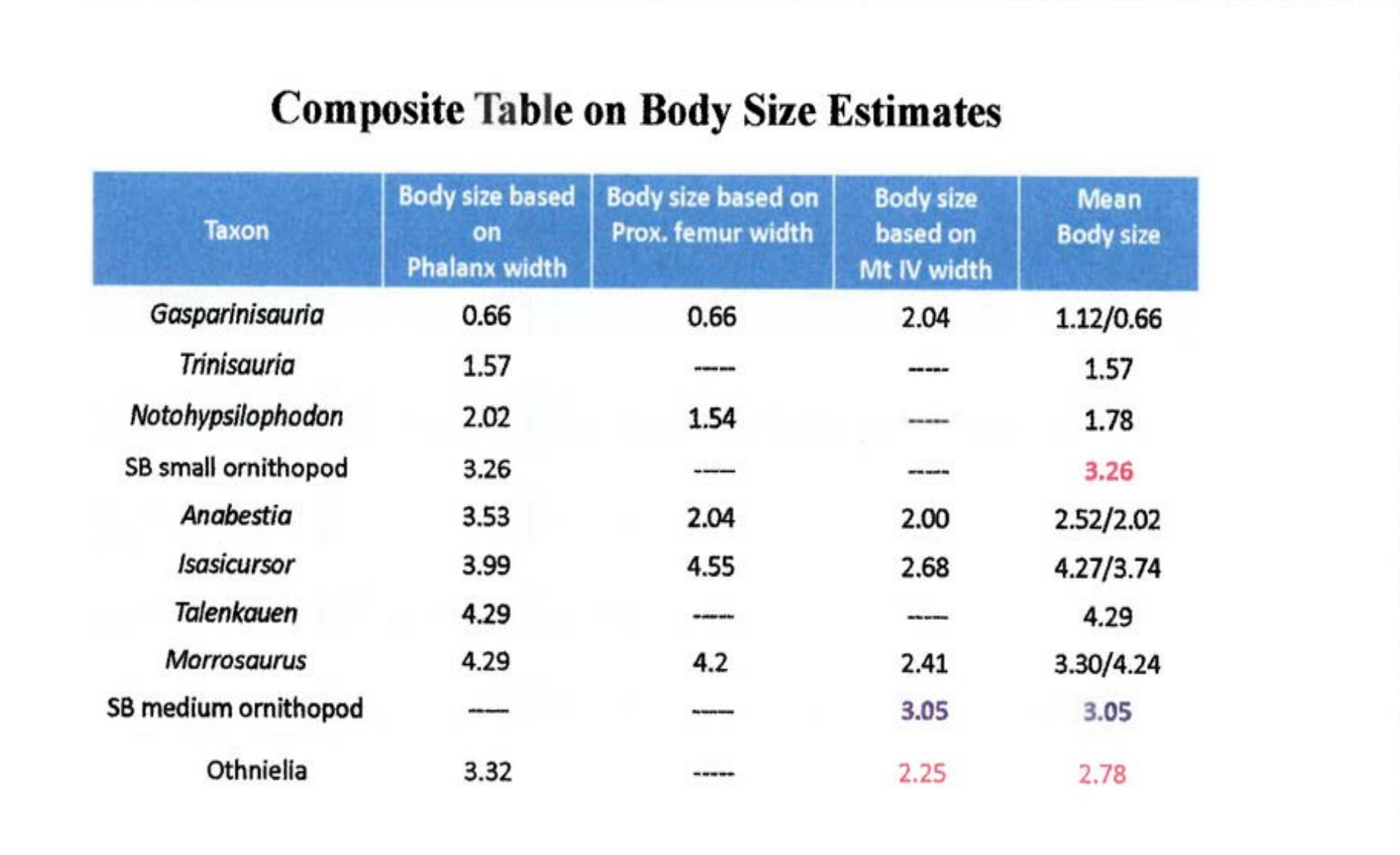
– Initial size estimates indicate the smaller elasmarian is 3.26 m long and the medium elasmarian is 3.05 m long. This result is most likely caused by lack of data points and using two different elements to determine size.

– This will be revisited to create a range of possible sizes of both elasmarians.

– We calculated several trees based on tooth morphology with varying parameters.

– The top tree removes one of the outgroup members, which put all of the Australian and South American members into distinctive clades.

