

POSTER PRESENTATION ABSTRACTS

2019 ANIMAL BEHAVIOR CONFERENCE

Organized alphabetically by first author last name. Numbers indicate poster numbers.

1 PROXIMATE PREDICTORS OF VARIATION IN EGG REJECTION BEHAVIOR BY AVIAN BROOD PARASITE HOSTS

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The rejection of parasitic eggs by avian brood parasite hosts is one of the most effective defenses against parasitism. Despite its adaptive significance, egg rejection shows substantial inter- and intra-specific variation. Understanding variation in egg rejection requires that we study variation in parental motivation to care for eggs alongside the cognitive and sensory contexts of the parasitized nests. Here we asked if life-history and physiological factors known to be linked to motivation and perception explained variation in rejection of model eggs by American Robin (*Turdus migratorius*) females. We found that the probability of egg rejection was negatively related to the clutch size: females with fewer eggs were more likely to reject the model eggs. Females with greater mass, higher corticosterone levels, and later in incubation were less likely to reject model eggs. Our data suggest that proximate predictors of egg rejection behavior include both the components of the nest's perceptual environment (the ratio of foreign vs. own eggs) as well as contributors to maternal motivation towards eggs (endocrine and temporal factors). Future experiments should focus on the causal roles of these and other factors in egg rejection across the diverse brood parasite and host systems.

2 WHEN IS ANTAGONISTIC BEHAVIOR FAVORED? USING EXPERIMENTAL EVOLUTION TO DETERMINE THE EFFECT OF COMPETITION ON BACTERIOCIN PRODUCTION

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Across organisms, antagonistic behavior often comes with a cost to the actor. Thus, unless the benefits of antagonism outweigh their costs, these behaviors will not be maintained. Here, we test this hypothesis by examining the evolution of an antagonistic behavior, bacteriocin production, in the presence or absence of competitors. Bacteriocins are allelopathic toxins produced by bacteria. These toxins can target and kill closely related strains, but their production comes with a severe cost, as producing cells must lyse to release the toxin. In this project, we examine how the gram-negative bacterium, *Xenorhabdus bovienii* (Bov 218) evolves in response to competition with a comparatively faster growing interspecific competitor, *X. koppenhoeferi* (Kop 79). In vitro assays show that Bov 218 produces a bacteriocin that kills Kop 79 and gives it a competitive advantage. However, *in insecta*, Bov 218 grows slower than Kop 79. Will repeated evolution of Bov 218 in the presence of sensitive Kop 79 result in an increase in bacteriocin production? Or, will Bov 218 forgo this costly antagonistic behavior in favor of faster growth? We are currently passaging four producer-only lines (Bov 218) and four mixed, producer-sensitive lines (Bov 218 + Kop 79) through the insect host *Galleria mellonella*. We predict that frequency of Bov 218 in our mixed lines will increase with each passage as our design allows Bov 218 to evolve, but keeps Kop 79 fixed. After 10 passages, we plan to compare the growth, competitive success, and bacteriocin production of Bov 218 from the producer only treatment with Bov 218 from the mixed treatment. This study will provide one of the few experimental evolution evaluations of how an antagonistic behavior evolves in response to competition.

3 THE EFFECT OF AVIAN BROOD PARASITISM ON HOST PARENTAL STRESS AND IMMUNE RESPONSES

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Raising an avian brood parasite is costly for hosts because parasitism redirects parental resource allocation to genetically unrelated offspring and biases allocation into the current brood over future reproductive opportunities. Host parents may also experience trade-offs between provisioning parasitized broods and self-maintenance. Dynamic shifts in the secretion of glucocorticoids, including corticosterone, in response to stress have been shown to provide adaptive responses for survival but also can be maladaptive when it represents a tradeoff with lowered immunocompetence. We studied the effect of brood parasitism by Brown-headed Cowbirds *Molothrus ater* on corticosterone production and immunocompetence in Prothonotary Warbler *Protonotaria citrea* adults during the nesting stage. Contrary to predictions, we detected a lack of tradeoff between these traits at the level of provisioning parents. Specifically, we found that cowbird parasitism increased corticosterone response in males, but not in females, and that corticosterone concentration declined with increasing brood size. In turn, parasitized warblers and warblers with larger broods showed reduced immunocompetence, while parents later in the season showed increased immunocompetence. Together, these findings provide a basis to assess the physiologically-mediated fitness cost of brood parasitism paid by Prothonotary Warblers during the nestling provisioning period.

4 THE FUNCTION OF BODY COLORATION IN MALE COMBAT AND MATE CHOICE IN THE POLYMORPHIC CICHLID FISH *ASTATOTILAPIA BURTONI*

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Color based signaling is an important communication cue in many animal species. In haplochromine cichlid fish, males compete aggressively for access to territories and subsequent mating opportunities. Territorial males express greatly increased coloration and body coloration is an important target in sexual selection. In the cichlid fish *Astatotilapia burtoni*, males are either blue or yellow and males can change color. Previous research has shown that these plastic color morphs are linked to unique physiological profiles. However, the function of coloration in relation to sexual selection is unknown in this species. We tested whether blue or yellow males are more socially dominant than the other using dyadic physical contests over available territories. We also tested which male color morph is preferred using a novel, full contact mate choice paradigm.

5 LARVAL FISH EXPOSURE TO HARMFUL ALGAL BLOOMS CAUSES LONG-TERM EFFECTS ON SENSORIMOTOR INTEGRATION

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Cyanobacteria, commonly known as blue-green algae, can form harmful algal blooms (HABs) in freshwater environments that have been linked to disruptions in neurofunction, growth, and survival. Emerging research suggests that cyanotoxins produce non-lethal, but substantial effects on resident aquatic wildlife, including alterations in central nervous system (CNS) and behavior. Little is known about how subtle, HAB-induced changes in the behavior of affected organisms influences fitness. This deficit in knowledge is important because the effects of exposure to neurotoxins on species and species interactions is critical in accurately producing risk assessments for population and community level outcomes. The aim of this project was to evaluate the short- and long-term effects of exposure to 2,4-diaminobutyric acid (DABA), a common cyanobacterial neurotoxin, on the cognitive and motor performance of fish while foraging for live prey. The central hypothesis of the project is that chronic, low-dose exposure to neurodegenerative cyanotoxins alters the outcomes of species interactions through deterioration in sensorimotor feedback during prey-capture events. To test this hypothesis, data were collected on the prey-tracking performance of larval (21 days) and adult (7-8 months) fathead minnows, *Pimephales promelas*, during hunting events. Foraging efficiency and prey-capture trials indicated that exposure to DABA was associated with a significant reduction in prey consumption, potentially due to a reduced ability to detect or recognize prey. Sensorimotor deficits of fathead minnows under lab conditions suggest that these effects would also be apparent in wild populations. A permanent or temporary reduction in motor performance can interfere with prey-capture behavior and decrease capture success. Such changes are important because have the

potential to alter the dynamics of natural aquatic populations and communities if they translate into increased mortality.

6 HOW CRAYFISH DOMINANCE INFLUENCES BURROW SELECTION AND BEHAVIOR

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Procambarus clarkii, or red swamp crayfish, are animals with well-known dominance behaviors. Such behaviors help establish social hierarchies that influence resource access and use, however, it is not clear how such social behavior is influenced in the face of life-threatening environmental stimuli (loss of surface water). In the current study, it was predicted that dominant crayfish would select preferred burrow sites in clay substrate over less preferred sand substrate, when prompted by the sudden removal of surface waters. The submissive crayfish would relocate to the less preferred substrate, the sand. Individual crayfish were transferred from a common stock tank to individually housed 1.5-L aquaria with oxygenated, carbon-filtered tap water for at least 72 hours. Two crayfish were each placed in the experimental tanks (28 cm x 25 cm x 30 cm) at the start of the experiment (10 replicate pairs). Each tank contained medium grain sand in half of the tank bottom, and clay in the other half of the tank bottom, to a depth of 4 cm. Another 4 cm of surface water was added. This was a total depth of 8 cm of substrate + water. Experimental crayfish were able to establish dominant-submissive behavior for the first 24 hours. Each trial was chosen randomly as to whether the surface water was removed or not. The surface water was drained at 24 hours and this prompted burrowing behavior. Crayfish activities were recorded for an additional 24 hours after surface water removal. Results are still being analyzed, but we predict that the dominant crayfish would establish control of the optimal burrow sites, in the clay-based sediment. These results are important because it will show how acute changes in resource availability may influence dominance behaviors and resource use in a social organism.

7 PESKY PRIMATES AND LURKING LEOPARDS: CAN PREDATOR STIMULI REDUCE CROP-RAIDING BY GREEN MONKEYS (*CHLOROCEBUS SABAEUS*)?

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For as long as humans have been establishing settlements, they cause dramatic changes to the landscape, such as clearing vegetation for buildings, roads, and crops. When cultivated areas are positioned close to the forest edge, species with behavioral flexibility and an omnivorous diet, such as non-human primates can benefit. Crop foraging requires less time, allowing for more rest (Strum, 2010), and results in higher fertility and lower mortality (Higham et al., 2009; Lodge, Ross, MacLamon, & Ortmann, 2013) when compared to foraging for wild food sources. Thus, for primates, crop foraging represents a behavioral adaptation that likely increases the survival and reproduction. For humans, crop foraging by primates is typically referred to as “crop raiding,” a term suggestive of malicious intentions on the part of the “raiders” (Hill, 2018). This negative view is due to the detrimental impact of crop foraging on the humans that cultivate crops. Sustenance and cash crop farmers across the globe regularly lose portions of their crops to primates that have adopted this successful foraging strategy. Crop-loss to green monkeys is considerable problem on the Caribbean island of Barbados, where the green monkey population has been isolated from natural predators for nearly 400 years. Yet, they continue to show fear, avoidance, and produce alarm calls in response to images of an ancestral predator (leopard). We measured whether monkeys would avoid food placed near an image of a leopard (Exp 1) and how close to a leopard image monkeys were willing to forage (Exp 2). The results indicate that the leopard image was an effective deterrent for monkeys that ranked high in the social hierarchy. In contrast, low ranking monkeys were more likely to spend time foraging near the leopard image in both experiments. These findings indicate that predator-related stimuli are not effective deterrents for all members of a troop, thus, are unlikely to reduce crop foraging behavior.

