Speaker	Abstract
Jackson Michaels	Kinematic imaging of salticid eyetubes with noisy xray video
Cesar Bertinetti Cerrato	**From phenotypes to behaviour: Performance consequences of differential opsin gene expression in cichlid fish** Variation in visual systems often correlates with photic conditions in many fish species and thus tends to be considered adaptive despite the lack of direct empirical evidence of its consequences for performance. Here, we test the effects of differences in visual traits on foraging performance. For this, we compare the reaction distances of Midas cichlid fish species (A. cf. citrinellus) from the Nicaraguan Great and Crater Lakes foraging on live prey under light conditions mimicking native and foreign photic environments. We combine automated tracking of fish in individual feeding trials with gene expression and morphological data to link phenotypic traits with their maximal foraging performance. Our results provide experimental evidence that highlight the role of photic habitats as drivers of adaptive phenotypic variation in aquatic ecosystems.
Verner Bingman	**Whip spider olfactory-tactile multisensory integration does not generalize to the intramodal integration of two olfactory stimuli: Implications for navigation and the neural architecture of learning.** Tropical and sub-tropical, nocturnally active Whip spiders, Amblypygids, are excellent navigators with an impressive ability to return to their home refuge even after experimental displacements. It has been hypothesized that the success of whip spiders returning to their home refuge would require a navigational mechanism(s) reliant on the integration of multisensory inputs. Under controlled laboratory conditions, whip spiders can integrate olfactory and tactile information in a form of configural learning to recognize a home refuge. By contrast, employing the same configural-learning experimental design revealed an inability to combine two distinct olfactory stimuli into a configural representation to support refuge recognition. Similarly, whip spiders fail to demonstrate negative patterning when two olfactory stimuli are used in a refuge recognition task. The data suggest that one likely neural substrate for the learning of salient environmental features, the mushroom bodies, can only support the integration of inputs from different sensory modalities, failing to do so when the simultaneous processing of two olfactory cues is required to discriminate locations in space.
Erin Brandt	**A baffling conundrum: why don't more cricket species use acoustic tools?** Some tree crickets make tools known as acoustic baffles to overcome acoustic inefficiency and make their mating calls louder, but no other crickets do. The “lack of utility” hypothesis suggests that tools lack sufficient utility in most scenarios to drive their evolution, so we tested this by quantifying the utility of baffle use across cricket species. We measured wing sizes and calling frequencies for 113 cricket species across 7 clades, and used finite element analysis to model sound fields generated by cricket wings within their natural wing size and call frequency ranges. We also modelled realistic scenarios incorporating the effect of reflective and scattering surfaces like the ground and vegetation. We plotted data from real crickets onto landscapes of predicted calling efficiency across parameters and scenarios, which allowed us to determine the maximum efficiency achievable with a baffle for each species. We found that calling from the ground could dramatically increase calling efficiency, sometimes even exceeding baffling efficiency.

Fernanda Duque

Evolution of high-frequency hearing in hummingbirds. Some hummingbird species produce high-frequency vocalizations beyond the hearing range of most birds. The Ecuadorian hillstar (Oreotrochilus chimborazo) produces a courtship song with the highest fundamental frequency among all birds. The Ecuadorian hillstar's courtship song is complex and exhibits dialects across populations, making it ideal for investigating the evolution of high-frequency communication signals. Neural evidence shows that the hillstar can hear these vocalizations; however, a detailed characterization of the hearing sensitivity in this hummingbird is still missing. Understanding the evolution of high-frequency vocalizations and hearing in hummingbirds will elucidate how sensory systems evolve to facilitate communication in challenging environments.

