117-7 SANTANA, SE*; ARBOUR, JH; CURTIS, AA; University of Washington; *ssantana@uw.edu*
Echolocation and Diet Shaped Cranial Evolution During the Ecological Diversification of Bats
The mammalian skull performs multiple functions, including feeding and protecting the brain and sensory organs. Dietary adaptation is considered a major driver of mammal skull diversity, but there have been few, large-scale quantitative tests of the impact of feeding versus other functions on skull morphological evolution. Bats are an ideal group to investigate this issue because they represent 20% of all mammals, are diverse in cranial morphology, and encompass nearly the full spectrum of mammal diets and sensory ecologies. We explore whether and how the macroevolution of skull shape is related to feeding strategies in bats, or if other functional demands have influenced their cranial diversity. We compiled a large dataset of 3D representations of bat skulls, spanning all major bat lineages, diets and sensory ecologies. We used this dataset in phylogenetic comparative analyses of skull shape to (1) map major evolutionary trends, (2) detect selective regime shifts without imposing a priori hypotheses, and (3) investigate the association among skull shape evolution, diet, and primary sensory modality across bats. We found that the bat skull morphospace is characterized by gradients in skull elongation, facial flexure, and zygomatic breadth. Old World fruit bats (Pteropodidae) tend to be morphologically distinct, as are lineages of specialized neotropical frugivores (Stenodermatini) and insectivores (Mormoopidae). The evolution of skull shape across bats is well explained by selective regimes that broadly match echolocation use and type. However, patterns of skull shape evolution mirror dietary evolution within the most trophically diverse bat lineage (Phyllostomidae). Altogether, these results illuminate how multiple functions have impacted skull evolution during the ecological and lineage diversification of bats.

129-3 SANTHANAKRISHNAN, A*; KASOJU, VT; SENTER, M; ARMEL, K; MILLER, LA; Oklahoma State University, Univ. of North Carolina, Chapel Hill, Univ. of North Carolina, Chapel Hill; *askrish@okstate.edu*
How Tiny Insects Get Far: Intermittent Parachuting with Bristled Wings
Free takeoff flight recordings of thrips (body length under 1 mm) show that they can intermittently cease flapping and float passively downwards by spreading their bristled wings. This type of drag-based parachuting can be advantageous in lowering the falling speed, and could potentially aid in long-distance dispersal by minimizing energetic demands needed for active flight. It is unclear whether bristled wings such as those observed in thrips can reduce drag generated in parachuting. In this study, we comparatively examine parachuting using bristled wings and solid (non-bristled) wings. Forewing angles in parachuting and settling velocities were obtained from free takeoff flight videos. A solid wing model and bristled wing model with bristle spacing to diameter ratio of 5 performing translational motion were comparatively examined using a dynamically scaled robotic model. We measured force generated under varying wing angle from 45-75 degrees across a Reynolds number (Re) range of 1 to 15. Drag experienced by the wings decreased in both wing models when varying Re from 1 to 15. Leakiness of flow through bristles, visualized using spanwise particle image velocimetry measurements, and implications for force generation will be presented.

103-8 SANTIBANEZ-LOPEZ, CE*; NOLAN, ED; SETTON, EVW; SHARMA, PP; Univ. Wisconsin-Madison; *santibanezlo@wisc.edu*
Gene expression in appendages of Centruroides sculpturatus clarify the evolutionary origin of the scorpion pectine
The versatility of the articulated appendages of arthropods has contributed to their evolutionary success, granting them expansion of their ecological niche space. While the genetic mechanisms controlling the patterning of appendages are well understood for arthropod models like *Drosophila melanogaster*, the genetic basis for the patterning of appendages unique to arachnids (e.g., book lungs, chelicerae) remains a mystery. Within Arachnida, scorpions are among the oldest lineages and are distinguished from other arachnid groups by a unique pair of wing-like organs called pectines, whose relationship to the walking leg is unclear. We utilized a developmental transcriptome of *Centruroides sculpturatus* to identify homologs of appendage patterning genes common to arthropods, such as *dachshund* (dac), *engrailed* (en) and *wingless* (wg). To elucidate the nature of the scorpion pectine and build upon understanding of its positional and genetic homologies to other appendages, we surveyed the expression of these genes in developing scorpion embryos. Based upon these data, we homologize walking legs with the inner ramus of the pectine, whereas our data suggest that the blade of the pectine represents an exopod derivative. The lack of distal expression of *Distal-less* and *aristal-less* suggests that their patterning is fundamentally different from telopodal appendages (e.g., pedipalps or legs).

18-1 SANTINI, F*; ZAPFE, K; FREDERICH, B; DORNBURG, A; Associazione Italiana per Studio Biodiversita', North Carolina State University, University of Liège, North Carolina Museum of Natural Sciences; *francesco.santini@alumni.utoronto.ca*
A macroevolutionary look at the history of herbivorous fishes in coral reefs
Herbivorous fishes play a key role in coral reef habitats, controlling the growth of algae on corals and thereby preventing negative cascading effects on both reef health and community-wide patterns of species diversity. Herbivory has evolved independently in several groups of coral reef fishes, including rabbitfishes (Siganidae) and surgeonfishes (Acanthuridae). Although both of these groups posses a rich fossil record that makes them ideal groups from which to study how the evolution of herbivory has impacted reef fish diversification dynamics, few studies have investigated these clades in detail. Combining molecular and morphological datasets that include both extant and fossil taxa into a total evidence approach, we provide a new timescale for the evolutionary history of these clades. Our results demonstrate much earlier origins of these groups than those indicated by the fossil record, supporting a substantial a radiation of herbivorous fishes that began in the Cretaceous, followed by episodes of significant extinction during the late Eocene and Oligocene. Integrating our timetree with morphometric data collected from over 1000 digitized images for both groups, we further investigate the tempo and mode of phenotypic evolution within these clades, and will discuss our findings.