8 HEAT WAVE TIMING, CONTINUITY, AND LENGTH AFFECT TEMPERATURE-DEPENDENT SEX DETERMINATION IN A FRESHWATER TURTLE

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Climate change has the potential to threaten thermally sensitive species, such as reptiles with temperature-dependent sex determination (TSD), if heat waves increase in frequency and length as predicted. In species with TSD, temperature affects sex determination most acutely during the thermosensitive period (TSP), which falls in the middle third of development as defined by constant temperature studies. Presently, we know little about how the timing during development or continuity of heat waves affects sex determination. We hypothesized that exposure to daily fluctuations of $25\pm 3^\circ\text{C}$ (which produce all males) and heat waves of $29.5\pm 3^\circ\text{C}$ that varied in either timing during development or continuity would affect resulting sex ratios in *Trachemys scripta*. Exposure to a 15-day heat wave early or late in development did not significantly affect sex ratios (all male-biased), but heat waves occurring between days 24 and 45 resulted in an average sex ratio of 80% female. Further, the observed TSP was shorter than the TSP defined by constant temperature studies. Only the 12-day heat wave early in the TSP produced a female-biased sex ratio in the continuity study. Decreasing continuity resulted in male-biased sex ratios, resulting from continuity effects or lowered sensitivity later in the TSP. We also quantified *Dmrt* and *aromatase* expression following 6, 9, 12, and 16 days of heat wave exposure to determine how heat waves affect gene expression. *Aromatase* expression was significantly up-regulated after 12- and 16-day heat waves, while *Dmrt1* expression did not significantly change over the course of the heat wave. These results clarify the timing and length of the TSP and provide information on the timing of up-regulation of *aromatase* expression under fluctuating conditions. Further, these data provide detailed insight into the physiological effects of climate change, in the form of heat waves, on species with TSD.

9 EXERCISE IS NEUROPROTECTIVE FOLLOWING PARTIAL MOTONEURON DEPLETION

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Motoneuron loss is a severe medical problem that can result in loss of motor control and eventually death. We have previously demonstrated that partial motoneuron loss can result in dendritic atrophy and functional deficits in nearby surviving motoneurons, and that treatment with androgens can be neuroprotective against this dendritic atrophy. Exercise has been also been shown to be protective following a variety of neural injury models and, in some cases, is dependent on androgen action. In this study, we explored whether exercise shows the same neuroprotective effect on induced dendritic atrophy as that seen with androgen treatment. Motoneurons innervating the vastus medialis muscles of adult male rats were selectively killed by intramuscular injection of cholera toxin-conjugated saporin. Following saporin injections, some animals were allowed free access to a running wheel attached to their home cages. Four weeks later, motoneurons innervating the ipsilateral vastus lateralis muscle were labeled with cholera toxin-conjugated horseradish peroxidase, and dendritic arbors were reconstructed in three dimensions. Dendritic arbor lengths of animals allowed to exercise were significantly longer than those not allowed to exercise. These findings indicate that exercise following neural injury exerts a protective effect on motoneuron dendrites comparable to that seen with exogenous androgen treatment.

10 SEX DIFFERENCES IN ACTIVITY AND LEARNING FOLLOWING REPEATED ADMINISTRATION OF PSYCHOSTIMULANTS

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Behavioral responses to acute administration of psychostimulants differ in male and female rats. This study examined the effects of repeated administration of psychostimulants, METH and cocaine, on activity and simple learning in adolescent rats. Following 4 repeated daily administrations of METH (5mg/kg), cocaine (100g/kg), or saline, spontaneous activity was measured in an open-field and simple learning was measured using fixed-ratio 5 (FR5), which required five lever-presses to earn each food pellet. Behavioral responses to METH and cocaine differed between males and females. METH increased activity in both males and females, with higher open-field activity in females. For simple learning, METH decreased response latency and run time, reflecting impulsivity. Compared to males, however, female rats showed

smaller decreases in response latency and run time, reflecting differential METH effects on motivation. Alternatively, cocaine increased spontaneous activity, with a greater increase in males than females. In the simple learning task, cocaine increased response latency similarly in both sexes. Cocaine also increased runtime in both sexes, and significantly more in females, reflecting differential cocaine effects on motivation. Cocaine produced no change in pellet retrieval or consumption. The present findings suggest that psychostimulants administered during development produce different effects in males and females, with responses of males suggesting greater abuse potential, and responses of females suggesting greater effects on motivation.

11 INTRASPECIFIC BROOD PARASITISM IN FIELD SPARROWS (*SPIZELLA PUSILLA*)

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Extra-pair Parentage (EPP) is when socially monogamous male and females mate outside of their social pair that results with offspring that are not genetically related to one of the parents. Intraspecific brood parasitism (IBP), one way in which this can occur, is when a female lays her egg in the nest of another female of the same species nest. This reproductive strategy is thought to influence reproductive fitness by reducing the cost of parental care. In this study we investigated rates of IBP in breeding Field Sparrows (*Spizella pusilla*). At Saint Patrick's County Park in South Bend, IN adults were captured, bled, and color banded through the June and July 2018 months. Blood samples were taken from 23 social parents and possible IBP mothers. We found eight nests and eighteen offspring were sampled for genetic analysis. Using Cervus 2.0 data program, each individual was genotyped at five microsatellite loci. We identified four potential cases of IBP in two nests. These results show Field Sparrows are participating in IBP, and that IBP mothers may lay multiple eggs in hosts' nests.

12 FEAR IN THE VETERINARY CLINIC: HISTORY AND DEVELOPMENT OF THE FEAR FREESM INITIATIVE

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Concern for fear, anxiety, pain, and stress in companion animals in the veterinary setting has existed for decades. However, this concern did not translate into published material until approximately 2012. Gaps in material, education, and research may have led to the delay in change in the veterinary professional community. Tracing the history and development of the Fear FreeSM initiative, this research project will reveal a material gap starting in 1999, the absence of thorough animal behavior educational curricula, and the transition from the acceptance of fear, anxiety and stress (FAS) in the veterinary clinic to an expectation of FAS-free visits. This research project will not be outlining fear in domestic animals, but rather fear, anxiety and stress as it has been addressed in the veterinary community.

13 STRESS IN A SOCIAL HIERARCHY: IMPACTS OF OXIDATIVE STRESS ON SOCIAL STABILITY AND SOCIAL ASCENT IN A CICHLID FISH

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For many species, social systems consist of dominance hierarchies where social rank influences access to resources and dictate overall health and fitness. The costs of maintaining high social status have been under study since the conceptualization of social hierarchies, with recent evidence linking higher social status with higher oxidative stress – the imbalance between the generation of reactive oxygen species and antioxidant defenses. Failure to neutralize reactive oxygen species can result in oxidative damage, harming cellular components. How status-specific oxidative stress and agonistic effort/social stability interact remains unclear, however. Our study explores the link between oxidative stress, social status, social stability, and social ascent – subordinate males rising to dominance – in males of the cichlid fish *Astatotilapia burtoni*. To manipulate social stability, we altered territory availability in a community-setting on a weekly basis across 22 weeks. Following the 22-week experiment, males were sacrificed to collect blood and tissue samples. To study social ascent, we removed the dominant male in secluded condos (2 males 6 females) to stimulate the subordinate male to become dominant. Following ascent, we observed behavior for up to 14 days and sacrificed males to collect blood and tissue samples. We found that in

stable colonies, dominant males experienced greater stress than subordinate males, however unstable colonies did not. For social ascent, we found a drop in both oxidative damage and antioxidants following ascent before increasing towards dominance levels. Despite the increased oxidative damage in either experiment, no change in DNA damage was found. Our study provides a unique take on how both the social environment and dominance tenure influence oxidative stress, and how levels of oxidative stress depend on both the oxidative stress marker used and biological component analyzed.

14 THE MEANING OF SONG STRUCTURE: EXPLORING BEHAVIORAL RESPONSES OF FIELD SPARROWS TO THREE SIMPLE SONG TYPES

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The frequency, rate, and overall quality of a male's song may indicate the singer's physical quality, either as a threat or as a potential mate. However, the degree to which a song must differ acoustically to communicate different information about the singer remains unclear. Analysis of male field sparrow (*Spizella pusilla*) simple song recorded in southwest Michigan revealed three structurally distinct clusters of simple song that differ in frequency characteristics. We hypothesize that songs in each cluster convey information about the singer and that receivers respond more strongly to songs more similar to their own song. To understand whether males distinguish among song clusters, we performed playback experiments on 32 males presenting simple song from the three clusters in a randomized order. We recorded behavior including number of songs, perch changes, and distance from the speaker before, during, and after song playback. We extracted two axes from a principal component analysis that reflected space use during trials (PC1) and song rate (PC2), and then ran linear mixed models to test whether males respond differently to songs from the different clusters and whether their own song influenced response. Males responded to songs from each cluster, as they changed behavior to playbacks, but males responded similarly to the song clusters. However, the male's own song appeared to influence his response, as males with narrow bandwidth songs tended to sing more during playback than males with broad bandwidth songs. This suggests that narrow bandwidth song may communicate male quality or aggression.

15 ELECTROPHYSIOLOGICAL RESPONSES TO CHEMOSENSORY STIMULI IN CEPHALOPOD ARMS

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Chemosensation is important for cephalopod behavior and survival because they use their arms constantly to probe and sense their environment. There have been studies on the anatomy and behavior of chemosensation in the suckers and olfactory pits. However, the physiology of the chemosensory abilities of cephalopod arms and suckers has not been thoroughly researched. In this study, the neural activity in the brachial nerves of both *Doryteuthis pealeii* (n=17 individuals) and *Octopus bimaculoides* (n=9 individuals, 21 arms) were recorded when perfused with environmentally relevant chemical stimuli. Arms were surgically removed from euthanized squid or anesthetized octopuses and then attached to suction electrodes. Chemical stimuli, including amino acids, fish skin, and cephalopod skin and ink, were perfused over the arm and neural electrical responses were recorded and quantified. *D. pealeii* arms did not remain responsive over the duration of the experiment, so insufficient data was collected to allow analysis. *O. bimaculoides* arms remained alive for the whole experiment. These arms elicited the most robust responses to fish skin, glycine, methionine, and conspecific skin, showing significantly greater nerve activity to these stimuli than to sea water controls. Arms and suckers often physically moved in response to these stimuli as well. Notably, cephalopod ink was not detected by the arms. We concluded that chemosensory receptor cells on *O. bimaculoides* arms were able to detect environmentally relevant chemicals and even drive local motor responses. Ink may be detected through another sensory pathway, such as through vision or the olfactory pits located on the head. These physiological techniques could be used to further explore chemosensation in octopus and other cephalopods.

