Missouri Herpetological Association

Newsletter

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MISSOURI HERPETOLOGICAL ASSOCIATION NEWSLETTER NO. 29

Contents

Cover: Juvenile Western Cottonmouth (Agkistrodon piscivorus). The snake was observed basking approximately 0.5 m above the ground at Otter Slough Conservation Area, Stoddard County, MO, on May 14, 2016. Photo by Bruce Schuette.

INTRODUCTION

The Twenty-ninth Annual Meeting of the **Missouri Herpetological Association** was held 17-18 September 2016 at Missouri State University **Bull Shoals Field Station** on the Drury-Mincy Conservation Area, Taney County, Missouri. This organization is designed to provide herpetologists in Missouri and surrounding states with an opportunity to meet and exchange ideas regarding current efforts in research and other professional activities. High on the list of priorities is to provide students, involved in research at either the graduate or undergraduate level, (1) the chance to interact with senior herpetologists, and (2) an outlet to present, in a semi-formal setting, the results of their labors.

This newsletter is the result of a decision made at the inaugural meeting to provide a means of publicly acknowledging papers presented at this and subsequent annual meetings. Further, the newsletter will inform the herpetological community of new distribution records of Missouri's herpetofauna, additions to the bibliography dealing with the state herpetofauna and provide an outlet for the publication of short notes dealing with the natural history of Missouri amphibians and reptiles.

MHA on the Net

The Association has an official site on the Internet. Point your browser to http://mha.moherp.org/ for copies of current and past publications and to view photos and information from past field trips and meetings. Send ideas, suggestions, comments, and content to the Webmaster (webmaster@moherp.org).

ANNOUNCEMENTS

30th Annual Meeting of the Missouri Herpetological Association

The Thirtieth Annual Meeting of the Missouri Herpetological Association will be held 16-17 September 2017. We will be returning to the **Reis Biological Station** in Crawford County, Missouri. The "call for papers" and registration materials will be sent electronically in mid-July. For more information, please contact **Jeff Briggler** at:

Missouri Department of Conservation
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Jefferson City, MO 65102-0180
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Abstracts of Papers Presented at the 29th Annual Meeting of the Missouri Herpetological Association

Bull Shoals Field Station
17-18 September 2016

HABITAT CORRELATES TO QUANTITY AND SPECIES OF TURTLES CAPTURED IN PONDS ON THE MISSOURI WESTERN CAMPUS

Chris Watson, Jessie Green, and Mark S. Mills
Missouri Western State University, St. Joseph, MO

As part of an eight-year study of the turtles on the campus of Missouri Western State University we investigated potential correlates to the quantity and/or species of turtles captured and marked in each of nine campus ponds. We measured the mean depth, perimeter, surface area, water temperature, and water clarity of each pond. We estimated percent cover of vegetation in and surrounding the ponds using digital images taken using a drone. Campus ponds vary greatly in size (489-9696 m^2), mean depth (0.65-2.20 m), maximum depth (1.07-3.5 m), and aquatic vegetation (0 to 100%). Of the variables measured or estimated, we found none significantly correlated to the number or species of turtles captured in campus ponds. We will discuss the results and future plans for this study.

THE WORLD'S MOST ENDANGERED TURTLES *AND WHAT IS BEING DONE TO SAVE THEM*

Hugh Quinn
Kirksville, MO

Of the world's 328 living turtle species, 50% are considered in peril of extinction (classified as Vulnerable, Endangered, or Critically Endangered by the IUCN). Case histories, current status, and population outlooks of the Critically Endangered Red River giant softshell turtle (*Rafetus swinhoei*) (China, Vietnam) and ploughshare tortoise (*Astrochelys yniphora*) (Madagascar) are presented as examples of the extreme peril facing turtles today. Key causes of population decline among turtles worldwide include habitat destruction and unsustainable harvest for food, traditional medicine, and the pet trade. Other significant threats include invasive alien species, chemical and hormonal pollution, climate change, and introduced pathogens. Examples of how conservation organizations are addressing these and other global turtle threats include habitat restoration, law

enforcement training, education/awareness programming, nest protection, head starting, assurance colony formation, reintroduction, artificial insemination, land purchase to form reserves, land trusts, and community involvement. Insights about conducting successful conservation programs are presented, and include forming partnerships, involving local communities, creating multi-faceted programs, using good science, defining clear and quantifiable goals, planning time and money for project completion, and retaining drive and passion despite obstacles encountered.

