Research Experience

As you read this document, you are likely hearing some semblance of my voice. Even without crucial auditory cues in writing, audition is still being utilized. Along with being used for vocal communication within and between species, hearing is often necessary for sound localization (determining where a sound originated from), effective predator avoidance, prey capture, and more. Given the vast uses of hearing, I am interested in understanding the sensory ecology of audition in both extant and extinct reptiles. What were extinct reptiles using their hearing for and what selective pressures lead to changes in they way they respond to auditory cues? We can better understand how extinct reptiles used hearing to navigate their environment by studying extant reptiles including birds, elucidating the mechanics of how they hear, and assessing their hearing ranges and sensitivity.

My current research project focuses on using preservable morphology and characters of the middle and inner ear to develop new proxies to predict the hearing ranges of extinct reptiles. More broadly than this project, I am most interested in exploring the relationships between morphometric measurements and traits for model development. I am interested in predicting shifts and changes in traits in deep time with these predictive models. I use interdisciplinary approaches at the intersections of Geology, Biology, and Computer Technology to develop these new proxies. My methodologies include the use of X-ray Computed Tomography (CT) data, coding in R and Python languages, and various phylogenetic comparative methods. Considering the breadth of methodologies utilized in such a project, I believe I would be a good fit in the Geology department of Prestigious University.

At your university, I will continue to do research within the focus of sensory ecology in Reptilia and exploring how extinct taxa interacted with the auditory cues in their environments. With this project and others described below, I have space for both undergraduate and graduate students to participate in research. From segmenting CT data and collecting 3-D morphometric measurements to collecting data in the field with future projects, students will have the ability to design and lead their own projects with guidance, mentorship, and skill development provided by me and other lab members. The projects I plan to continue and guide student projects in are listed below.

Hearing Capabilities in Reptiles

As mentioned previously, I am developing better proxies for hearing range and maximum hearing frequency in extinct reptiles. Identifying bony and preservable characters in the middle and inner ears of extant reptiles, students would have the ability to segment CT data, make measurements, and learn to use phylogenetic comparative methods to analyze the data. This project was envisioned upon realizing that no current proxies to determine the hearing capabilities of extinct reptiles utilized any phylogenetic analysis, which is crucial for reducing error when the data is heavily affected by the relationships between different species (the non-independence of species). In this way, the models produced through this project may reveal new clade wise relationships between the characters of study and hearing range or maximum hearing frequency. This project has already revealed that phylogenetic models perform better at predicting hearing range and maximum frequencies in reptiles.

Bone Histology and Metabolic Rate

Along the lines of my previous project, I am also interested in exploring the relationships between histological thin section measurements and metabolic rate. It has been proposed that the size and estimated volume of the osteocytes present within the bone are good predictors of basal metabolic rate within reptiles, including birds. This is the resting rate of metabolism and is especially important when thinking of the relationship between flight and metabolism. We see that volant or flying taxa have significantly higher metabolic rates, but the causation has yet to be differentiated. Does a higher metabolic rate evolve first and then allow for volancy, or is the higher metabolic rate a result of flight? To get at the answer to this question, you can develop proxies that allow you to discern the metabolic rate of within extinct species and map those predicted values onto a phylogeny. This would then reveal if there was an increasing trend of metabolic rate within Theropoda before we have evidence of flight. Preliminary results have shown that these osteocyte measurements are good predictors of metabolic rate. Applying this proxy extensively to the fossil record to evaluate these shifts is the current phase of this project. This work has been done with help from undergraduate students within my lab, whom I have helped advise on the

Future Projects

As a continuation of my project developing proxies to predict the hearing capabilities of Reptiles in deep time, I would like to apply these proxies at a large scale. No large scale studies have yet been done to see how hearing range and maximum hearing frequencies have shifted within Dinosauria. I propose to apply my new models and perform ancestral state reconstructions to see how the processing of auditory cues has changed. My research has demonstrated that hearing in birds is significantly extended in the high frequency ranges in comparison to other Reptiles, but no one has explored where this shift occurs and why. I hypothesize that changes in body mass as well as vocal communication may have led to these shifts within Aves. These hypotheses would be explored during my time at Prestigious University.

In terms of new projects in sensory ecology, I have proposed to study the soundscape of portions of the cloud forest within Ecuador. Within this area, there is a large amount of avian biodiversity, especially in terms of vocal communication I plan to input long term monitors that would continually collect soundscape data from multiple perspectives and areas within the forest. This data would then be listened to and analyzed for distinct species of bird, the frequency bands of vocal communication present, and how the sounds of the cloud forest change from day to night. A project like this, though crucial in assessing up to date biodiversity levels of the forest, may also provide some insight as to what the soundscape may have been like in the past, as well as how different environments and geological features shape these soundscapes.