16 POST TRAUMATIC BRAIN INJURY AFFECTS ON MOBILITY IN THE ZEBRAFISH MODEL

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Researchers at the University of Toronto developed a method of inducing TBI in the zebrafish model using ultrasonic wave pulses (1MHz) and found that TBI compromises the mobility of adult zebrafish (3-6 months) (McCutcheon et. al., 2017). The goal of this study was to attempt to replicate the resulting effect in zebrafish mobility using the previously mentioned TBI in zebrafish model. The current study uses adult zebrafish (12-18 months) and TBI was induced inside system water with a 1MHz pulse directed at an adult zebrafish in a 4cm³ crate. Mobility was assessed by measuring distance swam and velocity of swimming. Our preliminary results have found no significant difference in mobility between TBI zebrafish and the control group. Zebrafish in the control group (N=3) swam an average total distance of 260.7 μm (sd:143.1) at an average velocity of 13.2 $\mu\text{m}/\text{second}$ (sd:7.2) five minutes post a sham TBI protocol while TBI zebrafish (N=3) swam an average total distance of 273.8 μm (sd:62.3) at an average velocity of 13.8 $\mu\text{m}/\text{second}$ (sd:3.1) five minutes post the TBI protocol. The control zebrafish swam an average total distance of 319 μm (sd:78.8) at an average velocity of 17.2 $\mu\text{m}/\text{second}$ (sd:4.0) and 265.8 μm (sd:74.5) at an average velocity of 13.3 $\mu\text{m}/\text{second}$ (sd:3.8) at 24 hours and 48 hours post sham TBI protocol respectively. The TBI zebrafish swam an average total distance of 303.1 μm (sd:113) at an average velocity of 15.2 $\mu\text{m}/\text{second}$ (sd:5.7) and 375.7 μm (sd:140.1) at an average velocity of 21.2 $\mu\text{m}/\text{second}$ (sd:7.1) at 24 hours and 48 hours post TBI protocol respectively. Replication failure could be due to the zebrafish in this study being older and possibly less susceptible to the 1MHz ultrasonic sound wave. It is possible that an ultrasonic wave of higher frequency is necessary for older zebrafish or perhaps the pulse that is administered must be increased in duration. Understanding how differences in methods impacts results helps further understanding of the model.

17 SOCIAL EXPERIENCE MODULATES SEX DIFFERENCES IN COMMUNICATION IN A TERRITORIAL SPECIES OF ELECTRIC FISH

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Communication signals may serve multiple functions in different social contexts in sex-specific ways. Experience with familiar social partners can also modulate how often and what types of signals are produced. This is common among individuals who share territorial boundaries, such as male songbirds that type-match with their neighbors. Weakly electric gymnotiform fishes produce electric organ discharges (EODs) used for electrocommunication. Chirps, or transient increases in the EOD frequency, are produced primarily during social encounters. However, chirp production is usually studied in response to artificial playbacks, so conclusions about chirp function are often simplified. Plus, chirp structure and use are sexually dimorphic and context-dependent, indicating their function is likely complex. Here, I investigate how long-term social experience modifies chirp use in a highly aggressive species of electric fish (*Apteronotus albifrons*) across sex and context in order to determine the function of chirping. If chirps serve multiple functions, then chirp rate will likely vary across sex and social context. Fish were housed in opposite-sex pairs, same-sex pairs, and in isolation for five weeks, during which overnight recordings were collected once a week. Although previous studies using artificial playbacks showed males and females have similar chirp rates, I found that males chirped more than females in live social interactions. Results also suggested there was a strong context-dependent social novelty response in this species, after which chirp rate quickly declined over the course of the five weeks, but only in male-male pairings. This suggests chirps may signal status during aggressive encounters, but that their function is likely complex and context-dependent.

18 SOCIAL STABILITY ALTERS COLOR PHENOTYPE IN A COLOR POLYMORPHIC CICHLID FISH

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Color change enables animals to alter their color phenotype in response to environmental conditions. It is often the case that little is known about the mechanisms of color change, especially in taxa that use body coloration as a social signal. In the cichlid, *Astatotilapia burtoni*, males can be either yellow or blue and color phenotype is plastic. Body coloration in this species is more intense in territorial males and it is an important communication cue for female mate choice and male-male competition. Color phenotypes

have distinct behavioral and physiological profiles and it is thought that this color plasticity can be used to maximize fitness in response to changes in the social environment. We tested the hypothesis that social stress induced from an unstable social hierarchy would influence color expression. Social instability was induced over a 21-week experimental period in which the number and location of available breeding territories was altered weekly, resulting in drastic increases in social hierarchy fluctuations. We found that nearly all males changed color at least once over the course of the experiment. The proportion of yellow males increased over time in both the stable and unstable communities; however, the rate of increase was significantly higher in unstable tanks. In addition, males that experienced more status shifts over the course of the experiment were more likely to end up yellow. Our study provides evidence that chronic social stress promotes yellow coloration and can help to better understand the physiological mechanisms underlying the phenotypic plasticity displayed in these and other fish species.

19 IMMUNE DEFENSE AS A METRIC OF STRESS: AN ANALYSIS OF THE EFFECTS OF A BROKEN PAIR-BOND IN CAPTIVE ZEBRA FINCHES

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It is well documented that a wide range of avian species breed monogamously and that divorce of a pair bond results in physiological changes at the endocrine level. For example, the separation of a mate from the pair-bond can alter the plasma hormonal titers of corticosterone (an immunosuppressant) in avian species, including captive Zebra Finches (*Taeniopygia guttata*). Our study examined the effects of pair-bond dissolution on immunocompetence in male Zebra Finches. We used the bacteria-killing ability (BKA) of blood as a metric of immune function in caged isolated, caged pair-bonded, and aviary housed male subjects. Contrary to expectations, we found that finches that were separated from their pair-bonds for a three-day period and housed with a similarly separated male had higher BKA than birds paired with a female. Additionally, caged Zebra Finch did not differ in BKA from conspecific aviary males. Lastly, when comparing aviary housed Zebra Finches (a monogamous parental species) to aviary-housed male Pin-tailed Whydahs (*Vidua Macroura*; an obligate brood parasitic, lek-breeding species), as expected, we found that whydahs showed higher BKA. Our results indicate that social status and species identity both influence immune function in our focal captive bird taxa.

20 ZOO VISITOR EFFECTS ON BOLIVIAN GRAY TITI MONKEY BEHAVIOR AND SPACE USE

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How visitors affect zoo animal welfare is a widely-studied topic in zoo animal welfare science. Here, we focus on Bolivian gray titi monkeys (*Callicebus donacophilus*) and ask whether larger crowds are associated with avoidance of visitor areas or an increase in behaviors associated with stress. In this study, we conducted behavioral observations on one social group of titi monkeys (n = 3) for 23-months. Using ZooMonitor, an app developed at Lincoln Park Zoo, we conducted 10-minute focal follows (average of 5.96 follows per day, between the hours of 7 am and 5 pm). At the start of each focal follow, the observer recorded crowd size at the viewing glass. During each focal follow, the titi monkeys' behavior and location in the exhibit were scored at one-minute intervals. The monkey's behavior and exhibit space use used to monitor their comfort level in relation to different crowd sizes. For one of the three individuals (the eldest female), stress-related behaviors tended to increase when she was exposed to larger crowd sizes. However, space use of the entire group did not appear to vary dependent upon crowd sizes. The results of this study can be used to improve the welfare of the Bolivian gray titi monkeys at Lincoln Park Zoo, as we are better informed about individual differences in reactions to varying crowd sizes.

21 ENVIRONMENTAL FACTORS AS ACTIVATING AGENTS OF SEMIOCHEMICALS FOR THE AMERICAN COCKROACH, *PERIPLANETA AMERICANA*

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Once emitted, semiochemicals are exposed to environmental factors that may alter the set of compounds, disrupting the chemical communication. However, as facing habitat conditions is unavoidable, some species may have adapted to detect environmentally-mediated breakdown products as semiochemicals. We demonstrate that *Periplaneta americana* cuticular hydrocarbons (CHCs) react with environmental agents producing volatiles that prevent roaches from aggregating. In behavioral assays, roach nymphs strongly avoided aggregating under shelters conditioned with breakdown products from cuticular alkenes. Chemical analyses of the headspace of CHCs exposed to these agents confirmed that volatile organic compounds (VOCs) are formed. Behavioral responses were then tested with mixes of synthetic standards that mimicked original amounts of VOCs. When short-chain fatty acids and remaining compounds were tested separately, no preference for control or treated shelters was observed. However, the original avoidance behavior to treated shelters was reconstituted when both mixes were tested together. Our results demonstrate that environmental agents degrade CHCs into semiochemicals, as volatile cues possibly as necromones or to avoid colonized shelters as CHCs are deposited on aggregation sites.

22 IS AVIAN INCUBATION REINFORCED BY OPIOID ACTIVATION?

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Contact comfort is a type of reward that usually stems from physical contact with a conspecific (Machin & Dunbar, 2011). In mammals and birds, contact comfort results in release of endogenous opioids and an associated feeling of euphoria and contentment (Nelson & Panksepp, 1998). In mammals, contact comfort can also arise from stimuli associated with nests (Machin & Dunbar, 2011). However, it is unknown if aspects of avian nests (e.g. warm eggs) can also elicit opioid-mediated contact comfort. If so, the pleasurable effects of contact comfort may explain why birds return to the nest for their daily bout of nest sitting. In the first experiment, we injected male doves when they were incubating eggs with the opioid receptor antagonist (naloxone) or saline. Time spent off the nest during the 30 minutes following each injection was measured. Doves injected with naloxone spent significantly more time off the nest than doves injected with saline. However, it was unclear if the birds stayed off the nest because the naloxone stripped the birds of the contact comfort or created physical discomfort (Howard, 2010). The second experiment was designed to differentiate between these alternative explanations. We used a condition-placed preference (CPP) paradigm to determine whether naloxone creates an aversive internal state. Naloxone was paired with one visually distinct context and saline with another on alternating days for two weeks. On test days, the door between training contexts was removed so subjects could move freely throughout apparatus. Subjects did not show a conditioned aversion to the context that had been paired with naloxone. These results suggest that the disruption in incubation seen in the first experiment was not due to naloxone creating a physical discomfort. Taken together, the results from both experiments provide support for the opioid hypothesis for avian incubation.

