SYSTEMATIC REVIEW ON THE EFFECTS OF CLIMATE ON AUDITORY BULLAE SIZE IN GEOGRAPHICALLY OVERLAPPING PEROGNATHUS SPECIES

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Abstract
The purpose of our summer research is to compile results and trends observed in previous studies to better understand the function of auditory bullae, the variations in size and shape throughout the overlapping geographic distribution of Perognathus species, and the relationship between bullar size and climatic patterns. Our research found that there is a negative correlation between auditory bulla size and the amount of moisture in the habitat. Large and inflated auditory bullae are observed in arid and open habitats. Although there are conflicting evidence on whether or not auditory bullae inflation is directly driven by the lack of precipitation, all of the studies agreed that the dryness of the environment creates a common selective pressure that results in phenotypic convergence in geographically overlapping Perognathus species.

Introduction
- Species of the Perognathus genus are desert pocket mice found throughout the open habitats of the North American deserts and grasslands.
- Large and inflated auditory bullae are observed in arid and open habitats
- Inflated auditory bullae aid in low-frequency hearing (Mason, 2015)
- Williams (1971) suggested that it may be a result of variable climate and environment throughout the wide geographic range that they occupy
- Negative correlation between bullar size and precipitation (Williams, 1971)
- Taxonomy of Perognathus species relies on cranial morphology
- Individuals could be misidentified due to cranial variations

We hypothesize that the size of the auditory bullae will correlate more strongly with precipitation than genetic distance.

Methods and Materials
Finding the Specimens
- P. flavescens and P. apache specimens, collected and genetically sequenced by Neiswenter and Riddle (2011), were located through ARCTOS, a database of museum collections.
- Specimens were treated as two distinct species
- We have requested 28 specimens from Museum of Southwestern Biology, and will be requesting additional specimens from Denver Museum of Nature and Science, and The Museum at Texas Tech.

Collecting the Measurements
- The auditory bullae are three-dimensional, and vary highly in size and shape in different individuals.
- We will be collecting 14 cranial measurements, following the morphometric traits described by Williams (1971).
- Images of the skulls will be taken with a digital camera in three different orientations: dorsal, ventral, and lateral.
- We will be using TpsDig2 to create digitized landmarks on the images, which will digitally generate our cranial measurements.

Methods
- An auditory bulla is three-dimensional and elongated.
- We will treat the bullar shape as a cone and an ellipsoid to calculate the bullar volume.
- The calculated bullar volume will be compared with the climatic patterns from each locality
- Data for P. flavescens and P. apache will be analyzed separately to observe if there are any patterns of morphological convergence of bullar size as the habitat’s overlap

The volume of a cone will be calculated using the formula:
\[
\frac{1}{3} \times \pi \times r^2 \times HAB
\]
where
\[
r = \frac{WAB}{2}
\]

The volume of an ellipsoid will be calculated using the formula:
\[
\frac{4}{3} \times LAB \times WAB \times HAB
\]

Further Studies
- Continue our research by following the methodology that we have developed to find correlations between bullar volume and climatic patterns
- Generate relevant data that would help us better understand the relationship between auditory bullae size and selective environmental pressure
- Identify morphological traits in each Perognathus species that can identify individuals more accurately with their genotypes

References

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