Nicholas Boulanger

Grant Proposal

**Introduction.**

My objective is to test whether fossil evidence of transitional bats (order Chiroptera) in North America can be predicted based on paleontological and stratigraphic data. Modern bats are an incredibly diverse taxon, but discerning evolutionary relationships between bats and other extant mammals is difficult and potentially unreliable without fossil evidence. An important step in advancing the study of prehistoric life is increasing the reliability and precision with which scientists can locate fossils evidence; in the past, this process has been largely guesswork (Oheim 2007). I hypothesize that the presence of transitional fossil forms representing primitive bat lineages can be found, using a multidimensional approach including stratigraphy, existing fossil records, and Geographic Information Systems (GIS).

**Justification.**

Despite decades of research, the origin of Chiroptera remains unclear. Morphological and genetic analyses support the conclusion that bats are monophyletic (Gunnell and Simmons 2005, Simmons et al. 2008), but their evolutionary relationship with other mammals is, as of yet, undetermined. The primary reason for this is simple: intermediate forms between bats and more primitive mammalian ancestors have not been found in the fossil record (Gunnell and Simmons 2005, Simmons et al. 2008). The first bats to appear as fossils already have the complex and derived traits associated with flight and, in many cases, echolocation as well (Gingerich 1987, Simmons et al. 2008, Hand et al. 2015), although echolocation apparently developed after flight (Simmons et al. 2008). In order to determine how these derived traits evolved, paleontologists must attempt to fill in gaps in the depauperate bat fossil record (Eiting 2009). Predicting where such fossils might be found, however, is a difficult task. Nevertheless, more sophisticated predictive modelling of sites where fossils are likely to be found should have huge payoffs, both in the study of Chiropteran and all other prehistoric life.

**Research Plan.**

I will use the distribution of known bat fossil occurrences in the Paleontology Database to determine where temporal gaps in the Chiroptera fossil record are present. For example, since superficially modern-looking bats are found in late Paleocene and Eocene deposits, transitional forms might be found in early Paleocene or late Cretaceous strata. Stratigraphically relevant data from the Paleontology Database, as well as the MacroStrat Database, will be used to determine where deposits of the appropriate age are exposed. After that, I will use GIS data of those sites to produce a suitability matrix determining where within promising deposits fossils are likely to be found, based on metrics such as terrain accessibility, vegetation coverage, and elevation. Fieldwork will be conducted in the summer of 2017. I will travel to at least one site for which transitional fossils are predicted by the above analyses, and prospect for fossils.

**References.**

Eiting, T.P, 2009. Global Completeness of the Bat Fossil Record: Journal of Mammalian Evolution, v.16, n.3, p.151-173.

Gingerich, P.D., 1987. Early Eocene bats (Mammalia, Chiroptera) and other vertebrates in freshwater limestones of the Willwood Formation, Clark’s Fork Basin, Wyoming: Contributions from the Museum of Paleontology, University of Michigan, v.27, n.11, p. 275-320.

Gunnell, G.F., and Simmons, N.B., 2005. Fossil Evidence and the Origin of Bats: Journal of Mammalian Evolution, v.12, n.1, p.209-246.

Hand, S.J., Sigé, B., Archer, M., Gunnell, G.F., and Simmons, N.B., 2015. A New Early Eocene (Ypresian) Bat from Pourcy, Paris Basin, France, with Comments on Patterns of Diversity in the Earliest Chiropterans: Journal of Mammalian Evolution, v.22, n.3, p.343-354.

Oheim, K.B., 2007. Fossil site prediction using geographic information systems (GIS) and suitability analysis: The Two Medicine Formation, MT, a test case: Palaeogeography, Palaeoclimatology, Palaeoecology, v.251, n.3-4, p.354-365.

Simmons, N.B., Seymour, K.L., Habersetzer, J., and Gunnell, G.F., 2008. Primitive Early Eocene bat from Wyoming and the evolution of flight and echolocation: Nature, v.451, p. 818-821.

Teeling, E.C., Springer, M.S., Madsen, O., Bates, P., O’Brien, S.J., and Murphy, W.J., 2005. A Molecular Phylogeny for Bats Illuminates Biogeography and the Fossil Record: Science, v.307, p.580-583.