23 DO OLFACTORY CUES AFFECT FEMALE MATE CHOICE IN PRAIRIE VOLES, *MICROTUS OCHROGASTER*?

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Choice of a mate is known to have a major impact on a female's reproductive success. This may be especially true in species with biparental care of offspring where male assistance may allow females more time to forage. A male's quality or his ability or willingness to engage in paternal care may be assessed through indicator cues. Female rodents use primarily auditory and/or olfactory cues as indicator traits. In a previous study, female prairie voles displayed social and mating preferences for males with longer arginine vasopressin 1a receptor (*avpr1a*) microsatellites. The length of the *avpr1a* microsatellite influences male parental care and pair bonding. The specific cues that female prairie voles use to differentiate between males with different microsatellite allele lengths are not known, but evidence indicates that female preference is not based on male courtship behavior. If females use olfactory cues to assess mate preference, then they should spend more time investigating olfactory cues from males with long *avpr1a* alleles than cues from males with short *avpr1a* alleles. We conducted female preference tests

by simultaneously placing soiled bedding (containing cues from feces, urine, and scent glands) from two males, one with two long and one with two short *avpr1a* alleles at the opposite ends of a 3-chambered arena. Both estrus and non-estrus females (N = 20/treatment) were tested because females may only show a preference when they are in estrus. Females were filmed for 24 hours and Ethovision software was used to quantify time spent with bedding from each type of male. Results of this study will be discussed.

24 EFFECTS OF AGE ON PHYSIOLOGY AND BEHAVIOR IN SIBERIAN HAMSTERS (*PHODOPUS SUNGORUS*)

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Previous studies have shown that aging significantly impacts a suite of behaviors, including social behaviors, cognition, learning, and memory. While this topic has been studied extensively in mice and rats, it is relatively unexplored in other rodent models. The goal of the current study was to investigate the effect of aging on anxiety-like, repetitive, and social behaviors in male and female Siberian hamsters, a species that exhibits robust changes in behavior in response to their physiological state. We divided 76 male and female hamsters into four different age groups: early-life (2-3 months), early adulthood (3-11 months), late adulthood (11-18 months), and aged (≥ 18 months). To assess whether anxiety-like, repetitive, and social behaviors differ with age, we measured these behaviors using an open field test, nestlet shredding test, marble burying test, and a resident-intruder paradigm. Our preliminary data suggest that there are sex differences in both the extent of nestlet shredding and the number of marbles buried during behavioral testing. Specifically, late adulthood and aged males trend toward a significant increase in nestlet shredding, and aged males trend toward an increase in number of marbles buried relative to early-life females. In contrast, aged females show significantly elevated nestlet shredding, yet show no significant difference in marble burying compared to early-life females. Data for aggression, investigation, scent-marking, and grooming behaviors will also be presented. Collectively, our study provides insight into the sex-specific effects of aging on social and solitary behaviors and emphasizes the importance of considering and controlling for age during experimental testing.

25 MOBILE DATA COLLECTION WITH SURVEY123; IMPROVING FIELD-BASED WILDLIFE BEHAVIOR RESEARCH

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Field-based studies of wildlife behavior, habitat use, and distribution often still rely on traditional pen-and-paper data collection. When spatial data is required, a separate GPS unit must also be managed. These methods are prone to high rates of human error, require large time investments in data entry and organization, and involve extensive data manipulation prior to analysis. ESRI's "Survey123" is a digital, form-centric application that allows the user to create, modify, and share data sheets across multiple devices. Survey123 is directly integrated with ArcGIS Online and each survey can be paired with geolocations taken directly on the application. During our study of breeding Mississippi Kite *Ictinia mississippiensis* distribution, abundance, and habitat selection in southern Illinois, we are collecting nest-site and behavioral data on digital data sheets and ethograms using Survey123 on an iPad mini or personal smartphones paired with a Garmin Glo 2 GPS unit. This system had numerous benefits over paper and external GPS methodologies, including decreasing the risk of human and random error, eliminating the large time requirement of manual data entry, allowing incidental data collection by multiple parties, and seamless integration of spatial and behavioral data. Data were uploaded daily to ESRI's online portal where it can be viewed on any device via ArcGIS Online and exported in numerous formats. We intend to use this data to create Habitat Suitability Index models for breeding Mississippi kites using MaxEnt in order to estimate the minimum number of nesting pairs in southern Illinois. The results of our study will be used by the Illinois Endangered Species Protection Board to inform management decisions regarding the status of Mississippi Kites in the state. The numerous advantages of digital data recording using Survey123 make this method an excellent option not only for studies of wildlife, but research in the social and political sciences as well.

26 CONNECTING THE DOTS ON EGGHELL PIGMENTATION: THE RELATIONSHIP BETWEEN PIGMENTATION AND FEMALE AND OFFSPRING CONDITION AND MALE PROVISIONING EFFORT

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Despite a wealth of research in avian breeding ecology, little is known regarding the mechanisms or functions of the different pigments maternally deposited into eggshells. One hypothesis posits that shell pigmentation is an honest signal of female quality by reflecting her level of oxidative stress, one that may be used by males to influence paternal investment. Support for this hypothesis has been mixed, especially in regards to the brown pigment protoporphyrin. Using a cross-fostering design we tested whether clutch pigmentation correlates to either female or offspring fitness metrics or male provisioning effort in house wrens (*Troglodytes aedon*), a species that lays eggs dominated by protoporphyrin. We found no effect of clutch pigmentation, foster-parent clutch pigmentation, or their interaction, on female or offspring mass or tarsus length, nor was there an effect on nest success. We conclude that neither perceived nor actual clutch pigmentation is an indicator of female or offspring quality with respect to our fitness metrics. We are currently analyzing the effects of clutch pigmentation on female and offspring oxidative stress as well as on male provisioning effort.

27 SOCIAL EXPERIENCE MODIFIES RESPONSE TO PLAYBACK AND INCREASED SYSTEMIC SEROTONIN

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Previous social experience is an important factor in the perception and response to social cues. Changes in perception due to an individual's prior experience may be a result of changes to sensory brain regions. In house mice, extracellular serotonin in the auditory midbrain is related to both previous social experience and cues from a social partner, leading us to hypothesize that previous experience will impact perception of a social cue and response to changes in serotonin. In order to test this hypothesis, we measured the response of male house mice response to broadband vocalization (BBV) playback in different social housing conditions (n=19) and after injection of a serotonin precursor (5-HTP; n=12). Individuals in the social housing experiment were randomly assigned to be housed either in pairs or isolated for 1 week resulting in 3 groups, Isolated (n=7), Social Dominant (n=6), and Social Subordinate (n=6). Males were placed on the opposite side of a plexiglass barrier from a novel female and played 5 minutes of BBVs preceded and followed by 5 minutes of silence. Playback significantly decreased male vocal behavior across all social groups. Isolated males produced significantly more of a specific male vocalization correlated with mounting and Social Dominant males spent significantly less time investigating than Isolated and Social Subordinate individuals. These results indicate that BBVs are socially relevant signals for male mice and that reproductive behavior varies with previous social experience. To test the relationship between BBVs and serotonin in the auditory system, males (n=12) were injected with a serotonin precursor (5-HTP) or saline prior to BBV playback. Response to the 5-HTP injection and BBV playback varied depending on the male's social rank, indicating both prior experience and available serotonin may be involved in BBV perception.

28 HARMFUL ALGAL BLOOMS IMPAIR INNATE PREDATOR-EVASION BEHAVIOR IN A FRESHWATER FISH

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Cyanotoxins produced by harmful algal blooms (HABs) are commonly detected in freshwater systems in the United States and abroad. Emerging evidence suggests that chronic exposure of fish and other aquatic organisms to cyanotoxins may induce sub-lethal effects on behavior, negatively influencing individual fitness. Along with reducing recruitment of young into the population, exposure may increase the rate of transfer up the food chain, posing significant health risks for humans. For example, exposure to neurodegenerative cyanotoxins through the consumption of contaminated foods has been linked to sporadic increases in diseases such as amyotrophic lateral sclerosis (ALS), and Parkinson's and Alzheimer's disease. Despite the potential for similar cognitive and motor impairment in aquatic organisms, the effects of neurodegenerative cyanotoxins on the performance of fish in real-world contexts is largely unknown. In this study, we examined the sub-lethal effects of a common algal neurotoxin, 2,4-diaminobutyric acid

dihydrochloride (DABA), on the innate predator-evasion performance of larval fathead minnows, *Pimephales promelas*. Eggs and larvae were exposed to a range of concentrations of DABA (0, 1, 5, 25, 125 and 625 µg/L) for 21 days. On day 22, behavioral assays were conducted by administering a non-point source vibrational stimulus to an arena containing a focal larva. Responses were filmed using a high-speed camera at 1000 fps, and perceptual and motor components of the response were analyzed separately. Compared with nonexposed fish, exposure to DABA significantly modulated the response of larvae to a simulated predator. This research is among the first to attempt to understand how neurodegenerative cyanotoxins affect the behavior of aquatic organisms in real-world contexts and could be used by managers to predict the fate of aquatic communities in areas afflicted by HABs.

29 COLD-INDUCIBLE RNA-BINDING PROTEIN MAY REGULATE GONADAL DEVELOPMENT IN THE RED-EARED SLIDER TURTLE

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Temperature-responsive genes, such as those coding for heat shock proteins, play a vital role in embryogenesis. Cold-inducible RNA-binding protein (Cirp) is a heat shock protein present in the gonadal tissues of multiple taxa with a potential regulatory role in the sex-determining pathway. The red-eared slider turtle (*Trachemys scripta elegans*) exhibits temperature-dependent sex determination (TSD), where thermal cues trigger gonadal differentiation during development. In *T. s. elegans*, Cirp is up-regulated concurrent with estrogen-inducing transcripts at female-producing temperatures. Intron retention has been proposed as a regulatory mechanism for sex-specific development, and RNA-binding proteins can regulate the retention of introns. As Cirp is an RNA-binding protein localized in developing gonads, we hypothesize that Cirp plays a regulatory role in gonadogenesis by impacting the stability of target transcripts via intron retention. *T. s. elegans* eggs were incubated under fluctuating temperature treatments and either held under conditions that should produce males, or given a simulated heatwave to induce female development. Gonads from embryos were dissected for immunoprecipitation and RNA-seq. Sequenced RNA product will be aligned to an internal transcriptome developed from published raw reads to identify the target transcripts. Target transcripts will be translated and aligned to the painted turtle (*Chrysemys picta*) proteome to identify alignment gaps that correspond to retained introns. Our approach will help us understand how Cirp responds to fluctuating temperature treatments, and how it may regulate the nuclear expression of reproductive genes.