PRELIMINARY SURVEY OF TWO WEST TENNESSEE RIVER DRAINAGES RESULTS IN TWO POPULATIONS OF THE ALLIGATOR SNAPPING TURTLE (*Macrochelys temminckii)*

Dustin F. Garig II[1], Jon M. Davenport[1], Joshua R. Ennen[2], Rob L. Colvin[3], Jeremy S. Dennison[3], Andrew J. Feltmann[1], Madison A. Herrboldt[1], Caitlin M. Weible[1]
[1]Southeast Missouri State University, Cape Girardeau, MO; [2]Tennessee Aquarium Conservation Institute, Chattanooga, TN; [3]Tennessee Wildlife Resources Agency, Jackson, TN

The Alligator Snapping Turtle (*Macrochelys temminckii)* is the largest freshwater turtle in the United States and is distributed within the Mississippi and Gulf Coast river drainages reaching as far north as Iowa. ASTs are apex predators in these drainages, but have experienced dramatic declines throughout its range due to overexploitation. Despite the type locality from West TN, very little distribution and demographic information is available from this part of their range. For conservation measures from years 1992 to 2005, Tennessee Wildlife Resources Agency (TWRA) released 444 ASTs into West and Middle Tennessee river drainages. Unfortunately, no data is available assessing the success of those introductions along with the current status of the AST. Therefore, our initial work has investigated the distribution and abundance of ASTs in two West TN drainages, the Wolf and Hatchie Rivers. During the spring and fall of 2016, we surveyed 15 sites with baited hoop net arrays of various sizes. The various sizes allowed us to determine what age classes if any were present. During this sampling period, we located two populations of ASTs. We are confident that only one of these populations is naturally occurring, while the other population is a successful result of the reintroduction efforts by TWRA.

MERCURY CONCENTRATIONS IN THREE FRESHWATER TURTLE SPECIES OF WEST TENNESSEE

Madison A. Herrboldt[1], Caitlin M. Weible[1], Dustin F. Garig II[1], Andrew J. Feltman[1], Rob L. Colvin[3], Jeremy S. Dennison[3], Joshua R. Ennen[2], and Jon M. Davenport[1]
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Mercury is a heavy metal that bioaccumulates in a variety of organisms, causing physical and neurological effects. Turtles are one group of organisms that bioaccumulate mercury in their tissues and some species (*e.g., Chelydra serpentina*) are used as biomonitors of mercury. In general, turtles are model organisms for studying

bioaccumulation of heavy metals largely because of their longevity. In this study, we focused on three species of turtles, the red-eared slider (*Trachemys scripta),* the common snapping turtle (*Chelydra serpentina)*, and the alligator snapping turtle (*Macrochelys temminckii*), to determine mercury concentrations in West Tennessee turtles. To achieve this goal, a total of twelve sites were sampled across West Tennessee from March to July 2016. Toenails were taken from the back feet of each captured turtle and analyzed in a Nippon MA-3000 Direct Mercury (Hg) Analyzer. We found that all species sampled had a significant level of mercury in their toenails, and there was significant difference in mercury levels between species. Secondarily, we found that common snapping turtles, which are still harvested, have mercury levels much higher than the EPA recommended consumption level for freshwater fish.

EFFECTS OF LIFE-HISTORY REQUIREMENTS ON THE DISTRIBUTION OF A THREATENED REPTILE

Denise M. Thompson[1], Day B. Ligon[2], Jason C. Patton[1], and Monica Papes[1]
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Survival and reproduction are the two primary life-history traits essential for species' persistence; however, the environmental conditions that support each of these traits may not be the same. Despite this, reproductive requirements are seldom considered when estimating species' potential distributions. We sought to examine potentially limiting environmental factors influencing the distribution of an oviparous reptile of conservation concern with respect to the species' survival and reproduction and to assess the implications of the species' predicted climatic constraints on current conservation practices. We used ecological niche modeling to predict the probability of environmental suitability for the alligator snapping turtle (*Macrochelys temminckii*). We built an annual climate model to examine survival and a nesting climate model to examine reproduction. We combined incubation temperature requirements, outputs of modeled soil temperature data, and our estimated distributions to determine whether embryonic development constrained the northern distribution of the species. Low annual precipitation constrained the western distribution of alligator snapping turtles, whereas the northern distribution was constrained by thermal requirements during embryonic development. Only a portion of the geographic range predicted to have a high probability of suitability for alligator snapping turtle survival was estimated to be capable of supporting successful embryonic development. Historic occurrence records suggest adult alligator snapping turtles can survive in regions with colder climes than those associated with consistent and successful production of offspring. Estimated egg-incubation requirements indicated that current reintroductions at the northern edge of the species' range are within reproductively viable environmental conditions. Our results highlight the importance of considering survival and reproduction when estimating species' ecological niches, implicating conservation plans, and benefits of incorporating physiological data when evaluating species' distributions.