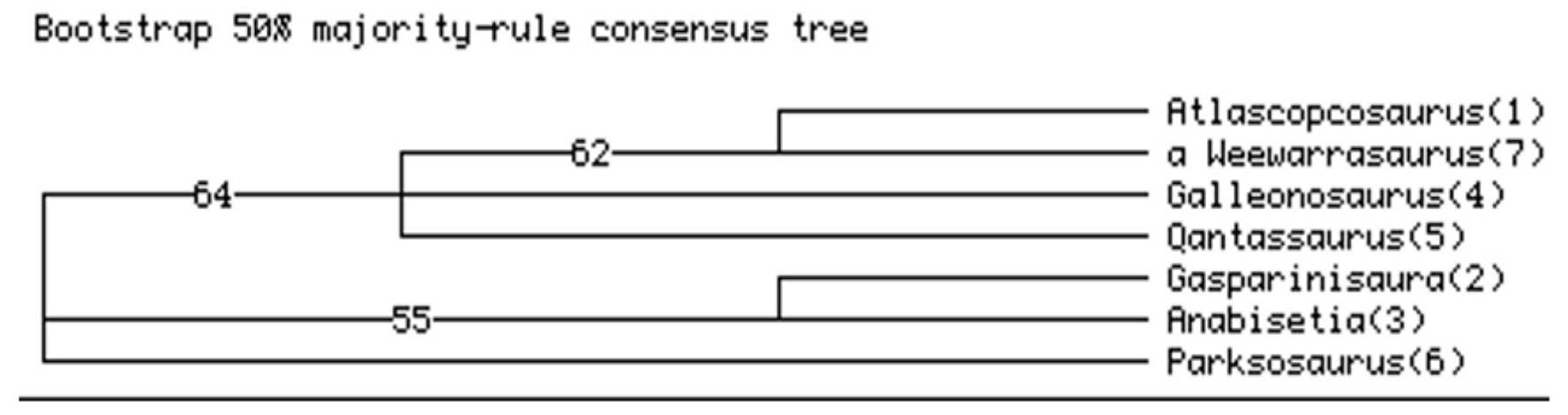
– The bottom one adds *Talenkauen* (a quite large South American elasmarian) which has very unique teeth and certainly skews the data.



