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M. S. Student Competition

Identification of novel transcripts involved in vertical transmission of *Borrelia miyamotoi* in *Ixodes scapularis*. L. Downs and S. Karim

Tick-borne diseases are a public health issue and they affect people every day. A new tick-borne pathogen, Borrelia miyamotoi, has emerged. It is a relapsing fever spirochete that is considered a distant cousin to Lyme Disease spirochete and has recently been found to cause disease in humans. This pathogen has been found in Ixoid ticks such as *Ixodes rinicus* (sheep tick) and Ixodes scapularis (black-legged tick). In humans, Borrelia miyamotoi causes recurrent fever, flu-like symptoms, and can also cause more severe illnesses such as meningoencephalitis. Unlike other Borrelia species, this pathogen can be vertically transmitted, passed from mother to offspring, which allows for the survival of the pathogen for many generations. There is very little to no research on B. miyamotoi that contribute to the understanding of the vertical transmission phenomenon. To study the vector determinants of B. miyamotoi vertical transmission, we generated infected Ixodes scapularis tissues using an artificial infection method. Total RNA from the tissues were submitted for RNAseq analysis and the coding sequences were used to reveal targets that could have a role in vertical transmission of B. miyamotoi. Our previous studies (Adamson et al., 2013) show that glutaminyl cyclase (QC) plays an important role in tick ovipositioning and embryogenesis. This enzyme, along with other potential targets uncovered by RNAseq, will be silenced by RNAi and observed to see if it impacts B. miyamotoi's vertical transmission. Promising targets that successfully inhibit vertical transmission of B. miyamotoi will

Impact of Novaluron on Ovarian Development and Maturation in the Tarnished Plant Bug *Lygus lineolaris* (Palisot de Beauvois). B. Catchot, F. Musser, J. Gore, R. Jackson, and N. Krishnan

The tarnished plant bug (TPB), *Lygus lineolaris* (Palisot de Beauvois) (Miridae: Hemiptera) is the most economically important pest in cotton in the mid-south region. It is highly polyphagous, and the most widely distributed species of Lygus in North America. Novaluron is an insect growth regulator and chitin synthesis inhibitor, which has primarily been used for its ovicidal and larvacidal activities. Here, we examined the impacts of novaluron on TPB ovarian (telotrophic ovariole) development and maturation, including fecundity and egg hatching. Results indicate that novaluron has a detrimental effect on ovarian development and maturation as revealed from histological studies resulting in degenerated follicular epithelial cells coupled with distorted oocytes exhibiting large vacuoles in vitellogenic sites. Field exposure results showed a significant reduction in percent hatch rate and nymphs/female/day compared to TPB from non-treated fields. Laboratory studies on joint exposure of males and females or single sex exposure indicated no significant differences in fecundity compared to controls. However, significant differences in egg hatch rate were observed with least eggs hatching following joint exposure or exposure of only females. On the contrary, in the male exposure treatment, significantly more eggs hatched than in the female only or the joint exposure treatments. Thus, the effects of novaluron may be female specific. This in turn can reduce overall nymph populations in the field through sublethal effects on adult female TPB. Also, impacts vary depending on adult age at the time of exposure, but effects persist throughout the life of the adult. Taken together, our results support the application of novaluron on young TPB adult populations to disrupt ovarian development and maturation and hence its fecundity and hatchability.

Biodiversity of the Bariditae (Curculionidae; Conoderinae) of Mississippi. R. J. Whitehouse

The state of Mississippi has more than 36 species of Bariditae (Curculionidae; Conoderinae) in more than 25 different genera. They have been found in every county in the state with some

being widespread while others appear to be restricted to a specific area like the Black Belt Prairie. *Odontocorynus salebrosus*, *O. umbellae*, *Geraeus picumnus*, and *G. penicillus* are some of the most common species found across the state and *Linogeraeus urbanus* is a notable exotic that was found. This examination of the species of one of the larger Curculionidae supertribes helps to increase our knowledge of the group and adds to the known biodiversity present in the North American Coastal Plain.

