The role of integration in driving the morphological diversity of mammalian jaws

Mammals are warm-blooded and so need to eat relatively large quantities of food to maintain their high metabolic rate. Teeth and jaws are the first point of contact with food, and different types of teeth and jaws are specialized for eating different types of foods. This relationship has led to a wide range of jaw shapes. For example nectar-eating bats have long and slender jaws for reaching into flowers, while spotted hyenas have short and sturdy jaws for crushing bones. Other factors unrelated to feeding can also influence the shape of the jaw, such as the need to make sounds for communication, dig burrows, and sometimes to fight for access to mates (e.g., baboons, elephant seals).

Given the many roles of jaws in mammals, our project set out to determine the range of morphological variation. More specifically, the project investigated the relationship between jaw shape and diet and how these shapes have evolved over time. Through this research we hope to learn how and why jaw shape is very diverse in some groups of mammals, but very limited in others.

The mammalian jaw can be thought of as a functional tool for performing tasks related to feeding, communication, and competition. Developmental evidence suggests that there are two primary regions (modules) that can evolve independently in the mammalian jaw: the ramus and corpus. The ramus is the back portion of the jaw and serves as the site of muscle attachments. The corpus is the front portion of the jaw and houses the teeth. As modules become more independent of one another there is greater scope for increasing morphological diversity. However, the extent of co-variation among modules can differ both within and between species. These differences arise due to a variety of genetic and functional constraints. We aimed to test the hypothesis that mammalian jaw diversity is facilitated by reducing the level of co-variation among different modules within the jaw.

This study used a combination of morphometric and phylogenetic comparative methods to investigate how modularity has influenced the range of jaw morphologies exhibited by mammals. We used a two camera set-up to gather 3D coordinate points that reflect the shape of the jaw in species from across the mammalian tree. Funds provided by the UMass Natural History Collections were used to, 1, cover travel expenses to the American Museum of Natural History (AMNH) and the Chicago Field Museum, and 2, provide an undergraduate with a stipend to assist in image collection at the AMNH. Funds were also used to send the undergraduate researcher to the Society for Integrative and Comparative Biology meeting in Portland Oregon.

During the trip we amassed more than 15,000 pictures from 1,800 specimens spanning all orders of mammals. We are currently analyzing this large dataset and hope to finish data analysis during summer 2016.

This exceptionally large picture database has provided the data necessary to conduct multiple undergraduate projects. There are currently three independent research projects ongoing in the lab, including from the undergraduate that assisted in data collection, and a further two members that are directly assisting in data collection related to the above project. These students have gained valuable research experience in collection-based methods. Many of these students now wish to pursue careers in medical professions or continue in education with graduate school.