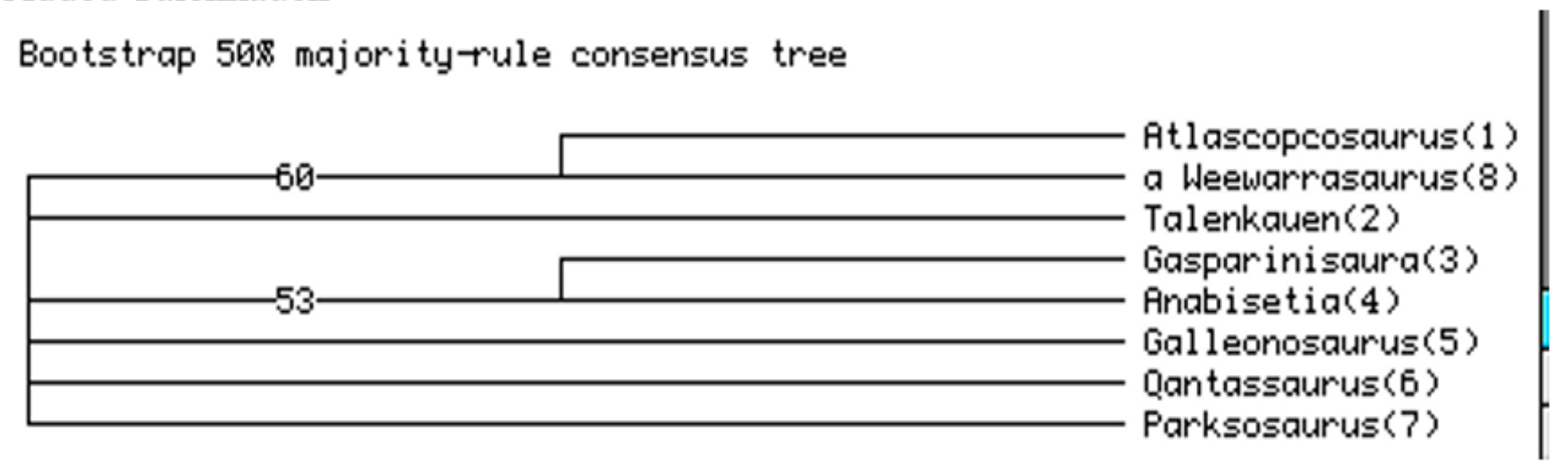
Composite Table on Body Size Estimates

Taxon	Body size based on Phalanx width	Body size based on Prox. femur width	Body size based on Mt IV width	Mean Body size
Gasparinisauria	0.66	0.66	2.04	1.12/0.66
Trinisauria	1.57	-----	-----	1.57
Notohypsilophodon	2.02	1.54	-----	1.78
SB small ornithopod	3.26	-----	-----	3.26
Anabestia	3.53	2.04	2.00	2.52/2.02
Isasicursor	3.99	4.55	2.68	4.27/3.74
Talenkauen	4.29	-----	-----	4.29
Morrosaurus	4.29	4.2	2.41	3.30/4.24
SB medium ornithopod	-----	-----	3.05	3.05
Othnielia	3.32	-----	2.25	2.78

Parksosaurus as the outgroup
No Hypsilohodon in analysis
Results - Australian elasmarians are a clade and South American elasmarians are a clade



Added Talenkauen



Conclusions

– Initial size estimates were not conclusive, with the smaller elasmarian seemingly bigger than the medium sized one. This suggests a new analysis is required to generate a size range for both of these dinosaurs. This will be important in determining what layer of the vegetation was available to these dinosaurs.

– Our analysis of functional tooth morphology indicates that biogeography influences different morphologies, with the Australian species and South American species forming loose clades. The exception to this is *Talenkauen* which is quite large and had quite powerful teeth, with the addition of both a piercing denticle and a cingulum.

– Research into functional tooth morphology will not only be important to our study of the SBF dinosaurs and their ecology. But to future research regarding other herbivorous dinosaurs.

Future Analysis

– More research will be required to create size estimates for our two elasmarians.

Skull of *Dryosaurus altus*

– We will run several Ranked Correlations (RC) between tooth size and morphological features to further determine the evolutionary driver of certain tooth morphologies. We will run one based on maxillary dentition morphology and another one for mandibular dentiition.

– Soon we are getting a cast of a Dryosaurus skull. Dryosaurids were primitive and not too dissimilar from elasmarians. We would determine functional jaw morphology of basal ornithopods based on this cast.

– Despite the lack of extant closely related taxa, we could compare some aspects of dentition to that of modern iguanas, as they have similar teeth and fill similar niches.

References

Case, J. A., Martin, J. E., Chaney, D. S., Reguero, M., Marenssi, S. A., Santillana, S. M., & Woodburne, M. O. (2000). The first duck-billed dinosaur (family hadrosauridae) from Antarctica. *Journal of Vertebrate Paleontology*, *20*(3). https://doi.org/10.1671/0272-4634(2000)020[0612:TFDBDF]2.0.CO;2

Lamanna, M. C., Case, J. A., Roberts, E. M., Arbour, V. M., Ely, R. C., Salisbury, S. W., Clarke, J. A., Malinzak, D. E., West, A. R., & O'Connor, P. M. (2019). Late Cretaceous non-avian dinosaurs from the James Ross Basin, Antarctica: description of new material, updated synthesis, biostratigraphy, and paleobiogeography. *1. Advances in Polar Science*, *30*(3).

Rozadilla, S., Agnolin, F. L., Novas, F. E., Aranciaga Rolando, A. M., Motta, M. J., Lirio, J. M., & Isasi, M. P. (2016). A new ornithopod (Dinosauria, Ornithischia) from the Upper Cretaceous of Antarctica and its palaeobiogeographical implications. *Cretaceous Research*, *57*. https://doi.org/10.1016/j.cretres.2015.09.009

Salgado, L., & Gasparini, Z. (2006). Reappraisal of an ankylosaurian dinosaur from the Upper Cretaceous of James Ross Island (Antarctica). *Geodiversitas*, *28*(1).

White, M. A., Bell, P. R., Poropat, S. F., Pentland, A. H., Rigby, S. L., Cook, A. G., Sloan, T., & Elliott, D. A. (2020). New theropod remains and implications for megaraptorid diversity in the Winton Formation (lower Upper Cretaceous), Queensland, Australia. *Royal Society Open Science*, *7*(1). https://doi.org/10.1098/rsos.191462