30 OPTOGENETIC APPROACH SUPPORTS GLIA'S IMPACT ON BEHAVIOR IN *DROSOPHILA*

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Past research labeled glial cells as support cells for neurons since their functions include insulating neurons in myelin and fighting infections without causing behavior; however, research in the last two decades shows that glial cells produce behaviors without neuronal contributions. Our project builds upon these findings by examining how glial cells impact neuronal circuits and underlying behavior in *Drosophila*. Since neurons communicate with one another through influxes of ions entering and exiting cells to cause a behavior, we hypothesize that previously observed changes in glial ion gradients are produced to directly impact behavioral output in larvae. To test this hypothesis, we implemented optogenetic methods to ectopically express a blue light-gated anion channel (GtACR1) in all glial cells. By shining a blue light on third-instar larvae, we activated GtACR1 and recorded subsequent behavioral changes. Interestingly, we observed a full body contraction called the accordion phenotype. To prevent neuronal contribution from causing this behavior, we used drivers to suppress GtACR1 expression in neuronal populations. These larvae still produced the accordion phenotype, suggesting that ion gradients in glial cells caused the behavior. To test if these glial cells are in the central nervous system, we performed brain dissections and immunostaining. Larvae have uniform GtACR1 expression in their optic lobes and ventral nerve cord, showing that cells in the central nervous system produced the accordion phenotype. Combined, our results support that glial cells in the central nervous system contribute to the neuronal circuit that produces the accordion phenotype.

31 USING TWO TYPES OF TRAPS TO EVALUATE RESPONSE BY BEETLES IN THE FAMILY STAPHYLINIDAE TO PLANT VOLATILES

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Beetles in the family Staphylinidae are important predators of arthropods in managed and unmanaged ecosystems, but methods to quantify the composition of species and their relative abundances have yet to be developed. In the summer of 2018, we tested the hypothesis that volatiles that may be associated with potential species of prey would be attractive to staphylinid beetles. We evaluated the response of staphylinids to five plant volatiles: ethanol, limonene, linalool, α -pinene, and α -terpineol, as well as the pheromone of a cerambycid beetle, 3-hydroxy-2-ketone. Separate transects of flight intercept and pitfall traps were baited individually with our treatments at two locations within east-central Illinois. We caught 169 staphylinids of six species in our study, with a mean of 8.69 ± 1.23 staphylinids in flight intercept traps and 1.94 ± 0.47 staphylinids in pitfall traps per replicate, respectively. Treatment had no effect on the response of staphylinids to traps in our study. The type of trap did influence our capture of staphylinids, with four species being found in only flight intercept traps, and two species only found in pitfall traps. We also found that location influenced trap catch, with 2x as many staphylinid beetles captured at Allerton Park compared to Forest Glen Preserve. Our findings suggest that within east-central Illinois, the location of sampling and trap type influence both the abundance and identity of captured staphylinids. While we found no evidence of attraction to plant volatiles by staphylinids in our study, further research should be conducted to evaluate the specific compositions of volatiles from plants associated with prey of staphylinids. Results from our study provides a greater understanding of the foraging behavior and natural history of staphylinids, as well as contribute to the development of traps and attractants to target different species of staphylinids.

32 NOCTURNAL MOVEMENT AND ROOST COALESCENCE IN THE AMERICAN CROW

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During the winter months, American crows (*Corvus brachyrhynchos*) aggregate in large communal roosts that may include thousands of individuals. While communal roosting is fairly common in birds, there is considerable variation in behaviors between species, and the factors influencing these behaviors are not especially well understood. In American crows, these roosts are a nightly occurrence in winter, with crows dispersing in the mornings and returning to the roost site in the evenings. This study explores the roost movements that occur after sunset, because entire aggregations may sometimes shift roost sites after dark. Beginning at sunset, we collected location and activity data via four hours of continuous observation of roosts in Charleston, IL. Last known roost locations were then checked for presence-absence of crows at eight hours and twelve hours after sunset. With this, we sought to answer two major questions. The first relates to our understanding of the nightly temporal patterns for roost selection. We examined if there is a time frame at which crows will generally cease movement to new sites. The second question relates to our understanding of the nightly spatial patterns for roost formation. We investigated whether crows tend to aggregate more tightly as the night progresses.

33 NOVEL ANTIDEPRESSANT AND ITS EFFECTS ON STRESS-RELATED BEHAVIORS AND MEMORY IN FISH

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Emerging evidence suggests that ketamine, a pharmaceutical often prescribed for off-label use as an antidepressant, may be an effective intervention for the treatment of major depressive disorders. Specifically, ketamine works quicker and more effectively than traditional antidepressants because of its ability to rapidly pass the blood brain barrier. However, few studies have been conducted to assess the effects of ketamine on behavior and organismal function; consequently, it is not yet approved by the FDA for use as an antidepressant. Robust studies of animal models are a first step towards understanding the potential utility of a novel medical therapy. Therefore, in vivo studies of the effects of ketamine are a high research priority. In this study, we evaluated the effects of ketamine on stress-related behaviors and cognitive learning in a fish model. Mature zebrafish (*Danio rerio*) were exposed to either 0, 5, 20, or 40

mg/L ketamine for 1 h before being tested in behavioral assays. We quantified changes in the exploratory behavior of fish in novel environments, including a narrow dive tank and a dark-light tank. We also utilized a plus maze to evaluate the influence of ketamine on simple associative learning. We found detectable effects of ketamine on both stress-related behaviors and cognitive learning. These results will contribute to a growing body of knowledge on the utility of ketamine for use as an antidepressant.

34 EXTRA-PAIR PATERNITY AND FEMALE MATE CHOICE IN FIELD SPARROWS (*SPIZELLA PUSILLA*)

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Extra-pair paternity (EPP) occurs when socially monogamous male and female birds mate outside of their social pair, resulting in young that are not genetically related to one of the parents. Extra-pair paternity may influence reproductive fitness by reducing the costs of parental care and providing genetic diversity to the offspring. Females are central in selecting males to engage in extra-pair copulations, potentially to increase the fitness of their offspring. Previous studies in Field Sparrows (*Spizella pusilla*) have suggested that females are more likely to choose younger males as extra-pair mates. In this study, I investigate rates of EPP in Field Sparrows, as well as patterns of social and extra-pair mate age. I observed breeding pairs of Field Sparrow at St. Patrick's County Park in South Bend, IN in June and July 2018. Pairs were captured, aged, bled, color banded, and observed to establish social pairs and locate nests. Blood samples were taken from 22 social parents and potential extra-pair mates. I found eight nests and sampled 18 offspring. Each individual was genotyped at five microsatellite loci and analyzed in CERVUS 2.0 to determine parentage. Territory and nest proximity influenced EPP, and extra-pair males were often captured in the same plot as social parents. The majority of EPP genetic fathers were younger than social fathers, suggesting females may select younger males as extra-pair mates. However, results in the current study could be biased by a large proportion of the population consisting of second year males.

35 LOSS OF SURFACE WATER AND AVAILABLE BURROWING SUBSTRATE AFFECTS THE CONSTRUCTION OF *PROCAMBARUS CLARKII* BURROWS

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Loss of surface water and available burrowing substrate affects the construction of *Procambarus clarkii*, red swamp crayfish, burrows and their behavior. To date, the energetic costs associated with burrowing under these different conditions has been elusive, because direct and indirect calorimetry measurements may be skewed by the presence of the burrowing substrate and the amount of time needed to assess such energetic costs. The current experiment was designed to determine the energetic costs associated with different burrowing substrates, when surface water was removed (trigger to prompt burrowing) using heart rate as the physiological index for energetic costs. It was predicted that when individual crayfish are placed in tanks with 8 cm of surface water there would be fewer burrows and a slower heart rate due to the low physical activity. When the surface water was drawn down it was predicted that the crayfish would have a higher level of burrowing activity and an increased heart rate when provided with clay burrowing substrate due to an increased level of activity, compared to those crayfish placed in an environment with sand burrowing substrate. To perform this experiment a crayfish was isolated in a tank with either sand or a mud substrate and 8 cm of surface water for 24 hours for an acclimation period. After the 24-hour acclimation period, the surface water was removed. Behavior data was collected using a camera, and heart rate data was collected using a data acquisition system, AD Instruments, with 3-lead electrodes. Our preliminary results indicate an increase in heart rate when the crayfish is active in the tank and an even greater increase in heart rate when the crayfish is actively burrowing. This experiment can be used to better understand the effect different substrates and behaviors have on the energetic cost of crayfish burrowing.

36 FUNCTION OF JUVENILE COLOR IN A CICHLID FISH

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Animals communicate using a variety of signal modalities, including visual signals. Juvenile coloration frequently differs from that of territorial adults for reasons that have been attributed to lowering adult aggressiveness, thus allowing for prolonged coexistence in the same area. The function of the yellow juvenile coloration in the cichlid fish *Variabilichromis moorii*, whose adults are black, was assessed in a natural setting by observing both juvenile and adult behavior towards each other and dummies.