Soybean Looper (*Chrysodeixis includens*) threshold refinement and validation in Mississippi Soybeans. M. Huff, D. Cook, J. Gore, A. Catchot, F. Musser, and T. Irby

Soybean loopers, *Chrysodeixis includens,* are a major late-season defoliator of Mississippi soybeans. Previous research has demonstrated that an economic threshold of 20% defoliation during the reproductive growth stages can prevent economic yield loss. Studies were initiated in 2017 and 2018 to determine the relationship between soybean looper densities and percent defoliation using both natural infestations and cage studies. Cage studies were infested with 5, 7, 9, and 12 pairs of soybean looper moths per treatment to obtain varying levels of infestation. Preliminary results from this study indicate that for each larvae found, defoliation increased by 0.64% and for each larvae ½" or larger found, defoliation increased by 0.8%. Additional studies were performed to compare the drop cloth and sweep net sampling methods to develop an equivalency between the two. This study was conducted in commercial soybean fields at various locations throughout Mississippi using multiple samplers performing 5 sets of 25 sweeps and 5 drops so that results could be paired. Preliminary results indicate that for each larvae found with a drop cloth, 3 larvae were found with a sweep net; with larvae ½" or larger 1 larvae found with a drop cloth equated to 2.5 larvae found with a sweep net. In addition to the field studies, a lab feeding study was performed to determine the feeding rates of soybean looper larvae based on instar.

The Impact of Brown Stink Bug, *Euschistus servus*, Damage on Early Vegetative Stage Field Corn Yield. William Hardman, Don Cook, Angus Catchot Jr., Jeff Gore, Brien Henry

Corn is one of the most important commodities in the United States and Mississippi, and 226,600 hectares were planted in Mississippi in 2017. Very little research has been conducted to understand the ecology of how brown stink bug, *Euschistus servus,* effects the corn agroecosystem. Brown stink bug damages plants by piercing the growing point below the soil surface in vegetative stage corn. When they pierce the growing point, this can cause yellowing, stunting, wilting, and even "dead-heart" which is when the plant ultimately dies. Under normal conditions, corn is planted early enough to avoid high pressure from brown stink bug, and they typically are not a major pest. However, brown stink bug is a sporadic pest. In the 2017 growing season, corn was impacted by brown stink bug damage more than most years. A study was conducted in 2018 at the Delta Research and Extension Center to determine the impact of simulated brown stink bug damage on early vegetative stage corn (V1, V2, and V3). Different levels of damage were applied to determine how many damaged plants it would take to impact yield. Another study was conducted in four fields across the Delta to evaluate different levels of natural infestation damage on yield.

The effects of Bt on bollworm development and behavior. R. Godbold, J. Gore, F. Musser, A. Catchot, and D. Cook

The bollworm, *Helicoverpa zea*, is a major polyphagous species that feeds on multiple agricultural crops including corn, soybeans, and cotton. Crop technologies that incorporate *Bacillus thuringiensis* Berliner var. kurstaki (Bt) have been used as a form of control since the mid-1990s. The use of these Bt proteins as a control measure in multiple plant host species has led to a build-up in resistant populations of H. zea. The fitness of populations that move between multiple Bt-expressing crops is an important question of interest. In this study, two bollworm populations were collected from a Bt-corn variety and a non-Bt variety to be reared for the establishment of

lab colonies. Two-day old larvae from both colonies were placed in white flowers of non-Bt, Bollgard II, and Bollgard III varieties of cotton. These flowers were removed from the plant and placed on floral water picks to provide moisture to the flower and boll. After a period of 3 days, the larvae were removed, weighed, and placed on diet. Larvae were then weighed once more after 8 days on diet to determine weight gain between populations. Observations of mortality, pupation dates, and pupal weights were also done through the entirety of development. Two additional behavioral studies were conducted using a lab colony collected from crimson clover (*Trifolium incarnatum*). The first study was to determine larval movement over time on individual cotton plants. Individual, two-day old, larvae were placed in white flowers of isolated non- transgenic, Bollgard II, and Bollgard III cotton plants. Observations of larval movement were made at 3, 7, 9, and 11 days after infestation. Feeding preferences studies were also conducted using leaf disks and small pinhead squares. Larvae were placed in petri dishes containing these structures of non-transgenic and transgenic cotton varieties. Observations were made daily to determine larval location and movement between structures.

Potential exposure of honey bees to neonicotinoids in rice. A. Catchot, III, J. Gore. J. Harris, and D. Cook

An experiment was conducted to determine the frequency at which honey bees visit rice during the flowering stage. The occurrence of honey bees visiting flowering rice varied among locations and time of day. Honey bees were observed in a low percentage of fields throughout the Mississippi Delta. A separate experiment was conducted to quantify levels of neonicotinoid insecticides in rice pollen and other floral structures from their use as seed treatments and foliar sprays. Neonicotinoid residues were rarely observed in reproductive structures. These data will be important for characterizing the potential exposure of honey bees to neonicotinoid residues in rice.