OCCUPANCY OF A THREATENED PRAIRIE SPECIALIST, THE CRAWFISH FROG (*Lithobates areolatus*), ACROSS NORTHWEST ARKANSAS

Chelsea S. Kross and John D. Willson
University of Arkansas, Fayetteville, AR

Understanding trends in species occupancy is key to making informed land-use and conservation decisions. The Crawfish Frog (*Lithobates areolatus*) is a prairie-associated amphibian that is currently experiencing precipitous declines throughout its range. Due to the species' unique habitat requirements, the loss of prairie habitat is thought to be the primary cause of decline. As a species of greatest conservation need in Arkansas, identification of sites inhabited by *L. areolatus* is a valuable resource for land managers and policy makers when making land-use decisions and selecting sites for protection or restoration. Our objectives were to (1) locate extant populations of *L. areolatus* within Northwest Arkansas, (2) use occupancy modeling to determine landscape and habitat characteristics that are important predictors of *L. areolatus* occurrence. We conducted repeated time-constrained auditory surveys at 60 potential *L. areolatus* breeding sites, including all historic localities in the region. We used occupancy modeling to examine relationships between occupancy probability of *L. areolatus* and other pond-breeding amphibians with current land-use and land-cover. We documented *L. areolatus* at 14 sites, including 75% of historic localities. Our results suggest that *L. areolatus* is common in select regions of Northwest Arkansas, but is threated by land-use change across much of this rapidly growing region.

POST-BREEDING MOVEMENTS OF THE WOOD FROG (*Rana sylvatica*) IN AN ARCTIC-SUBARCTIC ECOTONE

Stephanie Bishir
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Climate change will have disproportionately greater impacts on ecosystems in Arctic and Subarctic regions within a shorter time frame. The predicted effects will directly alter essential micro- and macrohabitat conditions for many organisms. Yet, there is a lack of basic information for many organisms in northern latitudes, including amphibians. Amphibians are an environmentally sensitive group and recent global declines highlight the importance for understanding their interactions with the landscape. We used radiotelemetry to study the post-breeding movements and habitat use patterns of adult wood frogs (*Rana sylvatica*) in the Hudson Bay Lowlands of Churchill, Manitoba, Canada. We tracked 57 frogs total (35 male and 22 female) across three wetland sites. Based on preliminary results, females and males exhibit differences in their movement patterns. Female frogs travelled longer total distances (mean=148.46 m, SE=37.74) than males (mean=93.34 m, SE=13.58) and also traveled farther net distances from the breeding wetland (mean=93.54 m, SE=21.23) than males (mean=55.90 m, SE=7.94). This study provides baseline terrestrial movement data for northern populations of wood frogs in a Subarctic environment. This information will aid in understanding how climate change will

impact populations of amphibians and can be used to better inform management and conservation plans for this threatened group.

ADDITIVE IMPACTS OF EXPERIMENTAL CLIMATE CHANGE INCREASE RISK TO AN ECTOTHERM AT THE ARCTIC'S EDGE

Jon M. Davenport, Blake R. Hossack, and LeeAnn Fishback
Southeast Missouri State University, Cape Girardeau, MO

Ectotherms are particularly susceptible to environmental change (e.g., warming and wetland drying). Several studies in temperate environments have examined the adaptive capacity of organisms to greater understand the potential repercussions of warming and associated accelerated drying for freshwater ecosystems. However, few experiments have examined these impacts in Arctic or Subarctic freshwater ecosystems, where the climate is changing most rapidly. To evaluate the capacity of a widespread ectotherm to anticipated environmental changes, we conducted a mesocosm experiment with the wood frog (*Rana sylvatica*) in the Subarctic. Three warming treatments were fully crossed with three drying treatments to simulate a range of predicted changes in wetland environments. We measured survival, growth rate, and size at metamorphosis. We predicted wetland warming and drying would act synergistically, with water temperature partially compensating for some of the negative effects of accelerated drying.

Across all drying regimes, a 1°C increase in water temperature increased the odds of survival by 1.79, and tadpoles in 52-day and 64-day hydroperiod tanks were 4.1–4.3 times more likely to survive to metamorphosis than tadpoles in 45-day tanks. For individuals who survived to metamorphosis, there was only a weak negative effect of temperature on size. Our results reveal that one of the dominant herbivores in Subarctic wetlands, wood frog tadpoles, are capable of increasing their developmental rates in response to increased temperature and accelerated drying, but only in an additive manner. The strong negative effects of drying on frog survival suggest that drastic alterations may be occurring in Subarctic wetland communities.

UNCOVERING DIVERGENT LINEAGES AND PHYLOGEOGRAPHIC STRUCTURE IN AN OBLIGATE CAVE-DWELLING SALAMANDER (*Eurycea spelaea*)

John G. Phillips[1], Dante B. Fenolio[2], Sarah L. Emel[1,3] and Ronald M. Bonett[1]
[1]University of Tulsa, Tulsa, OK; [2]San Antonio Zoo, San Antonio, TX; [3]Temple University, Philadelphia, PA

The biology of many cave-dwelling organisms (troglobites) is poorly known due to their cryptic lifestyles and habitat inaccessibility. Some widespread troglobites whose molecular phylogenies have been examined display geographic genetic structure due to low dispersal rates and their highly fragmented habitat. However, an insufficient amount of phylogeographic studies of troglobites exist. This is particularly important given the potential for unrecognized cryptic species within troglobitic taxa, which are commonly

imperiled by anthropogenic hazards such as land development, water pollution, and climate change. The Grotto Salamander (*Eurycea spelaea*) is endemic to the Ozark Plateau and its adults are confined to life in caves. There is only one currently recognized species of Grotto Salamander, but recent work has revealed high levels of genetic diversity, indicating the presence of cryptic lineages (three highly divergent lineages across the Ozarks). To further investigate the fine scale genetic diversity and geographic structure within *E. spelaea*, we have employed next-generation sequencing techniques and compared the observed patterns to mitochondrial divergence. Using a sequence capture method, we have successfully collected data for over 500 nuclear loci across *E. spelaea*, which have been used to construct a phylogenetic hypothesis for the *E. spelaea* species complex. We have used the phylogeny to identify evolutionary significant lineages within Grotto Salamanders.

