Lauren Silverstein
University of Wisconsin-Madison

Modeling possible stratigraphic forces on the Cretaceous sauropod hiatus

Problem, hypothesis and objectives

The 25-30 million-year sauropod hiatus was initially thought to indicate their extinction in the Northern hemisphere in the late Albian, followed by invasion in the Maastrichtian by South American taxa. Recent work suggests the hiatus is a product of stratigraphic biases; transgression of the Western Interior Seaway led to a shift to coastal deposition, excluding inland-dwelling sauropods from preservation.

I will assess the validity of the stratigraphic hypothesis with a regression model using occurrence data from the Paleobiology Database and Macrostrat. The model will yield probability of preservation through time for sauropods, dinosaurs with similar habitats that underwent no hiatus, and all dinosaur taxa through the Jurassic and Cretaceous. Similar probability of preservation for sauropods and other inland-dwelling dinosaurs would indicate a stratigraphic cause for the hiatus, while differing probabilities in preservation would suggest other forces at work.

Societal and scientific significance

Sauropods reached their peak diversity and abundance in the Jurassic period, but they spanned the Mesozoic and persisted until the Maastrichtian extinction (D'Emic et al., 2010) Until recently, no North American or European sauropod fossils were known from the Albian/Cenomanian through the Maastrichtian (D'Emic et al.,

2010). Recent work has narrowed the gap to approximately 10 million years in North America, and Gondwanan deposits display a continuous sauropod record (Mannion et al., 2011). These findings have led paleontologists to two conclusions: either the hiatus reflects extinction of sauropods in the Northern Hemisphere followed by invasion of southern taxa (Lucas, 1989), or it is an artifact of stratigraphic biases and indicates a shift in deposition away from sauropod ranges (Mannion et al., 2011). I intend to test the presence of stratigraphic biases that may be controlling Cretaceous preservation of sauropods, by comparing their preservation probability to those of contemporary taxa with similar habitats. Sauropods are preferentially preserved in inland environments (Lockley et al., 1994), as are other dinosaur taxa such as ceratopsians, theropods and ankylosaurs (Butler et al., 2008), yet no hiatus is seen among them.

Of all the organisms found in the fossil record, dinosaurs are among the most compelling to human curiosity. The results of this project may educate the public about this significant interval of the Mesozoic, thus generating increased interest in paleobiology and geology. Furthermore, our findings will contribute to a better understanding of sauropod evolution and may help advance the use of stratigraphy to solve gaps in the terrestrial record. In order to fully grasp how sauropods responded to their changing environment, we must first separate trends in their diversity from confounding stratigraphic biases (Kidwell et al., 2002). Identifying a cause for the hiatus, whether stratigraphic or biological, will direct future efforts in studying sauropod ecology.

Research Plan

I plan to model the probability of sauropod preservation across the Late Jurassic-Late Cretaceous at the stage level, using occurrence data of sauropods, dinosaurs with similar habitats, and all contemporary dinosaur taxa from the Paleobiology Database spanning the Late Jurassic-Late Cretaceous. The model will incorporate Macrostrat unit data on depositional environment (terrestrial versus coastal) and fossil occurrence data. Ceratopsians, pachycephalosaurids, theropods and some ankylosaurs are associated with sauropods in inland environments, while hadrosaurs are abundant in Cretaceous coastal units (Butler et al., 2008, Lockley et al., 1994). The regression model will assess whether significant differences exist in preservation between sauropods and terrestrial non-sauropod dinosaurs, with a weak correlation indicating some non-stratigraphic factor may be exerting control. I will normalize sauropod occurrences to those of terrestrial non-sauropods for each stage over the interval to better resolve preservation probability through time. Additionally, I will model the relationships between sauropod, terrestrial non-sauropod, coastal non-sauropod and all dinosaur occurrences, to gain a fuller picture of preservation dynamics over the interval. Sauropod preservation likelihood will correlate with other inland dinosaur preservation likelihood in a scenario controlled by shifts in depositional centers.

References:

Butler, R.J., Barrett, P.M., 2008. Palaeoenvironmental controls on the distribution of Cretaceous herbivorous dinosaurs.

D'Emic, M., Wilson, J., Thompson, R, 2010. The end of the sauropod dinosaur hiatus in North America.

Kidwell, S.M. and Holland, S.M., 2002. The quality of the fossil record: Implications for evolutionary analyses.

Lockley, M.G., Meyer, C.A., Hunt, A.P., Lucas, S.G., 1994. The distribution of sauropod tracks and trackmakers.

Lucas, S.G.,1989. *Alamosaurus* and the sauropod hiatus in the Cretaceous of the North American Western Interior.

Mannion, PD and Upchurch, P, 2011. A re-evaluation of the 'mid-Cretaceous sauropod hiatus' and the impact of uneven sampling of the fossil record on patterns of regional dinosaur extinction.

Wilson, J., 2015. Sauropod Phylogeny.