A Survey of Mississippi Mosquito Blood Meals. J. Aycock, J. Goddard, and D. Outlaw

Mosquito-borne pathogens such as haemosporidians, ZIKA virus, and West Nile virus, are transmitted to vertebrate hosts through the salivary glands of various mosquito species. Research on these vectors has been far behind that of the parasites and the vertebrate hosts, both of which have seen a resurgence in the last few decades, particularly in linking the relationship between the vertebrate host and the parasite. The purpose of this survey was to determine the vertebrate blood meal of various mosquito species throughout several counties in Mississippi. Of ~40,000 mosquitoes collected in Mississippi in 2013 and 2017, 73 specimens were engorged with a viable blood meal. Each mosquito was identified and processed for DNA extraction, and a polymerase chain reaction was performed to identify the bloodmeal. This project is the first of its kind in Mississippi and has provided substantial information on the feeding patterns of Mississippi mosquitoes.

Changes in the expression of immune genes in Zika infected Aedes aegypti mosquitoes. J. Masters, A. Drury, A. Badial, C. Dean, D. Yee, and J. King

Arboviruses transmitted by mosquitoes are a significant cause of mortality throughout the world. Transmission of these disease-causing agents is dependent upon the existence of competent arthropod vectors that have the capability to maintain the pathogen and transmit it to a subsequent host. Multiple studies of vector competence have suggested that the interaction that occurs between pathogens and the mosquito immune system plays a role in determining competence of the mosquito as a vector for disease. The ability of viruses to alter the host's immune system response suggests that host-pathogen interactions could influence the efficiency of a mosquito's immune response. In this study, we analyzed relative differential expression levels of a suite of immune genes from ZIKV infected *Aedes aegypti*. Mosquitoes were reared as part of a larger study investigating the effects of larval diet on vector competence. qRT-PCR, using previously published primer sets, was used to analyze relative expression at the

transcriptomic level. Analyses consisted of one group comprised of mosquitoes infected with Zika virus, as well as a second group of non-infected mosquitoes reared under identical conditions. Differential expression was observed in mosquitoes from the infected group in all immune genes analyzed when compared to the control mosquitoes, the general trend being down-regulation of genes when compared to housekeeping genes following viral infection. These results represent a step towards illuminating the influence of viral infection on the immune response in mosquitoes, which may have consequences for the transmission of arboviruses.

be investigated further.

Ph. D. Student Competition

Economic, human, and animal health impacts of black flies (Diptera: Simuliidae) in Mississippi T. M. Nations, W. C. Varnado, A. Harrison, and J. Goddard.

Black flies (BF) are notorious blood-feeding pests which are a serious problem and may transmit various diseases worldwide. BF outbreaks were common in Mississippi during the 1930's, but ended for unknown reasons. There has been a resurgence of BF problems in Mississippi since 2009, prompting this current research project to elucidate BF impacts in the state. Data on economic, human, and animal health impacts were collected by: 1) surveying published literature, including popular press and lay articles; 2) obtaining Mississippi hospital discharge data using ICD9 codes "insect bites, with or without infection" from the Mississippi Department of Health; and 3) conducting a statewide survey of people with backyard poultry or livestock. Thus far, we have found two recent published articles about annoyance and medical effects of BF biting in Mississippi. Preliminary analysis of ICD9 code data has not been informative as to biting patterns per Mississippi counties. Lastly, the backyard flock survey shows that 2009 and 2014 were the worst years for BF attacks, with peak months being May/June. Backyard poultry, primarily chickens, were most affected. Over $12,000 was spent on BF control during the time frame covered by our survey.

Managing Caterpillar Pest in Mississippi Peanut. B. L. Lipsey, J. Gore, A. L. Catchot, D. R. Cook, J. A. Bond, and J. M. Sarver.

A complex of defoliating caterpillars commonly infest peanut, *Arachis hypogaea* L., in Mississippi and often require management with foliar insecticide applications. To better understand the effects of defoliation on Mississippi peanut yield, experiments were conducted in Stoneville at the Delta Research and Extension Center and Starkville at the R. R. Foil Research Facility at several important peanut growth stages. To achieve defoliation in the early growth stage experiments, manual hand defoliation was necessary. Late growth stage experiments were infested with corn earworm, *Helicoverpa zea* (Boddie) and fall armyworm, *Spodoptera frujiperda* (J. E. Smith). A maximum of 50% defoliation was achieved in these infestation experiments. A significant relationship between defoliation and peanut yield was observed for both the early season and mid-late-season experiments. Based on the regression analyses, 5.66 lbs and 15.3 lbs of peanuts were lost for every 1% defoliation. These results will be important for improving current IPM strategies for defoliating caterpillar pests of peanut.