37 ESTROUS CYCLE-INDUCED SEX DIFFERENCES IN MSN EXCITATORY SYNAPTIC TRANSMISSION AND INTRINSIC EXCITABILITY IN ADULT RAT NUCLEUS ACCUMBENS CORE

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Naturally occurring hormone cycles in adult female humans and rodents create a dynamic neuroendocrine environment. These cycles include the menstrual cycle in humans, and its counterpart in rodents, the estrous cycle. These hormone fluctuations induce sex differences in the phenotypes of many behaviors, including those related to motivation, and associated disorders such as depression and addiction. This suggests that the neural substrate instrumental for these behaviors, including the nucleus accumbens core (AcbC), likewise differs between estrous cycle phases. It is unknown if the electrophysiological properties of AcbC output neurons, medium spiny neurons (MSNs), change between estrous cycle phases. This is a critical knowledge gap given that MSN electrophysiological properties are instrumental for determining AcbC output to efferent targets. Here we test whether excitatory synaptic input and intrinsic electrophysiological properties of adult rat AcbC MSNs differ across female estrous cycle phases and to males. We recorded MSNs using whole cell patch-clamp technique in two experiments: the first using gonad-intact adult males and females in differing phases of the estrous cycle, and the second using gonadectomized males and females wherein estrous cycle was eliminated. MSN intrinsic electrophysiological and excitatory synaptic input properties robustly changed between female estrous cycle phases and males. Sex differences in MSN electrophysiology disappeared when the estrous cycle was eliminated. These novel findings indicate that AcbC MSN electrophysiological properties change across the estrous cycle, providing a new framework for understanding how biological sex and hormone cyclicity regulate motivated behaviors and other AcbC-mediated functions and disorders.

38 CHARACTERIZATION OF BEHAVIORAL AND PHYSIOLOGICAL DIFFERENCES BETWEEN TWO DIFFERENT MALE MORPHS OF A WEAKLY ELECTRIC FISH *COMPSPARAIA SAMUELI*

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In many animal species, different male phenotypes can be associated with alternative mating strategies (ex. "sneaker" males). These male morphs often differ in the communication signals that they use for courtship or agonistic interactions. In weakly electric fish, some species have differences in communication signals between male morphs (*S. nattereri*), while in other species, male morphs do not produce different signals (*P. hasemani*) (Fernandes et al., 2010 Horm. Behav. 58:660-668; Petzold and Smith, 2016 Horm. Behav. 78:67-71). *Compsaraia samueli* is a weakly electric fish with substantial within sex variation in jaw length. However, little is known about within or between sex differences in signaling in this species. Our goal is to understand the behavioral differences (reproductive communication and agonistic behavior) and underlying physiological differences (hormone levels) between these male morphs. We measured gonad mass, body mass, jaw length, and used ELISAs to measure circulating levels of gonadal steroids. We quantified two different electrocommunication signals, electric organ discharge frequency (EODf) and chirping. EODf is the frequency at which the fish fires its electric organ, and in many species, EODf differs between sexes. Fish often use very short modulations of the EODf, called chirps, in social interactions. We used a playback paradigm to measure differences between male morphs in the production of chirps. Preliminary data suggest circulating androgen levels, gonadal somatic index, EODf, chirping propensity, or chirp structure ($p > 0.05$) did not differ between these male morphs under laboratory conditions. Similarly to *P. hasemani*, *C. samueli* males differ in jaw morphology, but do not differ in the types of communication signals they produce.

39 AGGRESSIVE BEHAVIOR AND SIGNALING IN TWO SPECIES OF NORTH AMERICAN WRENS

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Aggressive behavior and signaling are critical components of territoriality that have a direct effect on an individual's fitness. The selective factors shaping aggression are complex and can lead to divergence among populations and closely related species. We compared aggressive behavior and signaling in two, closely related songbirds, Carolina wrens (*Thryothorus ludovicianus*) and house wrens (*Troglodytes aedon*). Both species breed in North America, but they exhibit distinct life histories. Carolina wrens are sedentary and maintain year round territories while house wrens at our study site are migratory and only maintain seasonal breeding territories. To elicit aggression, we conducted simulated territorial intrusions consisting of five minutes of conspecific song playback without a visual stimulus. We found that male house wrens are significantly more active and sing significantly more broadcast songs than Carolina wrens in response to a simulated intruder. House wrens also maintained a high song output after the playback ended and remained in closer proximity to the speaker. Collectively, these results indicate two distinct aggressive responses that may be explained by the social conditions and life histories of both species. House wrens occur at substantially higher densities and experience frequent intrusions while Carolina wrens occur at low densities on stable, year round territories. As a result, house wrens may benefit from signaling broadly with song to many potential rivals and actively searching during an intrusion while Carolina wrens limit their long-range signaling and instead focus on locating and expelling the lone intruder. However, more data are needed to adequately test these hypotheses.

40 THE ONTOGENY OF CONSOLATION BEHAVIOR IN THE PRAIRIE VOLE

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In humans, there are behavioral responses shown towards an individual that is stressed to offer comfort. There has been evidence to suggest that adult, pair-bonded prairie voles also show comfort behaviors towards a stressed partner. To understand variation in age in this behavior's development, we focused on adolescent male siblings at two ages. We also examined the role of oxytocin in this behavior. In Phase 1, males were exposed to a restraint stress for 60 minutes before being repaired with either a sibling or a stranger of the same age (unstressed individual) for 30 minutes. Consolation-like behaviors (allogrooming; cross huddling; side-by-side huddling) were observed during the 30-minute reunion. Animals were tested at either postnatal day (PND) 30 or PND 45. A second group consisted of separating siblings for 60 minutes without the restraint being introduced, and then the same repairing process occurring. In Phase 2, unstressed individuals (PND 45) received an i.p. injection of either an oxytocin antagonist (OTA; 3 mg/kg) or a saline vehicle control after 30 minutes of restraint stress. The restraint stress lasted an additional 30 minutes and then siblings were repaired for 30 minutes. Consolation-like behaviors were again observed. In Phase 1 we hypothesized that the sum total of consolation-like behaviors shown by the unstressed individual would be significantly greater for siblings compared to strangers and significantly greater at PND 30 than at PND 45. In Phase 2 we hypothesized that unstressed siblings injected with an OTA would show less consolation-like behaviors than those injected with saline towards a stressed sibling. In Phase 1, there were significantly more consolation-like behaviors shown by siblings than strangers for both age groups. No differences were found between the two age groups. Phase 2 data are still being analyzed.

41 SEX SPECIFIC EFFECTS OF HATCHING ORDER AND SYNCHRONY ON NESTLING BASELINE CORTICOSTERONE

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Female songbirds hatch their eggs synchronously (within 24 hours) or asynchronously, (over 2-3 days) by altering the onset of incubation. In our study population of house wrens (*Troglodytes aedon*), these different hatching patterns have sex-specific size and condition effects on nestlings, and females allocate the sex of their offspring across the laying order to capitalize on these effects. We hypothesize that levels of circulating corticosterone in nestlings, the primary metabolic hormone in birds, mediate these sex-

specific effects, predicting that corticosterone levels in (i) first-hatched males in asynchronous broods will be highest, (ii) last-hatched males in asynchronous broods lowest, and (iii) females in asynchronous broods and all nestlings in synchronous broods intermediate. We will also experimentally create asynchronous broods by reciprocally cross-fostering nestlings at different stages of development, creating broods with one nestling significantly advanced or delayed in development as compared with its nestmates. This design will create comparisons of (i) first- and last-hatched nestlings for which maternal effects have been controlled, but their rearing environment differs and (ii) first- and last-hatched nestling for which maternal/genetic contribution varies, but their rearing environment is identical. In both comparisons, we predict that first-hatched nestlings will have higher baseline corticosterone levels than their brood mates, whereas last-hatched nestlings will have lower levels, but that the extent of these differences will be contingent on the sex of the nestling. Blood samples will be taken to determine nestling sex and baseline corticosterone levels.

42 SENSITIVITY TO TESTOSTERONE IN THE AVIAN EYE AND ITS RELATIONSHIP WITH SEX, SPECIES, AND TRAIT DIFFERENCES

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Certain animal behaviors, like aggression, may rely on sensory perception but the mechanisms mediating this are unknown. For example, if the left eye is covered animals will not respond aggressively, but if the right eye is covered, they still will, suggesting the left eye is critical for the expression of aggression. Testosterone (T) mediates different functions of an organism, including aggressive behaviors via tissue level “sensitivity” to T through androgen receptors (AR). Consequently, there could be a link between vision, AR expression, and aggression. However, sex steroid receptors have only been found in the eye of mammals in biomedical studies. Therefore, we examined if AR abundance in the eye is sensitive to circulating T levels and is related to T-mediated traits. We used three bird species (American Robin, *Turdus migratorius*; Eastern Bluebird, *Sialia sialis*; and Tree Swallow, *Tachycineta bicolor*) that differ in phylogenetic relatedness and T-mediated life-history traits, like nest competition and feather coloration. Each species has different feather coloration and studies suggest that both pigment-based and structural colors are influenced by T. We measured AR abundance relative to the housekeeping gene RPL4 in the left lens of all species using qPCR and compared sex, species, and seasonal AR expression. In addition, rump feathers were measured with a spectrometer to explore relationships between hue and AR expression. We found that males presented significantly more AR and there was a trend for AR to change seasonally along with changing T levels in female Tree Swallows, suggesting that AR in the eye could be sensitive to circulating T levels. We also found species differences, Bluebirds and Tree Swallows have more similar expression of AR compared with American Robins, suggesting shared life-history traits rather than genetic relatedness predicts AR patterns. Finally, in male Bluebirds, there was a positive trend between hue and AR, suggesting a link between AR expression and feather color, a proxy of aggressive behaviors. This is one of the first studies to search for and find a relationship between eyes and T, which is a first step in demonstrating the mechanistic link between vision and aggressive behaviors.

43 THE EFFECT OF AVIAN BROOD PARASITISM ON PHYSIOLOGICAL RESPONSES OF HOST NESTLINGS

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In avian brood parasitism, parasites lay their eggs in the nests of hosts which provide care for the foreign offspring. Avian brood parasitism may be a substantial stressor for the foster parents that provide misdirected care for foreign young, as well as for the host nestlings that are raised alongside the often competitive and larger parasitic chick(s). Whereas fitness costs due to reduced host offspring survival in parasitized broods have been studied in detail, the stress-relevant physiological changes of host nestlings caused by parasitism remain understudied. Here, we compared 8-day old nestlings of Prothonotary Warblers *Protonotaria citrea*, a locally frequent host of Brown-headed Cowbirds *Molothrus ater*, in unparasitized and in experimentally parasitized nests to determine if brood parasitism affects plasma corticosterone concentrations, immunocompetence, and nestling growth rates. We detected no trade-

offs between corticosterone concentrations and immunocompetence, but there was a negative relationship between corticosterone and growth rate. In turn, in nests with more cowbird nestlings, corticosterone levels of host nestlings were unaffected, immune responses were weaker, and growth rates were decreased. Our results suggest that host nestlings experience deteriorated phenotypes and trade-off physiological responses due to brood parasitism, likely because of the increased competition in parasitized broods for parental provisions.

