

RAYANN DORLEANS, University of Florida

Do Parasites Infect Optimally?

Mentors: Dr. Farrah Bashey-Visser and Ashwini Ramesh

Optimality theory suggests that organisms will group themselves in a way that affords the maximum amount of fitness. We attempted to test optimality theory in a host-parasite relationship and observe the consequences. Using a caterpillar-nematode system, we tested several infection densities in relation to female nematode size in order to test for the presence of a potential optimal infection concentration. We also allowed the offspring to emerge to observe any genetic effects. Upon doing so we discovered a pattern that greatly resembled that of optimality theory, but the level of extra variation suggests a possible flaw to completely optimal grouping of organisms. This may be a result of organisms attempting to maintain some level of genetic variation as a perfectly optimal system could result in more identical offspring and increased competition leading to decreased fitness.

BRENDA DZARINGA, Vassar College

Exploring the effects of olfaction on acoustic stimulation using the auditory brainstem response

Mentors: Dr. Laura Hurley, Dr. Kelly Ronald

The way we perceive our environment greatly depends on the combination of sensory information. However, the way in which sensory modalities combine still remains poorly understood. Previous work has shown that behavior in mice is heavily dependent on vocal and non-vocal cues. In mice, olfactory cues modify the behavioral response of mice to vocal signals of the opposite sex. In this experiment, we investigated whether olfactory information is able to modify responses to acoustic vocalizations in the auditory system, at the level of the brainstem. To address this issue, we measured the auditory brain stem responses (ABRs) to complex tone-bursts, which mimic squeaks. The amplitudes and latencies of Waves I-V of the ABRs were compared before and after the presentation of female estrous-phase urine and cat fur. We have observed changes in amplitude coinciding with stimuli presentation, suggesting that olfactory information may be influencing activity in the auditory system. These findings add to the body of the work suggesting the way we perceive our environment is dependent on the integration of external stimuli.

ALEJANDRO (Alex) GONZALEX, University of Notre Dame
Intraspecific Variation in Fitness in a Nematode-Bacteria Symbiosis
Mentor: Dr. Farrah Bashey-Visser

The genotypes in a symbiosis can play a large role in organismal fitness. By modifying the genotypes in the symbiosis of the nematode *S. affine* and the bacteria *X. bovienii*, we attempted to elucidate the importance of the microbe's genotype as it relates to fitness of the caterpillar *Galleria mellonella*. This was done by reassociating different combinations of bacterial and nematode genotypes. Once reassociated, each novel symbiotic pair was inserted into the host caterpillar and time of mortality as well as amount of bacterial carriage was observed. It was shown that the number of bacteria carried in the symbiotic pair has a direct correlation on the amount of time it took to kill the host. Furthermore, we observed that the nematode life cycle was propagated further in the presence of more bacterial carriage. We demonstrated the importance of the microbial genotype as it can directly affect a symbiosis and impact host fitness.

CIERRA MCKOY, University of Maryland Baltimore County

Are juvenile songbirds from extra-pair copulations less likely to be infected with avian malaria?

Mentors: Dr. Ellen Ketterson, Katie Talbot, and Daniel Becker

The Dark-eyed Junco (*Junco hyemalis*) is a socially monogamous songbird that frequently participates in extra-pair copulation (EPC) during the breeding season. Previous work has shown higher fitness in offspring from EPC, compared to those from within-pair copulation (WPC). We hypothesized that the prevalence of avian malaria parasites would also be lower in offspring of EPC if juncos seek EPC for 'good genes' benefits. To test this, we extracted DNA from blood samples collected from 89 paternity-assigned juvenile juncos. We used PCR and gel electrophoresis to determine infection status of each juvenile. Statistical analysis did not detect a significant difference in the odds of infection between offspring of EPCs and WPCs; however, this could be due to a low percentage of extra-pair offspring in our sample (19%). We detected a weak yet significant positive association between offspring age and infection status. These results suggest that pair status may not influence juvenile risk of avian malaria infection; however offspring age is not the sole contributor to juvenile infection risk, which prompts further investigation of other potential factors such as parental infection status.