Kristina Fialko

Evaluating light environment as a contributor to color variation in *Phylloscopus* warblers. Understanding the diversity of color in nature has been one of the more elusive evolutionary problems. Comparative analyses have associated color differences among species to light environment, background color and receiver perceptual abilities; however, much of this evidence has come from aquatic systems which experience stark gradients in light availability along the water column. In terrestrial environments, color differences in bird species have been associated with light differences between canopy and understory in tropical environments. Here, we evaluate the extent to which light environments vary between different tree types along an elevational gradient in the Himalaya and examine color variation across 12 very similar species of warblers belonging to the genus Phylloscopus, which possess subtle but present differences in color and distribute themselves between different habitats along this gradient. We quantify variation in plumage color and model perception of these patches under the light conditions found in species habitats. While several habitats present distinct light environments, we find no evidence that irradiance affects the color of patches across species, suggesting that color variation in Phylloscopus is not attributable to differences in their sensory environments. While what drives the specific colors observed remains unclear, we suggest the differences between tail and wing coloration may be a consequence of their potential use in different signaling functions.

Megan Freiler

Differential expression of steroid-related genes across electrosensory brain regions in two sexually dimorphic species of electric knifefish. Although hormones can modulate signal perception, actions of hormones on sensory brain regions have not been characterized as well as hormone actions on circuits that influence signal production. The electric organ discharges (EODs) of weakly electric fishes are diverse and sensitive to gonadal steroid hormones, providing an opportunity to study how steroids modulate both signal production and perception across sex and species. Here, we asked whether steroid-related genes are expressed in electrosensory brain regions and whether this expression differs between sexes and two species that have different patterns of sexual dimorphism in EOD signaling: Apteronotus leptorhynchus and Apteronotus albifrons. Using qPCR, we measured mRNA expression of genes for androgen receptors (ARα, ARβ), an estrogen receptor (ESRα), and aromatase (Cyp19β) across males and females of both species in two electrosensory brain regions: the electrosensory lateral line lobe (ELL) and the dorsal torus semicircularis (TSd). Androgen receptor transcript abundance did not vary substantially by sex or species, ESRα expression was higher in A. albifrons than in A. leptorhynchus, and aromatase mRNA abundance was higher in females than in males in both ELL and TSd. These results show for the first time that electrosensory brain regions express steroid-related genes, which suggests that gonadal steroids have the potential to influence central processing of EOD signals.

Marco Gallio

Temperature sensing in Drosophila flies: from molecular receptors and neural circuits to the evolution of behavior Rapid climate change is one of the most important challenges of our time. Increasing temperatures will have enormous impacts on ecosystems around the world, many of which are poorly understood. As small, "cold blooded" animals (poikilotherms), insects are particularly vulnerable to global warming. Yet, we know little about how insect communities respond to changes in climate. The Gallio Lab uses techniques of modern genetics and neuroscience to study how insects respond to environmental variables such as temperature and humidity. Using the common Lab fruit fly Drosophila as well as fly species from different thermal habitats (from high altitude forests to hot, dry deserts), we study the molecular and cellular mechanisms controlling temperature and humidity responses, with the goal of identifying what determines a species' preferred temperature and humidity and its potential vulnerability to climate change.

Eric Gulson-Castillo

Testing for magnetoreceptive behavior in birds without a putative magnetoreception protein The ability of birds to detect magnetic fields has always been mysterious due to the difficulty in pinning down a mechanosm for magnetoreception, but the retinal protein cryptochrome 4 has emerged as a promising candidate for magnetoreception. A recent phylogenetic analysis has revealed that a clade with long-distance nocturnal migrants, the New World suboscines, experienced a gene deletion for cryptochrome 4. We use Emlen funnels and electromagnetic coils to compare orientation behavior in a New World suboscine clade, the Empidonax flycatchers (Tyrannidae), to a bird known to respond to magnetic fields in experimental settings, the Swainson's Thrush (Turdidae). Our experimental control is the local magnetic field in southeast Michigan while our treatment is that same field turned 120°. We will discuss results in the context of the evolution of magnetoreception.