44 THE EFFECT OF A SHORT-TERM STRESSOR ON IMMUNE INVESTMENT IN FEMALE HOUSE WRENS USING A SIMULATED PREDATION ATTEMPT

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Because energy is finite, organisms must be strategic about how and when energy is allocated to competing physiological processes. Corticosterone, an immunomodulatory hormone, has been hypothesized to enhance immune function in response to stressors of short duration and to suppress immune function in response to long-term stressors. In this study, we examined the effect of a short-term stressor on allocation to immune function in female House Wrens (*Troglodytes aedon*). Specifically, we exposed experimental females (n=13) with 2-6 day old nestlings to a five-minute simulated predation event using a model snake, a common nest predator. During this time, we recorded anti-predator behaviors such as flyovers, attacks, alarm calls, and the amount of time spent within 1 m and 5 m of the nest. At the end of the trial, the snake was removed and the female was captured within 0-13 min post-trial (mean=7.5 min). A blood sample was collected within three minutes following the female's capture and used to measure bacterial killing ability (*E. coli*), leukocyte counts, and plasma corticosterone levels. Control females (n=14) with 2-6 day old nestlings were not exposed to the simulated predator presentation but were caught and sampled identically to experimental females. Experimental females had significantly higher bacterial killing ability than control females (t=-2.87, df=25, p=0.008). Differences in leukocyte differentials and antipredator behaviors between experimental and control females will be presented. Results suggest that failed predation events may enhance immunity over a short time scale, which is consistent with a complex relationship between stress and immune function in a free living system.

45 INFLUENCE OF SUBSTRATE ON BEHAVIOR OF CICHLID FISH

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The purpose of this experiment is to determine how substrate type influences behavior in a group-living cichlid fish (*Neolamprologus pulcher*). Preliminary observations suggest a decrease in reproductive success of lab-reared fish living in tanks with darker substrate. I hypothesize that substrate type influences behaviors involved in reproduction, such as mating displays and maintenance of breeding shelters. Therefore, I predicted that fish in tanks with light colored substrate would exhibit higher frequencies of such behaviors as compared to tanks with darker substrate. To test this, I established 10 groups of three fish each. The substrate in five of the tanks was light-colored; substrate was dark in the other five. Over a period of 10 weeks, two rounds of 15 min behavioral observations were conducted per tank each week using the event-recorder software, Boris. I examined investment in breeding shelter maintenance by filling these with sand and measuring the rate at which fish removed sand over a 4-week period. Analysis of data is ongoing, and the results will contribute to understanding the relationship between habitat composition and behavior in fish.

46 EXPOSURE TO HARMFUL ALGAL BLOOMS IMPAIRS SWIM PERFORMANCE IN A FRESHWATER FISH

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Beta-methylamino-L-alanine (BMAA) is a chemical commonly found in freshwater systems that is produced by cyanobacteria in harmful algal blooms (HABs). Emerging research suggests that fish and

other organisms exposed to BMAA experience substantial, sub-lethal impairment of the central nervous system and individual fitness and behavior. In addition to potential adverse effects on aquatic populations, exposure to cyanotoxins poses a human health risk, as the consumption of contaminated food has been linked to diseases such as amyotrophic lateral sclerosis (ALS), Parkinson's disease, and Alzheimer's disease. In this study, we examined the long-term effects of BMAA on the endurance and fatigability of fathead minnows, *Pimephales promelas*. Eggs and larvae were exposed to the chemical under a range of real-world concentrations (0, 5, and 25 µg/L) for 21 days. Beginning at 77 days old and repeating monthly until six months of age, the fish were tested in a swimming assay to evaluate the effects of BMAA on locomotor performance. Our preliminary results suggest that exposure to BMAA has a detectable effect on swimming capabilities. Decreased endurance in natural populations could lead to higher mortality rates in affected individuals and speed the transfer of BMAA up the food chain.

47 THE EFFECTS OF CURRENT AND HISTORICAL FOREST MANAGEMENT STRATEGIES ON COSTA RICAN PRIMATE POPULATIONS

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While Costa Rica is equal to <1% of the planet's land mass, it is composed of more than 5% of the Earth's biodiversity. From 1950 to 1970, Costa Rican rainforest cover decreased by 21%; environmental protection policies of the 1990s, such as "Pagos de Servicios Ambientales" (Payments for Environmental Services), were instituted to counteract deforestation by recognizing the environmental services of forests and incentivizing forest restoration and conservation. To evaluate the effectiveness of these policies, this study examines the relationship between primate population density and dispersal, forest condition, and changes in land cover use in areas of/surrounding the biological research stations of La Selva, Las Cruces, and Piro. Broad surveys were conducted across forests enrolled in various land management strategies to estimate primate population density and determine the distribution of mantled howler monkeys (*A. palliata*), white-faced capuchins (*C. capucinus*), squirrel monkeys (*S. oerstedii*), and Geoffroy's spider monkeys (*A. geoffroyi*) across these sites. Forest condition was sampled through random nested plots to assess the age and structure of the protected and unprotected forests surrounding the stations. A change detection analysis of land cover use across the 3 regions will be conducted via satellite imagery from 1997 to 2017 using GIS and remote sensing. The comparison of historical and current land cover use, current forest condition, and current primate populations at these stations will indicate the success of current environmental protection policies.

48 EFFECTS OF SIGMA-1 RECEPTOR ANTAGONIST PD144418 ON MOTIVATIONAL ASPECTS OF FEEDING BEHAVIORS IN MALE AND FEMALE RATS

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A contributing factor to the obesity epidemic is the lack of balance between energy intake (food) and energy expenditure. Accumulating evidence regarding the sigma-1 receptor ($\sigma 1R$) suggests its involvement in rewarding and motivational processes, through the effects vary based upon the ligand studied. PD144418 has been characterized as a potent and selective $\sigma 1$ ligand, exhibiting a high affinity and selectivity for $\sigma 1R$ s, however, nothing is known about its effects on motivation related to food. The behavioral tasks were used to examine PD144418's effect on motivation were a progressive ratio (PR) operant task to examine motivation for food and a free feeding paradigm. Additionally, to determine the effects of acute food deprivation on the motivational effort to work for food pellets, home-cage chow availability was altered in the final experiment. Findings revealed that when rats are pretreated with PD144418, there is a significant reduction in their motivational effort to work for food pellets under a PR schedule of reinforcement but not of consumption when said pellets are freely available. Interestingly, when animals are in a state of energy deficit, as is the case following 24-hr food deprivation, PD144418 does not alter motivationally driven operant responding as measured by the breakpoint but does alter the

number of active lever responses. Such effects of PD144418 on active lever responses appear to be mediated by sex and time.

49 CHARACTERISTICS OF AMERICAN CROW (*CORVUS BRACHYRHYNCHOS*) ROOST SITES

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During the winter months, American crows (*Corvus brachyrhynchos*) congregate in large communal aggregations that include pre-roosts that form before sunset and roosts that persist through the night until dawn. This study was designed to test characteristics of communal pre-roosting and overnight roosting locations of American crows in Charleston, Illinois in the 2018-2019 winter. The characteristics that I tested include tree height, light levels in the area, and height within the tree that the birds occurred. I located groups of American crows and compared characteristics of the roost trees with nearby unused trees. Light levels were recorded at three locations (at the roost site, 50 m from the roost, and at a random location within town), and I also compared both absolute and relative tree heights. The American crows tended to roost in trees which were taller than the neighboring unused trees, and in areas which had higher light levels. Taller trees and better lighting may allow the crows better vision of their surroundings. This may allow American crows to better identify potential threats and identify other crows within the roost.

50 ROLE OF THE LATERAL LINE SYSTEM DURING MALE-MALE TERRITORIAL INTERACTIONS IN FATHEAD MINNOW (*PIMEPHALES PROMELAS*)

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The lateral line system is made up of mechanoreceptors called neuromasts, which can commonly be found along the head and body. The lateral line system in aquatic vertebrates serves to detect movement, vibration, and pressure gradients in the water. The usage of this system varies between species, but mechanosensory information has been shown to be important in the contexts of predator escape, foraging, and competition. Emerging evidence suggests that information about opposing males may be obtained through these mechanosensors. Less is known about how it is used in intraspecific behaviors, such as mating. In this study, we investigated the role of the lateral line in male fathead minnow (*Pimephales promelas*) during male-male territorial interactions. Male fathead minnows display many territorial behaviors such as charging, butting, biting, and tail flicking. These behaviors may be brought on by water movement from an opposing male and felt through the mechanoreceptors and neuromasts of the lateral line. We conducted a factorial behavioral experiment that paired males with ablated and non-ablated lateral lines. We used the antibiotic streptomycin to ablate their lateral line systems prior to testing. Video footage was recorded in ten-minute intervals over a four-day period. Our studies found that lack of a lateral line system altered male-male territorial behaviors. In addition to providing insight into the role of mechanosensory communication during reproductive activities, these data also suggest that antibiotics present in streams and river have the potential to alter intraspecific communication dynamics.

51 CAFFEINATED ALCOHOL AFFECTS REWARD AND PREFERENCE COMPARED TO ALCOHOL ALONE IN BEHAVIORAL TASKS

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The consumption of caffeinated alcoholic beverages (CABs) is pervasive among adolescent and young adults. The popularity of such drinks also matches their higher consumption compared to alcohol alone; however, the reasons adolescents consume more CAB is not well defined. The addition of caffeine allows individuals to consume alcohol for longer periods, since it blocks alcohol's sedative effects, but some evidence suggests that the rate of consumption is also faster. Thus, we hypothesize that caffeinated alcohol could activate reward systems differently than alcohol alone, driving faster consumption of CAB. Studying these effects in humans is challenging, because consumption patterns and history of use vary, and longitudinal studies are cumbersome. Thus, to test this hypothesis, we first observed intake patterns in an animal model of voluntary CAB consumption. Next, we examined whether CABs differentially

activate reward systems using an intracranial self-stimulation (ICSS) task. Lastly, we assessed whether CABs are preferred over alcohol using a conditioned place preference task, which controls for differential activation of motor systems. Results showed that CAB consumption escalated more quickly than alcohol alone, matching consumption patterns of human adolescents. ICSS data preliminary suggest that CAB causes greater activation of reward circuitry than alcohol alone, while conditioned place preference data suggest that CAB also reduces the aversive properties of alcohol. Combined these results suggest that the addition of caffeine to alcohol increases its rewarding potency and decreases its aversive. These results shed light on human CAB use patterns, and provide mechanistic insights to guide future studies.