JULIENNE NIEMYSKI, Mount Holyoke College

Degeneration of Class IV neurons affects nociceptive behaviors in *Drosophila* larvae

Mentors: Dr. Dan Tracey and Dr. Stephanie Mauthner

Specialized neurons that are able to detect noxious stimuli, a process known as nociception, can be manipulated to understand behavioral responses in *Drosophila* larvae. Using various assays to assess the behavioral response to noxious stimuli, mutant larvae with degenerated Class IV neurons are tested to see if they still exhibit a normal "rolling" response when compared to a control group with all neurons intact. Experimentally we found that mutant larvae with degenerated sensory dendrites on average respond less to noxious stimuli compared to larvae with normal dendritic arbors. These findings suggest that specifically Class IV neurons are important for detecting noxious stimuli.

SIERRA REESE, Howard College

Do Opposites Attract? Are Female Rainbow (*Etheostoma caeruleum*) and Fantail Darters (*E. Flabellare*) Making Mate Choices Using MHC-based Olfactory Signals?

Mentors: Dr. Curt Lively and Dr. Troy Smith, Kara Million and Misty Proffitt

As climate change, deforestation, and many other extreme environmental changes continue, it becomes more essential to understand animals and the decisions they make to survive. By studying mating choice researches are able to get a better understanding of animals, and knowing information from prior work, we can begin to recognize patterns or changes in behavior. We focused our study on Rainbow and Fantail darters and their mating decisions, to see if similarly to humans, they use major histocompatibility complex genes to pick their mates and what it means for their offspring. While the two species vary phenotypically, they also differ in behavior, the Fantail male is the only one between the two species that provides parental care. This led me to believe that the Fantails would take more information to make a decision, that being a male with a dissimilar genotype; however, I believed the Rainbows would be using visual stimuli as their deciding factor because of the males change in coloration during the breeding season. The experiment had three phases to measure importance, an olfactory stimulus, visual stimulus, and then a combined olfactory and visual stimulus but choosing males that specifically had similar or dissimilar MHC genes from the female. We found that the Rainbows were repelled by the olfactory stimuli and the Fantails showed no preference, but when the MHC genes and visual stimuli were combined both species were most active and tended to prefer the dissimilar genotype. This means that the offspring will have a better chance of genetic variability and will have a more diverse immune system to protect themselves from parasites and diseases.

LAYNE SERMERSHEIM, Indiana University, Bloomington
Behavioral and developmental responses to heat in tree swallows (*Tachycineta bicolor*)

Mentors: Dr. Kimberly Rosvall and Mary Woodruff

Because tree swallows (*Tachycineta bicolor*) are shifting their breeding ranges south due to climate change, while other bird species are shifting north, they were the subject of this study. While some heat coping mechanisms of adult songbirds are known, much less is known about tree swallow chicks. In the experiment, I hypothesized that when in a heated nest box, chicks will acclimate (adjust plastically) to increased temperatures over time. I experimentally heated nest boxes with heat packs, recorded chick behaviors with a camera, and obtained nest cup temperature using a temperature logger. I analyzed the videos for chick behaviors such as panting and begging, and chick spread, how close the chicks were to one another. In heated nests, chick behaviors were affected, but there was no significant difference in growth across treatments. Because there were behavioral, but not developmental changes in heated chicks, they may be able to cope with heat through these behavioral adjustments which allow them to develop at a rate similar to the control chicks. This research was an initial step in exploring how chicks respond to a warmer thermal environment, but more research is needed to inform how other species are coping with climate change.

CASSANDRA SHERIDAN, University of Iowa
Episodic Memory in Young Humanized ApoE4 Knock-In
Mentors: Dr. Jonathon Crystal and Danielle Panoz-Brown

In the US, more than 5 million patients have been diagnosed with Alzheimer's disease (AD), and approximately one-third of people over 85 years of age are afflicted with AD. One of the most debilitating aspects of AD is episodic memory (e.g. memory of unique, personal past experiences) impairment. The $\epsilon 4$ allele of the apolipoprotein E (ApoE4) gene is one of the greatest known risk factors for developing late-onset AD (LOAD). Currently, there is a gap in research investigating the effect of AD on episodic memory. For example, most preclinical models of AD focus on general assessments of learning and memory (e.g. spatial cognition) rather than on the types of memory that are impaired in this disease (e.g. episodic memory). This project was designed to characterize the role of hApoE4 in age-dependent episodic memory function using an animal model with the hApoE4 gene knocked-in (KI) and an items-in-context approach to test episodic memory. The central hypothesis is that the hApoE4 gene increases production of the protein amyloid-beta in the brain, which ultimately causes the cognitive impairment, specifically in episodic memory, associated with AD. Using our olfactory based items-in-context approach, episodic memory function was characterized in young hApoE4 KI and wildtype (WT) rats. Here, we show that young hApoE4-KI and WT rats' accuracy in episodic memory assessments have no significant differences between genotype and sex. Our results here, show that KI and WT rats have great episodic memory, because for the KI rats AD pathology has not become detectable yet.