POPULATION ECOLOGY OF CAVE-DWELLING SALAMANDERS FROM SELECTED MISSOURI OZARKS CAVES THAT VARY IN ANTHROPOGENIC DISTURBANCE

Olivia Graves and Brian Greene
Missouri State University, Springfield, MO

Amphibians are the most endangered class of vertebrates and are experiencing worldwide population declines. Conservation actions designed to ameliorate this problem require quantitative demographic and life history information to inform management efforts. Accumulating a foundation of empirical ecological data is particularly essential for data deficient species. Although research and monitoring initiatives are ongoing for many North American amphibian species, cave-dwelling species represent an important gap in coverage. In Missouri, recent data on cave-dwelling salamanders were derived from cave surveys, which have mainly provided basic general information on abundance. We conducted monthly mark recapture samples of salamanders, with particular interest in the grotto salamander, *Eurycea spelaea*, in four caves with varying degrees of environmental impact, including an urban location (Giboney Cave, Greene County), a rural location (Dream Cave, Ozark County), and rural show caves (Smallin and Fielden Caves, Christian County). Our study provides detailed population-specific ecological data on densities, seasonal abundance, movement and habitat use of salamander communities in several cave systems and how these communities vary with environmental factors. Salamander communities were diverse at each site. Trends in spatial patterns, individual movements, and seasonal activity were similar across sites but species abundances varied across caves. Data from this study will provide more insight into the structure of cave-dwelling salamander communities and hopefully help inform conservation strategies.

A MODEL OF THE SOCIAL ORGANIZATION WITHIN *Plethodon cinereus* IN VIRGINIA

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Based on almost 50 years of research on the ecology and behavioral ecology of *Plethodon cinereus* we propose a tentative model for the social organization of that species in Virginia. We discuss the roles of neonates, juveniles, and adult males and females. Neonates and juveniles remain in or near parental territories (cover objects) for 2-3 years, then as young adults they begin to compete for their own territories. Adults tolerate these juveniles in their territories because they recognize them as kin or as just familiar cohabitants, but displace them during courtship seasons. Large male and female adults aggressively defend their territories, which harbor prey when the leaf litter dries, by postural displays, pheromonal signals, and biting of intruders. Cover objects vary in quantity and quality of prey therein, and large males obtain prey-rich territories. Females prefer to align themselves with large territorial males, but such males have a relatively short tenure of territorial ownership due to male-male competition. Territories allow occupants to forage optimally except when defending against intruders. Large adult males and females tend to either overlap their territories or pair as social monogamous partners from September, when females begin to yolk ova, until May, when eggs are laid and brooded. Males then explore new associations with females that will lay eggs the next year (i.e., biennial reproduction). Social monogamy is maintained by competition with intruders for scarce prey by mutual mate guarding (intrasexual expulsion of intruders), and sexual coercion (aggressive intimidation of socially fickle partners), but extra-pair matings are common. Territorial cooperation against intruders by females reduces post-conflict aggression by males towards socially polyandrous partners. Once territories have been established, both males and females show site tenacity, except during foraging trips into the leaf litter after rainfalls, while defending against same-sex intruders.

THE EFFECT OF VARYING LEVELS OF PREDATION RISK ON TERRITORIALBEHAVIOR BY MALE AND FEMALE OZARK ZIGZAG SALAMANDERS, *Plethodon angusticlavius*

Sarah Heimbach and Alicia Mathis
Missouri State University, Springfield, MO

The benefits of territorial defense have been well-documented and include increased access to food and/or mates. However, territorial defense also incurs costs, including increased visibility to predators. To minimize detection during territorial contests, individuals are predicted to exhibit lower levels of behavioral displays and overt fighting when exposed to increased levels of predation risk. Additionally, salamanders that can accurately assess the level of predation threat might be able to adjust their territorial behavior to maximize the difference between costs and benefits. In this study, prior to territorial contests, Ozark Zigzag salamanders, *Plethodon angusticlavius*, were exposed to different degrees of predation stress in three treatments: only chemical cues from predators

(presumed lower risk), only physical attacks (presumed intermediate risk), and a combination of chemical and physical stimuli (presumed highest risk). Both males and females reduced the time spent in the high-visibility aggressive posture (all trunk raised: ATR) to all three levels of predation threat in comparison to the control. Responses were more nuanced with respect to the low-visibility submissive posture (trunk FLAT against the substrate). Female salamanders increased their levels of FLAT equally following all three levels of predation threat, whereas males only increased FLAT in response to the highest level of threat (combined physical and chemical). The differential response by males and females may indicate that the sexes differ in the costs and benefits associated with territorial defense and antipredator behavior.