52 INVESTIGATING THE RELATIONSHIP BETWEEN A SOCIAL TRAIT, BACTERIOCIN PRODUCTION, AND VIRULENCE IN PATHOGENIC BACTERIA

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Social behaviors of microorganisms can affect their interactions with their animal hosts. For pathogens, if social behaviors alter growth within the host, they can affect the amount of damage a pathogen can cause to its host, which is also known as virulence. Theoretical modeling has shown that incorporating key social traits of bacterial parasites such as, bacteriocin production, can affect virulence. Bacteriocins are proteinaceous toxins that can kill closely related competitors and are ubiquitously produced by almost all known bacteria. Model results predict that higher virulence correlates with low bacteriocin production. In this project, we harnessed the power of experimental evolution to directly test this prediction. We used experimentally evolved *X. nematophila* populations that showed higher virulence to compare bacteriocin production between an ancestral lineage and 16 evolved lineages. Bacteriocins were chemically induced and extracted from each lineage. Then, bacteriocin production was estimated using a growth inhibition assay and the extracts were tested against two distinct sensitive strains in the inhibition assays. Our results across both sensitive strains are consistent with the prediction that evolution of increased virulence correlates with decreased bacteriocin production. We also examined growth across these 16 lineages and found that the evolved lineages grow faster than the ancestral lineage *in vitro*, and that there is a significant negative correlation between bacteriocin production and growth in these lineages which supports the underlying assumption of theoretical models. These results provide, to the best of our knowledge, the first direct test of how bacteriocin production and virulence coevolve in natural pathogenic populations. They also provide an insight into how host health can be affected by social behaviors of pathogenic bacteria.

53 COLORFUL LANGUAGE: RAPID INCREASE IN SEXUAL SIGNALING IN A CICHLID FISH DURING SOCIAL ASCENT

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Color based sexual signaling is important for attracting mates and deterring rivals for most species with significant color vision. In the haplochromine cichlid fish of the African Rift Lakes, males compete aggressively for social dominance and territorial ownership to obtain access to resources such as mates. Coloration is more pronounced in territorial males and it has been shown that coloration is an important target of sexual selection. However, this type of signaling is costly for the organism and typically only increases when an individual invests in reproduction. We quantified color expression in the cichlid, *Astatotilapia burtoni* during social ascent - when males are transitioning from nonterritorial status to territorial status - over a two-week period using digital image analysis. To date, most analyses of dynamic color expression in cichlids have been based on spectrophotometric or digital image analysis after transferring males to a confined space or taking them out of the water which may result in color loss. In order to limit stress induced color change, a more sensitive protocol was developed of noninvasive, video recordings of males showing their natural behavior. We show that males rapidly increase yellow or blue coloration in regards to their nominal morph. We also quantified dynamic signaling of the black eye bar, vertical bars on the body, and the red humoral patch. These patterns are all known to play a role in sexual signaling in cichlids. Our study forms a strong basis for quantifying dynamic color change in animals behaving in a naturalistic setting using digital image analysis of noninvasive, video recordings.

54 CONNECTING STRESS PHYSIOLOGY TO BEHAVIOR IN A WILD RODENT

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Human-induced changes to natural systems have the potential to increase stress experienced by wildlife, but studying these impacts is challenging because it requires the integration of physiology and behavior. In vertebrates, changing environmental conditions stimulates the hypothalamus-pituitary-adrenal (HPA) axis, which regulates the production of glucocorticoids (GC's). GC's, specifically corticosterone in rodents, are often used as a quantifiable proxy for "stress". Our goal is to examine the effects of increased stress on habitat use and movement behaviors using wild banner-tailed kangaroo rats *Dipodomys spectabilis* as a model organism. Using an automated telemetry system in conjunction with corticosterone-releasing implants, our project seeks to link behavior and stress. We predict that kangaroo rats treated with higher levels of corticosterone will have smaller home ranges and will forage shorter distances than animals treated with lower levels and control animals. Understanding how stress impacts wildlife species is crucial for addressing the inevitable increase of human influence on natural habitats.

55 SEX-SPECIFIC ALTERATIONS IN MICROGLIA AND ASTROCYTE FUNCTION ARE ASSOCIATED WITH SYNAPTIC DEFICITS AND DEPRESSIVE-LIKE BEHAVIORS IN CHRONIC STRESS

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Chronic stress confers risk for development of major depressive disorder, a debilitating mental health condition that causes significant socioeconomic burdens. Previous reports indicate that chronic stress-induced synaptic deficits in the prefrontal cortex (PFC) promotes depressive-like behaviors. Other studies have linked chronic stress-induced glial dysfunction in the PFC and depressive-like behaviors. Of note, prior work shows that chronic stress exposure drives astrocyte dystrophy, and our work shows that microglia-mediated neuronal remodeling contributes to stress-induced synaptic deficits in the PFC. Despite these findings, the temporal dynamics of stress-induced glial dysfunction and development of depressive-like behaviors remain unclear. In these studies, male and female mice were exposed to chronic unpredictable stress (CUS) to assess the molecular and cellular adaptations of neurons, microglia, and astrocytes in the PFC. Consistent with prior studies 14 days of CUS caused depressive-like behaviors and cognitive impairment in male, but not female, mice. Further analyses in male mice showed that 14 days of CUS reduced GFAP immunolabeling in the PFC, and decreased mRNA levels of *Gfap*, *Eaat1*, and *Tgfb2* in sorted PFC astrocytes. In addition, 14 days of CUS increased microglia-mediated neuronal remodeling and synaptic deficits in the PFC of male, but not female, mice. After extended CUS exposure (28 days) both male and female mice displayed depressive-like behaviors that corresponded with astrocyte dystrophy in the PFC, however, PFC microglia no longer expressed remodeling markers. These findings suggest that male mice have greater susceptibility to CUS-induced glial dysfunction and microglia may be a primary driver of synaptic deficits in male, but not female, mice. Future studies will elucidate the dynamic, cell type-specific role of neurons, astrocytes, and microglia in the pathophysiology underlying stress-induced depressive-like behaviors.

56 WHY ARE TREE SWALLOWS EXPANDING THEIR RANGE IN THE SOUTH? A COMPARATIVE GENOMIC APPROACH

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Anthropogenic climate change is dramatically altering conditions across the globe, and yet, it is unclear whether and how animals adjust over time to thermally challenging environments. Here, I aim to investigate acclimation and adaptation to heat in the tree swallow (*Tachycineta bicolor*), a songbird species currently undergoing a unique shift in its breeding range to warmer, southern climates. Specifically, I am exploring whether variation in heat sensitivity may facilitate this seemingly counterintuitive southern movement. To ask these questions, I focused on heat shock proteins (HSPs) because HSPs are mobilized to prevent cellular damage and promote recovery from exposure to stressors like heat. I quantified gene expression (using qPCR) of multiple HSPs across geographically distinct populations, individuals, and tissues (e.g., brain and peripheral) to assess which suite of HSPs may

facilitate variation in heat sensitivity across levels of organization. Across populations, I found that HSP gene expression follows a latitudinal gradient in which expression is higher in warmer vs. cooler breeding climates. Furthermore, juvenile birds have more variable HSP gene expression compared to adults, suggesting that standing variation in HSPs of juveniles, who cannot escape the thermal environment of their nests, facilitates the ability of some to withstand and survive thermal challenges. These results lay the groundwork for future field experiments exploring thermal resilience within and among populations, and ultimately, will inform our understanding of how birds respond to climate change.

57 THE EFFECTS OF MATERNAL ANTIBIOTIC TREATMENT ON SOCIAL BEHAVIOR OF POST-WEANING OFFSPRING

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Gut microbiota have been shown to have important effects on brain, behavior, and development, including alterations of anxiety-like and social behaviors in rodents. We examined some consequences of disrupting the mother-offspring microbiome (M-OM), via antibiotic ingestion by the dam, on offspring social and emotional development, as measured in a post-weaning social interaction test. Beginning on Gestational Day (G) 12 through Postnatal Day (P) 14, antibiotic treated (Abx) pregnant mouse dams received a mixture of neomycin (5mg/ml) and pimaricin (1.25µg/ml) in their drinking water; control dams received regular tap water. After P14 all dams received tap water. This procedure produces dysbiosis in the offspring of Abx-treated dams. Individual Abx or control offspring were put in a social interaction test with an untreated stimulus mouse of the same sex and approximately the same age (P25–P30). Subject and stimulus mice were video recorded together in a Plexiglas chamber (25x25x35 cm) for 10 minutes. Videos were scored by trained observers (blind to condition) for social (e.g., sniffing) and non-social behaviors (e.g., exploration of the chamber). Videos were also scored using Ethovision software (Noldus Information Technology). Differences in the frequency and duration of several social and non-social behaviors were analyzed based on maternal treatment condition, sex of offspring, or any interactions.

58 THE BEHAVIOR OF SWAINSON'S HAWKS *BUTEO SWAINSONI* DURING PREDATION OF BRAZILIAN FREE-TAILED BATS *TADARIDA BRASILIENSIS* IN FLIGHT

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Predators that hunt in 3-dimensions and pursue prey that flee in 3-dimensions must use complex pursuit behaviors. While some research has been conducted examining the success rates of raptors predating bats, the types of pursuit behaviors that are most effective for catching bats has not been studied. In this study, I report a specific example of a predatory relationship taking place in 3-dimensions, a group of localized Swainson's Hawks *Buteo swainsoni* hunting a colony of Brazilian free-tailed bats *Tadarida brasiliensis*, and examine and characterize the hawks' pursuit behavior. I collected video and audio recordings of Swainson's Hawk predation events on Brazilian free-tailed bats for 15 evenings in June 2018. I quantified the hawks' pursuit and prey capture behavior using criteria that broke down each attack sequence into 3 distinct categories. I found significant associations between some of these behaviors and found that specific predatory behaviors were associated with increased prey capture success. However, the most frequently observed behaviors were not associated with increased capture success. My results suggest that Swainson's Hawks have not developed a specialized bat-hunting technique, which may be a result of the unreliability of these migratory bats as a food source, but more research is required to fully understand this predator-prey relationship.