Kathleen Higgins

Rapid expansion and specialization of a bitter taste receptor family in amphibians. Recent studies, including our own have suggested that the genomes of batrachian amphibians (i.e. frogs and salamanders) have experienced a drastic increase in the number of bitter taste receptors in comparison to other vertebrates, yet the sensory/ecological functions of these receptors and the processes driving their evolution remain largely unknown. Through a combination of comparative genomics, gene expression analyses, and in vitro assays of protein function, we explore the evolutionary dynamics and possible functions of TAS2R receptors in amphibians. We find evidence for exuberantly rapid gene family evolution within lineages, together with gene expression across the seven tested tissues, and strong signatures of tissue-specific expression in most tested species. Functional assays of a subset of receptors show that they are able to perceive a variety of chemicals, including frog toxins. Overall, our results suggest that the large repertoire of TAS2Rs in batrachians allow for tissue-specific recognition of a variety of both exogenous and endogenous molecules, and should therefore play an important role in their physiology and sensory ecology. Furthermore, the ability to test hypotheses from the molecular to the organismal level makes these genes an exciting system to study the ecology and evolution of sensory functions.

Michael Hogan

Sensory genomics and phenotypic evolution in snakes. Snake sensory systems are among the most biologically impressive and phenotypically unique in the animal kingdom, consisting of four primary senses: trichromatic color vision; bi-focal thermal or infrared perception via specialized facial pits; mechanoperception or touch; and dual-system chemoperception implementing both a functional olfactory bulb and a forked-tongue vomeronasal system. Of these senses, chemoperception represents the biggest gap in our genetic understanding of snake sensory perception.

Using a systematic homology and RNA-seq guided approach, we annotated all putative sensory genes present in the genome of the eastern diamondback rattlesnake (Crotalus adamanteus), highlighting an extreme diversity of chemoreceptors (~1200+ putatively functional genes) compared to the other senses. Genes coding for type-2 vomeronasal receptors (V2Rs) and olfactory receptors (ORs) represent the two highest copy-number gene families found in the genome, with over half of these occurring on sex chromosome Z. We evaluated chemoreceptor sequence diversity by combining gene-family phylogenetics, tests for positive selection, and predicted protein structure -- which provided evidence for stimuli-driven gene diversification. Conserved gene synteny allowed us to model the deeper evolution of a single V2R gene isolated on chromosome five spanning the rise of tetrapods from fish to snakes, giving us a glimpse into the macroevolutionary context of this receptor during major sensory transitions in vertebrate evolution.

Lata Kalra

Perceptual salience is insufficient for auditory streaming in eastern gray treefrogs. Acoustic communication, and hearing generally, relies on the ability to perceptually segregate relevant sound sequences from other concurrent sounds in the environment. Receivers achieve this by parsing the composite sound input, impinging on their ears, into distinct auditory streams, each corresponding to perceptual representation of the sound produced a given source. This process, called 'auditory streaming', involves integrating sounds produced by the same source into a single stream and segregating those produced by different sources into separate streams. Integration versus segregation relies on how different sounds are in their spectral, temporal and spatial features. Here, using treefrogs, we test a prominent hypothesis, derived from human psychoacoustics, that any perceptually salient acoustic difference between sounds is sufficient for their perceptual segregation. Our results do not support this hypothesis and highlight important taxonomic differences between humans and non-human animals in how they perceptually segregate relevant sound sequences.

Marco Lopez

Taking the long way around: ecology from morphology in Chondrichthyan cranial lateral lines canals The lateral line canals of the Bonnethead Shark *(Sphyrna tiburo)* differ wildly from the expected morphology relative to its close and distant relatives, even accounting for differences in head shape. Instead of being markers of phylogenetic constraint, the morphological characteristics of the lateral line system may reflect, and thus be a proxy for, fish ecology. Conserved in all fish, the mechanosensory lateral line organ is essential for behaviors like schooling, predation, predator avoidance, and navigation. The diverse forms of the system have been investigated phylogenetically, but little research has been done to determine how the pattern and structure of the line correlates with an animal's behavior and life history. With an ecomorphological disparity comparable to mammals, morphological convergence in distant lineages, and a well-conserved canal pattern throughout, sharks are used as the model clade for analyzing and comparing the lateral line organ. Using a representative sample of sharks, non-invasive and non-destructive digital data of the system is acquired and quantified from tomographic reconstructions of contrast-stained heads for testing the connection between ecology and lateral line canal morphology.