DIFFERENCES IN AGONISM IN TWO SPECIES OF *Plethodon*

Colton Lynn, Alicia Mathis, and Ben Dalton
Missouri State University, Springfield, MO

Territorial disputes are common among terrestrial, lungless salamanders of the genus, *Plethodon*. Two Missouri species, *P. serratus* and *P. angusticlavius* appear similar morphologically and ecologically, but differ in their levels of exploratory behavior in the lab and in the nature of their antipredator responses in the field. Although both species exhibit aggressive defense of territories, it is not known whether they differ in the level of agonistic behaviors. For both species, we introduced conspecific intruders into territories of residents and recorded the behavior of both individuals. Preliminary analysis indicates that the two species differed significantly in amounts of both agonistic behaviors that we recorded—ATR (All Trunk Raised; aggressive behavior) and EDGE (escape behavior)—which could be a reflection of higher overall levels of activity by *P. angusticlavius*. The preliminary data also indicate potential differences in levels of agonistic behavior according to sex and residency status of individuals.

RESPONSE TO CONSPECIFIC ALARM CUES BY LARVAL SPOTTED SALAMANDERS

Katy Gardner, Ben Dalton, and Alicia Mathis
Missouri State University, Springfield, MO

Detection of predators early in a predation sequence may allow prey to increase their probability of survival by taking evasive action. For aquatic species in ephemeral ponds, visibility is often limited, so assessment of predation risk via chemical cues can be useful. Prey may directly detect cues given off by a predator (e.g., predator scents) or indirectly detect the presence of a predator via alarm cues released when a predator attacks a nearby conspecific. The Spotted Salamander, *Ambystoma maculatum*, breeds in vernal ponds, and larvae suffer from high rates of mortality due in part to high levels of predation. We tested whether larvae can assess predation risk by detecting chemical (alarm cues) released from the skin of damaged conspecifics or heterospecific prey (American Toad

tadpoles). As a control, we also examined responses to damaged skin from a terrestrial salamander from a different taxonomic family (*Plethodon angusticlavius*). Since decreased activity is an antipredator response for larval *Ambystoma*, we recorded number of moves before and after presentation of the stimuli. Larval *Ambystoma* showed stronger reductions in activity to the skin extracts from conspecifics, but not to any of the other stimuli. Our results indicate that larval spotted salamanders possess a conspecific alarm cue, but, unlike some other species, they do not appear to respond to alarm cues from a syntopic species (American Toads).

NON-CONSUMPTIVE EFFECTS ON DIFFERENT PREDATORS ON BEHAVIOR OF LARVAL RINGED SALAMANDERS

Thomas L. Anderson[1,3], Thomas M. Luhring[2,3] and Raymond D. Semlitsch[3]
[1]University of Kansas, Lawrence, KS; [2]University of Nebraska, Lincoln, NE; [3]University of Missouri, Columbia, MO

Non-consumptive effects of predators frequently alter behavior of prey in many taxa. Such altered behavioral patterns are especially common among larval amphibians in pond ecosystems, who use water borne chemical cues or visual stimuli from predators to modulate their risk of being eaten. We tested whether activity patterns and foraging behavior of ringed salamanders was altered by the presence of multiple co-occurring predators. We conducted a large outdoor mesocosm experiment, where we combined ringed and spotted salamander larvae with the presence/absence of adult central newts, mosquitofish and/or aeshnid dragonfly larvae, in addition to the presence/absence of vertical cover. We counted the number of active individuals in each tank on 113 occasions from November 2012 to May 2013. We also conducted indoor foraging trials in plastic containers divided by plastic mesh partition in April 2016. We paired a ringed salamander larva with 16 spotted salamander hatchlings on one side the partition, and added either a single mosquitofish, aeshnid larvae or adult central newt to the other side. In the mesocosm experiment, we found that the number of visually active larvae were best predicted by interactions of predator and cover treatment with time. Larval counts were higher in the control, aeshnid, and aeshnid+newt tanks early in the experiment, but the latter two treatments declined significantly towards the end of the experiment. This result coincided with increased counts of dragonflies, indicative of either reduced behavior or increased predation to this predator. In the indoor laboratory experiment, larvae foraged less in the presence of aeshnids early in the experiment. By the end of the experiment, all treatments converged to an equal number of surviving prey. We hypothesize that larvae may become accustomed to cues the longer they are exposed, or are willing to trade off predation risk when food is limited as in our indoor experiment. Overall, our experiments indicated dragonflies are the most limiting predator of larval ringed salamanders of the three tested, but that different combinations of predators also induced strong consumptive and non-consumptive effects.

DO THE ABDOMINAL AND THROAT PATCHES OF THE PRAIRIE LIZARD FUNCTION AS A CONDITION-DEPENDENT SIGNAL?