VANESSA EATON, Spelman College

The Effect of Early-Onset Alzheimer's on Episodic Memory: A Rat Model

Mentors: Dr. Jonathon Crystal and Danielle Panoz-Brown

Alzheimer's disease (AD) is a degenerative disease that is widely known to affect the memory, speech, and motor skills of elderly patients. One of the hallmarks of AD is the impairment to their episodic memory (EM), a part of long-term memory (LTM). The objective of the current study is to look at the effect of AD on EM functioning. This project specifically models EM impairment in nonhumans that is seen in clinical patients with AD using rats. The rats are tested at 6, 11, and 16 months. Currently, the 6-month-old TG and wildtype (WT) cohort express similar EM measures because AD development is not detectable. Our data support the use of AD model rats to test pharmacotherapies that specifically target episodic memory function.

JACE KUSKE, California State University, San Marcos
The role of testosterone in Tree Swallow territorial aggression
Mentors: Dr. Kimberly Rosvall and Dr. Sara Lipshultz

Aggression is important for achieving reproduction and increases survival in many free-living animals. Specific types of aggression are performed by different animals and by different sexes. Female and male tree swallows (*Tachycineta bicolor*) both engage in territorial aggression to successfully claim a nesting site. Decades of research support that the steroid hormone testosterone (T) is predictive of male aggression. However, the biological mechanisms underlying female territorial aggression remains uncertain, perhaps because females have lower T levels than males, and high T levels constrain egg production and maternal care. Recent work shows that other components of the androgenic-signaling system related to T, like gene expression of receptors that regulate circulating T levels throughout the body, are better predictors of female songbird territorial aggression. To further explore this in territorial tree swallows, we measured their aggressive behavior during a simulated territorial intrusion and collected their trunk blood and gonads to measure T and androgen receptor (AR) mRNA expression. Ultimately, we found that females were more actively aggressive than males, in that they attacked and closely approached a conspecific decoy more often than males. Surprisingly, female T levels were predictive of their attack frequency, but not males. Interestingly, there were no sex differences in AR mRNA expression, nor was there a relationship between T levels and AR expression levels in females or males. This hints that enzymes that convert T to other metabolites, and not circulating T alone, may be important for explaining territorial aggression in female and male tree swallows.

ANDREA VELEZ, University of Puerto Rico, Río Piedras
Divergence in Timing of Reproduction in Junco Populations: Differentiation in Spring Anticipated Gonadal Recrudescence
Mentor: Dr. Ellen Ketterson and Dr. Devraj Singh

Every year in the anticipation of spring, a huge flock of birds either initiate growing their gonads or migrate to their breeding ground. The Dark-eyed Junco is a common North American passerine; different sub-populations have a huge range of breeding latitude. The Dark-eyed Juncos living in the mountains of the eastern US begin to breed or move northward in a recurring seasonal pattern of biological activities and associated physiology underlying migration and reproduction. In western North America there are multiple migratory populations of juncos that winter together and differ in their breeding distributions, which will permit multiple comparisons among migratory populations. Juncos that winter in the Black Hills of South Dakota, the mountains of Idaho, the mountains of California, and of Alaska can all be found intermingled in flocks during winter in Colorado and surrounding states. We tested divergence in the reproductive timing of different sub-populations by catching them from Mountain Lake Banding station (*Junco hyemalis hyemalis*; migrants and *J. h. carolinensis*; residents) and Colorado Field station (Grey headed junco, Pink-sided junco, Oregon junco, and, White-winged Junco). We measured baseline testosterone (T) and T after 30 min of injecting external GnRH to study difference in gonadal recrudescence response. We found elevated T in response to the GnRH challenge in Junco populations breeding at lower latitudes. Testing the latitude dependent differential gonadal recrudescence response in different Junco sub-populations enables us to pose further questions to investigate cues influencing seasonal timekeeping mechanisms.