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Grant Proposal Final Draft

Topic:

Characteristics of survivor taxon from Mass extinction: case study from Dinosauria during Triassic-Jurassic extinction in South Africa

Hypothesis and Objectives:

The least studied field in mass extinction is the characteristics of animals that survived a mass extinction. Dinosaurs are the best example because they survived end-Triassic mass extinction. I suspect body size is the important factor for their survival. Small body size is more advantageous during mass extinction because they have fewer energy requirements than animals with bigger body size. To test this out, firstly, I will list out the list of dinosaur genera from Elliot Formation and sort them out into Late Triassic and Early Jurassic category. Elliot Formation is useful fossil site for my study because it not only contains both Late Triassic and Early Jurassic strata but also provides abundant dinosaur specimens for data collection. Second, mid-shaft circumferences of available long bones from Elliot Formation dinosaurs will be measured to find out the body weight of dinosaurs. Third, the body weight of Late Triassic and Early Jurassic will be compared to test out my hypothesis.

Significance:

Earth is facing the sixth extinction right now (Baronsky et al., 2011). Therefore, conservation of ecosystem and understanding past extinction records are highly on the rise among the scientific field. One of the understudied subjects about the mass extinction is about survivors of the extinction. Studying traits of mass extinction survivors is important because it would give a deeper understanding of nature and ideas of conservation biology. Most of the mass extinction study is based on marine fossils due to their high preservation possibility, and a wide range of ocean compare to the landmass. Studying the terrestrial extinction is critical to gain knowledge about sixth extinction since humans are land-dwellers, and most of the conservational efforts are focused on the terrestrial realm. In result, studying the terrestrial record of mass extinction is worth studying despite its small amount of samples.

One of the most understudied mass extinction is End-Triassic mass extinction. End-Triassic mass extinction is strongly linked with modern extinction because both extinction events go through global warming events triggered by large CO_2 emission (Ruhl et al., 2011). End-Triassic mass extinction happened around 201.3 million years ago and brought extinct of various marine invertebrate faunas such as conodonts (Hallam, 2007; Schoene et al., 2010). In terrestrial realm, extinction of large amphibians and archosauromorphs led the way to the dominance of dinosaurs (Brusatte et al., 2010). Therefore, early dinosaurs are regarded as a survivor from mass extinction, and their traits are worth studying to understand what traits are important factor for surviving the mass extinction. South Africa's Elliot Formation is the best location to examine this idea. Elliot Formation spans from Norian to Sinemurian, which is the best place to study dinosaur fossil records during End-Triassic Extinction (Yates, 2002; Knoll & Battail, 2001)

Dinosaur paleontology of Elliot Formation is actively researched field due to its abundance of fossil and significance (Barrett, 2009; Butler, 2010). However, detailed analysis of dinosaur paleobiology in Elliot Formation has not published yet. Therefore, this study will provide not only the first detailed analysis of dinosaur paleobiology from Elliot Formation but also attempt to define characteristics of animals survive from mass extinction.

Methods:

According to Bordy et al., Elliot formation divided into two members. The lower member of Elliot Formation is dated as Late Triassic, and the upper member of Elliot Formation is dated as Early Jurassic (2004). Therefore, firstly, I will list dinosaur genera from Elliot Formation and categorize them into lower member fauna and upper member fauna for future comparison. Paleobiology Database (or PBDB) will be used to find out Elliot Formation dinosaur genera and categorization.