Christopher D. Robinson and Matthew E. Gifford
University of Central Arkansas, Conway, AR

In many taxa, colorful morphological features are used to advertise individual quality to conspecifics. Many studies have focused on the relationship between quality and colors derived from pigments (e.g., reds, yellows) due to their extreme color variation. Structural colors (e.g., blues) vary less, and therefore have had less focus devoted towards them, despite evidence that they too advertise condition. In the prairie lizard, *Sceloporus consobrinus*, males exhibit bright blue patches on their abdomens and throats, and these patches vary in both color and size. To test whether these patches serve as indicators of individual condition, we studied a population of prairie lizards in Sherwood, Arkansas during the summer of 2016. We measured morphological characteristics of 45 males, including snout-vent length, hind-limb span, head dimensions (length, width, and height), patch color (brightness, saturation, and hue), and patch size, as well as endurance, a metric of performance. We found that larger males have bluer throats and a higher proportion of blue on their abdomens. Generally, larger females mate with larger males, so females may use these signals as an assessment of male size. Larger females have more offspring on average than smaller females, which could result in directional selection for larger males to be bluer. Additionally, males with better endurance have a higher proportion of blue on their throats. Again, males with higher endurance sire more offspring, so bluer males could be selected for. Overall, data suggest that the blue abdominal and throat patches of *S. consobrinus* give some indication of male size and performance, which could translate to fitness advantages.

THE INFLUENCE OF EMBRYONIC ENVIRONMENT ON PHENOTYPIC VARIATION AND FITNESS IN *Sceloporus consobrinus*

Marci Polett
University of Central Arkansas, Conway, AR

Maternal effects of stress have been found to contribute to offspring phenotype and potentially influence offspring survival and fitness in many different species. Specifically, stress hormones like corticosterone (CORT) contributed by the mother in an embryonic environment have been shown to influence offspring morphology, growth, physiology, and behavior. Current studies are inconclusive as to the impact CORT has on offspring "personality" and how CORT can differentially impact the development of males and females. Using prairie lizards, *Sceloporus consobrinus*, as a model, we determined how exposure to CORT in the embryonic environment influenced offspring morphology, growth, stress response, and boldness. We expect to find significant phenotypic differences between treatments, but the direction of predicted phenotypic changes is unclear. Preliminary data indicate sex-specific differences hatchling body size among treatments as well as potential differences between early versus late clutches. These results will provide important clues to understanding both short term and long term impacts of embryonic

stress. These results will also provide a baseline for developing additional studies aimed at uncovering the cellular and molecular mechanisms involved in translating maternal hormonal effects into offspring phenotypes.

PRELIMINARY RESULTS ON A RADIOTELEMETRY STUDY ON PYGMY RATTLESNAKES (*Sistrurus miliarius*) IN SOUTHWESTERN MISSOURI

Dylan Wallace Maag and Dr. Brian Greene
Missouri State University, Springfield, MO

Despite a wide distribution throughout the southeast United States, pygmy rattlesnakes (*Sistrurus miliarius*) have received little research attention relative to other rattlesnake species. I captured a total of 30 pygmy rattlesnakes at the Drury-Mincy Wildlife Area (DMWA) and retained 14 large individuals (mostly pregnant females) for a radiotelemetry study. Pygmy rattlesnakes are widespread at DMWA where they were encountered in forest, savannah, and glade habitats. Snakes were mostly encountered during evening road driving surveys and were rarely observed in artificial cover transects and from fortuitous encounters. All telemetrically monitored snakes were relatively sedentary and occupied very small (< 1 ha) home ranges. Pregnant snakes were especially immobile during gestation, often limiting all activity to a few m^2 area. Parturition occurred in early-mid August with maternal attendance observed for several litters. An additional season of telemetry data is planned to derive comparative data for males and non-pregnant females and assess variation in microhabitat selection among adult snakes differing in sex and reproductive condition.

UNRAVELLING A BIOMECHANICAL PARADOX: USING FUNCTIONAL MORPHOLOGY TO UNDERSTAND HOW AN INTRAGUILD PREDATOR (*Lampropeltis*) DEFEATS INTRAGUILD PREY (*Pantherophis*)

David Penning and Brad Moon
Missouri Southern State University, Joplin, MO

Across ecosystems and trophic levels, predators are usually larger than their prey, and when trophic morphology converges, predators typically avoid predation on intraguild competitors unless the prey are notably smaller in size. However, a currently unexplained exception occurs in kingsnakes in the genus *Lampropeltis*. Kingsnakes are able to capture, constrict, and consume other snakes that are not only larger than themselves, but that are also powerful constrictors (such as ratsnakes in the genus *Pantherophis*). Their mechanisms of success as intraguild predators on other constrictors remain unknown. To begin addressing these mechanisms, we studied the scaling of muscle cross-sectional area, pulling force, and constriction pressure across the ontogeny of six species of snakes (*L. californiae, L. getula, L. holbrooki, P. alleghaniensis, P. guttatus,* and *P. obsoletus*). Muscle cross-sectional area is an indicator of potential force production, pulling force is an indicator of escape performance, and constriction pressure is a measure of prey-handling performance. Muscle cross-sectional area scaled similarly for all snakes, and there was no

significant difference in maximum pulling force among species. However, all kingsnakes exerted significantly higher pressures on their prey compared to all ratsnakes. The similar escape performance among species indicates that kingsnakes win in predatory encounters because of their superior constriction performance, not because ratsnakes have inferior escape performance. The superior constriction performance by kingsnakes derives in part from their consistent and distinctive coil posture as well as additional aspects of muscle structure and function that need to be tested in future research.