Wei Lu

Genetic basis of sex-limited eye diversification in *Heliconius* butterflies. Peripheral sensory structures such as eyes have been proposed as an important and labile target for evolutionary change that can lead to adaptive behavior. Mating preference is one such rapidly evolving adaptive behavior during the speciation process. *Heliconius cydno* butterflies display color-based male mating preference and previous comparative physiology experiments suggest that the color perceptions are different among males of different mating preference. To understand the genetic basis of this sex-limited eye diversification, we conducted single-cell RNAseq for both adult male and female eyes from different species. The single-cell RNAseq results imply that pigment cells, instead of photoreceptors, are strongly associated with divergent male mating preference through modifying color opponency computation.

Nate Morehouse

Complex displays as evolved strategies for capturing and retaining receiver gaze. A major outstanding question in sexual selection is why courtship displays often evolve to such extremes of complexity. One underexplored possibility is that such complexity arises simply to capture and hold receiver attention. We evaluated this possibility by studying interactions between complex courtship displays and receiver gaze, the latter a measure of receiver attention, across 15 species of jumping spiders in the genus *Habronattus*. Male *Habronattus* spiders engage in elaborate, temporally choreographed courtship displays that include vivid colors, complex patterns, and a variety motion-based display behaviors. We find that display motion and color appear to collaborate to promote sustained attention in female viewers (i.e., motions appear to guide female attention towards color ornaments, resulting in strong spatial correlations between motion and color in male displays). When paired with the extant variety of displays in even this single genus of jumping spiders, our results suggest that female attention may act as a powerfully generative force, selecting for ever more complex and "eye catching" male displays.

Brandi Pessman

Adjusting to environmental noise: Urban versus rural spiders respond to and adjust their webs differently in different vibratory noise environments. Substrate-borne (vibratory) noise is an understudied channel of sensory pollution that may affect the sensory ecology of animals living in and near cities, such as the funnel-weaving spider, Agelenopsis pennsylvanica. To understand how A. pennsylvanica with different vibratory noise experiences – i.e. spiders collected from urban (louder) versus rural (quieter) habitats – react to vibrations, we provided pure tone vibratory frequencies (100 Hz steps from 100 to 1000 Hz in random order) on their webs. We found that urban spiders were more likely to respond to frequencies above 500 Hz while rural spiders reacted more often to frequencies below 500 Hz, which is intriguing given that field-recorded vibratory noise in the area is concentrated below 500 Hz. Next, to determine whether urban versus rural spiders modify their webs to amplify/dampen different frequencies when noise is present, we measured vibration transmission across webs constructed by urban and rural spiders under artificial 'loud' or 'quiet' vibratory treatments in a fully crossed 2x2 design. After applying bursts of white noise (0-2000 Hz) at different locations across the web, the amplitude of the frequencies that reached the spider's retreat varied by habitat (urban/rural) and treatment (loud/quiet), especially around 500 Hz. These results provide evidence that urban versus rural A. pennsylvanica differentially respond to vibrations and modify their webs to potentially improve web-borne signal transmission and reception when vibratory noise is present.

Carlos Rodriguez-Saltos	**Time perception in animal displays.** How do animals perceive time? Laboratory studies show that animals become less precise at estimating time intervals as they become longer. We tested whether this pattern is followed in the song of a neotropical bird in which whistles are produced after intervals of silence of increasing duration. Surprisingly, the precision with which the birds timed their whistles stayed constant as the intervals increased in duration. Such precision was comparable to that of professional musicians with over a decade of experience. The finding suggests a mechanism that allows the nervous system to overcome constraints that reduce precision in time perception and may be specific to animal displays.
Carlay Teed	**The diversity of cone-opponent circuits in non-primate vertebrates.** Organisms use their sensory systems to gather information from the environment. This information is then processed through neural circuits. The evolution of sensors and the circuits that process signals has been observed to influence behavior. The neural circuits responsible for extracting color information are referred to as cone opponent circuits. In this talk, we will present an assessment of the diverse cone-opponent circuits found in non-primate vertebrates. While these circuits exhibit more diversity than some have suggested, they do not encompass the entire range of possible variations.