For my research, obtaining body weight of the dinosaurs is important because body weight is a good proxy for body size. However, dinosaur fossils are not always complete. Ergo, it is impossible to measure body weight using full skeleton. In this case, long bones (femur and humerus) can be very useful to measure body weight. Measuring the mid-shaft circumference of the long bone is a good proxy for calculating body weight of dinosaur (Anderson et al., 1985). For bipedal dinosaur, it is more useful because only femur specimen is necessary to measure their weight. Most of Elliot Formation specimens are housed in museums in South Africa. Therefore, most of my work will happen in South Africa around 2016 August to 2017 January. I will measure the mid-shaft circumference of available humerus and femurs. If there's genus without long bones in the museum, I will refer past

references to get the measurement. Genera without long bone measurement record or specimen, they will be excluded from this research. The allometric equation will be applied to deduce out the body weight of dinosaurs. For quadruped dinosaurs, $W=0.078C_{h+f}^{2.73}$ and, for bipedal dinosaurs, $W=0.16C_{f}^{2.73}$ are used for calculation (W means the weight of the animal, C means the mid-shaft circumference of humerus and femur) (Anderson et al., 1985). If there's more than one measurement from one genus, values will be averaged to find the mean value of the weight.

Measured weight of animals will be categorized according to the living time. However, there might be a possibility of unequal sample size for both time periods. The unequal variance t-test will be used to resolve this problem (Ruxton, 2006). t-values will be compared between two periods and find out whether size is an important factor in mass extinction survivors.

Reference

Anderson, J. F., Hall-Martin, A., Russell, D. A., 1985. Long-bone circumference and weight in mammals, birds, and dinosaurs: Journal of Zoology, v.207, n.1, p.53-61.

Baronsky, A. D., Matzke, N., Tomiya, S., Wogan, G. O. U., Swartz, B., Quental T. B., Marshall, C., McGuire, J. L., Lindsey, E. L., Maguire, K. C., Mersey, B., and Ferrer, E. A, 2011. Has the Earth's sixth mass extinction already arrived?: Nature, v.471. p.51-57.

Barrett, P. M., 2009. A new basal Sauropodomorph dinosaur from the Upper Elliot Formation (Lower Jurassic) of South Africa: Journal of Vertebrate Paleontology, v.29, n.4, p.1032-1045.

Bordy, E. M., Hancox, P. J., Rubidge, B. S., 2004. Basin development during the deposition

of the Elliot Formation (Late Triassic-Early Jurassic), Karoo Supergroup, South Africa: South African Journal of Geology, v.107, n.3, p.397-412.

Brusatte, S. L., Nesbitt, S. J., Irmis, R. B., Butler, R. J., Benton, M. J., and Norell, M. A, 2010. The origin and early radiation of dinosaurs: Earth-Science Reviews, v.101, n.1-2, p.68-100.

Butler, R. J., 2010. The anatomy of the basal Ornithischian dinosaur *Eocursor parvus* from the lower Elliot Formation (Late Triassic) of South Africa: Zoological Journal of the Linnaean Society, v.160, n.4, p.648-684.

Hallam, A, 2007. How catastrophic was the end-Triassic mass extinction?: Lethaia, v.35, n.2, p.147-157.

Knoll, F. & Battail, B., 2001. New ornithischian remains from the Upper Elliot Formation (lower jurassic) of lesotho and stratigraphical distribution of southern African fabrosaurids: Geobios, v.34, n.4, p.415-421.

Ruhl, M., Bonis, N. R., Reichart, G., Sinninghe Damste, J. S., and Kürschner, W. M., 2011. Atmospheric carbon injection linked to End-Triassic mass extinction: Science, v.333, n.6041, p.430-434.

Ruxton, G. D, 2006. The unequal variance t-test is an underused alternative to Student's t-test and the Mann-Whitney U test: Behavioral Ecology, v.17, n.4, p.688-690.

Schoene, B., Guex, J., Bartolini, A., Schaltegger, U., and Blackburn, T. J., 2010. Correlating the end-Triassic mass extinction and flood basalt volcanism at the 100 ka level: Geology, v.38, n.5, p.387-390.

Yates, A. M., 2002. A definite prosauropod dinosaur from the Lower Elliot Formation

(Norian: Upper Triassic) of South Africa: Palaeontologia Africana, v. 39, p.63-68.