NEW HERPETOLOGICAL DISTRIBUTION RECORDS FOR MISSOURI IN 2016

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The following list represents new county records accumulated or brought to our attention since the publication of Daniel and Edmond (2014) and Daniel, et al (2015). Publication of these records extends our knowledge of the amphibians and reptiles found within the state of Missouri. In addition, recipients of this list have the opportunity to update checklists and distribution maps. Finally, the publication of this list allows us to acknowledge the contributions of the many individuals who have contributed information or specimens.

The records listed below represent the first report of the species within a given county and are based on catalogued voucher specimens or photographs deposited in a public institution. Distribution records are presented in the standardized format of Collins (1989): common and scientific name, county, specific locality (unless withheld for species of special concern), legal description of locality, date of collection, collector(s), catalogue number and institution where the specimen is deposited.

Specimens reported in this note have been deposited in the Florida Museum of Natural History, University of Florida, Gainesville, FL (UF) and Dean E. Metter Memorial Collection, University of Missouri, Columbia, MO (UMC). Unless otherwise indicated, all distribution records are documented by post-metamorphic/hatchling fluid preserved specimens.

We would like to extend our appreciation to D. Baker, D. Hoisington, J. Karel, N. March, J. Miller, A. Nicholson, P. Paplanus, and K. Pulles for contributing photographs that were used in this note.

AMPHIBIA: CAUDATA (SALAMANDERS)

SPOTTED SALAMANDER
Ambystoma maculatum
Perry Co.: 2.74 km SSW St. Mary (T36N R10E Sect. 4); 13 March 2015; N. March (digital image, UMC 3088-3089P).

EASTERN TIGER SALAMANDER
Ambystoma tigrinum
Macon Co.: Macon (T57N R14W Sect. 14); 3 April 2015; N. March, J. March (digital image, UMC 3090P).
Ste. Genevieve Co.: 2.51 km SSW St. Mary (T37N R10E Sect. 32); 5 November 2015; N. March, J. March (digital image, UMC 3091P). Rt. F, 3.15km SW St. Mary (T36N R10E); 9 March 2016; M. Wishard, A. Wishard (digital image, UMC 3215P).

LONG-TAILED SALAMANDER
Eurycea longicauda
Dade Co.: 6.77 km SSW Dadeville (T31N R25W Sect. 17); 23 July 2011; C. Gustafson, K. Morris, N. Gustafson (digital image, UMC 3096P).

AMPHIBIA: ANURA (FROGS AND TOADS)

SPRING PEEPER

Pseudacris crucifer

Franklin Co.: Shaw Nature Reserve (T43N R2E Sect. 17); 25 March 2016; K. Pulles (digital image, 3049P).

AMERICAN BULLFROG

Lithobates catesbeianus

Pike Co.: Curryville (T53N R4W Sect. 5); 25 May 2016; B. Edmond, J. Edmond (digital image, UMC 3173P).

REPTILIA: SQUAMATA (SNAKES)

COACHWHIP

Coluber flagellum

Ste. Genevieve Co.: 3.57 km SSW Bloomsdale (T38N R7E Sect. 27); 13 April 2014; P. Paplanus (digital image, UMC 3046P).

EASTERN HOGNOSE

Heterodon platirhinos

Ste. Genevieve Co.: Horton Farm Conservation Area (T36N R7E Sect. 9); 3 November 2015; J. Karel (digital image, UMC 3042P).

SPECKLED KINGSNAKE

Lampropeltis holbrooki

Caldwell Co.: 1.4 km N New York (T56N R27W Sect. 4); 29 October 2016; R. Daniel (digital image, UMC 3105P).

Perry Co.: Red Rock Landing Conservation Area (T35N R12E Sect. 13); 25 April 2016; J. Briggler (digital image, UMC 3101P).

EASTERN MILKSNAKE

Lampropeltis triangulum

Polk Co.: Pleasant Hope Conservation Area (T31N R22W Sect. 11); 7 May 2016; B. Edmond (digital image, UMC 3150P).

DIAMOND-BACKED WATERSNAKE

Nerodia rhombifer

Perry Co.: 2.82 km Lithium (T36N R10E Sect. 1); 1 June 2016; N. March, J. March (digital image, UMC 3087P).

WESTERN RATSNAKE

Pantherophis obsoletus

Putnam Co.: 2.57 km N Livonia (T66N R16W Sect. 21); 23 April 2016; M. Lynch, M. Lynch (digital image, UMC 3079P).

DEKAY'S BROWNSNAKE

Storeria dekayi

Caldwell Co.: Rt. B, 1.8 km S Jct. US 36 (T57N R27W Sect. 28); 29 October 2016; R. Daniel (digital image, UMC 3104P).

Daviess Co.: 4.09 km SE Altamont (T58N R28W Sect. 5); 29 October 2016; R. Daniel (digital image, UMC 3119P).

Jasper Co.: 13.6 km WSW Jasper (T30N R32W Sect. 28); 4 July 2014; D. Holsington (digital image, UMC 3078P).

NORTHERN RED-BELLIED SNAKE
Storeria occipitomaculata
Madison Co.: 1.95 km SW Oak Grove (T33N R6E Sect. 8); 21 March 2015; A. Nicholson (digital image, UMC 3041P).

WESTERN RIBBONSNAKE
Thamnophis proximus
Caldwell Co.: Breckenridge (T57N R26W Sect. 10); 29 October 2016; R. Daniel (digital image, UMC 3115P).

COMMON GARTERSNAKE
Thamnophis sirtalis
Daviess Co.: 10.03 km SSE Gallatin (T58N R27W Sect. 15); 29 October 2016; R. Daniel (digital image, UMC 3117P).

REPTILIA: TESTUDINES (TURTLES)
SPINY SOFTSHELL
Apalone spinifera
Barton Co.: Prairie State Park (T32N R33W Sect. 16/17); 18 June 2016; D. Hoisington (digital image, UMC 3093P).
Dade Co.: Cedar Creek X Co. Rd. 22 (33N R28W Sect. 35); 22 May 2016; B. Edmond (digital image, UMC 3165P).
Jasper Co.: Spring River at MO 43 (T29N R33W Sect. 2); 13 August 2015; P. Lindeman (photograph, UF 176827) (Lindeman 2016a).
Macon Co.: Long Branch Lake (T58N R15W Sect. 12); 14 September 2013; N. March, J. March (digital image, UMC 3092P).

NORTHERN MAP TURTLE
Graptemys geographica
Dent Co.: Dry Spring Branch X Co. Rd. 318 (T35N R6W Sect. 32); 2 April 2015; M. Habecker (digital image, UMC 3040P).
Jasper Co.: Spring River at MO 43 (T29N R33W Sect. 2); 13 August 2015; P. Lindeman (photograph, UF 176825) (Lindeman 2016b). Hurter (1911) previously reported the occurrence of *G. geographica* from Jasper Co., but lacked a specific location or voucher specimen.

OUACHITA MAP TURTLE
Graptemys ouachitensis
Jasper Co.: Spring River at MO 43 (T29N R33W Sect. 2); 13 August 2015; P. Lindeman (photograph, UF 176828) (Lindeman 2016c).

FALSE MAP TURTLE
Graptemys pseudogeographica
Butler Co.: Black River at US60 (T25N R6E Sect. 24/25); 3 August 2015; P. Lindeman (photograph, UF 176818) (Lindeman 2016d).

RIVER COOTER
Pseudemys concinna

Douglas Co.: North Fork White River (T25N R11W Sect. 28); 27 August 2016; B. Edmond (digital image, UMC 3193).

Jasper Co.: Spring River at MO 43 (T29N R33W Sect. 2); 13 August 2015; P. Lindeman (photograph, UF 176829) (Lindeman 2016e).

ORNATE BOX TURTLE

Terrapene ornata

Taney Co.: Ridgedale (T21N R22W Sect. 13); 29 October 2016; M. Heeley (digital image, UMC 3126P).

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NATURAL HISTORY NOTES

NEW STATE SIZE RECORD FOR THE WESTERN PYGMY RATTLESNAKE (*Sistrurus miliarius streckeri*)

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On September 9, 2014 a large male *Sistrurus miliarius streckeri* was collected on MO 86, just south of the Roaring River bridge near Eagle Rock, MO by Cheyne Matzenbacher. It was collected immediately after being struck by an automobile and later died as a result of the sustained injuries. The snake was frozen and later deposited in the Dean E. Metter Memorial Collection at the University of Missouri, Columbia (UMC 8957). Prior to preservation the specimen was measured and found to have a SVL= 50.7 cm and TL= 57.7 cm.

The previous state size record was held by a Christian County female (UMC 8114) salvaged on September 20, 2008. This specimen, also measured prior to preservation, had a SVL= 49.1 cm and TL= 55.5 cm (Daniel 2011).

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ADDITIONS TO THE BIBLIOGRAPHY OF HERPETOFAUNAL REFERENCES FOR MISSOURI

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The following is a list of references dealing with the biology of amphibians and reptiles from Missouri that have been brought to the attention of the author since the publication of Daniel (2015). Readers are requested to notify the author of any additional references that should be included in future compilations.

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