Landscape level contributions of Helicoverpa zea in Mississippi corn. T. Towles, A. Catchot, J. Gore, D. Cook, M. Caprio, and C. Daves

Helicoverpa zea is a major pest of corn, cotton, and soybean and is commonly controlled through the use of foliar applied insecticides or transgenic crops expressing the Bt gene. To prevent the selection of resistant populations, refuge systems have been implemented into the agroecosystem. To test the efficacy of these traits and efficiency of various refuge systems on Helicoverpa zea, an experiment will be conducted at the Delta Research and Extension Center in Stoneville, Mississippi. A field trial containing three refuge blend scenarios and three solid

planting scenarios in field corn will be established in the 2017 growing season. The experimental design was a randomized complete block with 6 treatments and 4 replications. Treatment (1) 100% RR2 non-Bt; Treatment (2) 100% VT DoublePro; Treatment (3) 100% Trecepta; Treatment (4) 80% Trecepta + 20% RR2 non-Bt; Treatment (5) 90% Trecepta + 10% RR2 non-Bt; Treatment (6) 70% Trecepta + 30% RR2 non-Bt. Plots will be allowed to be naturally infested with Helicoverpa zea. After the immature zea exit infested ears and enter the soil for pupation, whole corn plants will be removed from the plot area. Twenty-five moth emergence traps will be placed within each plot and monitored weekly for adult emergence. H. zea adult emergence was recorded weekly and calculated to a per hectare basis. This experiment will be replicated four times. All data will be analyzed using SAS 9.4.

General Session

Trypanosomes Associated with the Alimentary Tract of *Bagrada hilaris* (Burmeister). M. J. Grodowitz, D. Gundersen-Rindal, B. Elliott, and M. Sparks

Bagrada hilaris is an invasive pentatomid first introduced in the U.S. in 2008 in California from presumably Africa and/or the Middle East. Its U.S. distribution is expanding now found as far north as central California and southern Nevada, east to central Texas, and south to northern areas in Mexico. Its primary food source is wild and cultivated mustards though in general it has a relatively wide host range. Interestingly, field populations have appeared to decline recently in several areas in the U.S. for unknown reasons though parasitism has been forwarded as a possible cause (unpublished data). A flagellated protozoan, a trypanosome, has been identified in the alimentary canal with preliminary molecular analysis placing it in the genera *Crithidia* or *Leptomonas.* The observation of cysts associated with the flagellum is more consistent with *Leptomonas* since cyst formation is not known to occur in *Crithidia*. More detailed molecular analysis continues. Number of trypanosomes per insect can exceed 100,000 per gut. Field collected individuals typically do not harbor trypanosomes though once in colony a high percentage of individuals apparently become infected. When present, trypanosomes are always associated with the midgut (100%) but can be found in the foregut (50%) and more rarely in the hindgut (33%). An axenic culture has been obtained using a modified Grace's Insect Medium containing both fetal bovine serum and various antibiotics. In culture, numbers of trypanosomes increase at first but with decreases in pH (reaching as low as 4.2) significant decreases in population numbers occur and by day 6 all individuals have expired. How individuals become infected is unknown, but transmission may occur via contaminated feces. Effects of trypanosomes on *B. hilaris* are unknown but efforts are underway to produce trypanosome free cultures which may allow experimentation to assess impact.

Inducing dysbiosis and disease in termites with chitosan. J. D. Tang, O. Raji, T. Telmadarrehei, and D. Jeremic

Intestinal dysbiosis or unhealthy shifts in microbial diversity can lead to disease in humans and other animals. To investigate whether the phenomenon also applies to arthropods, subterranean termites were fed wood treated with a sublethal concentration of chitosan, a compound with known antimicrobial activity. Results showed that chitosan-fed termites exhibited dramatic changes in their protist and bacterial hindgut communities compared to controls. Protist analysis in *Reticulitermes virginicus* showed a significant reduction in total counts of individuals, as well as a decrease in the number of species. Bacterial analysis in *Reticulitermes flavipes* showed not only a shift in the bacterial community, but also establishment of three opportunistic pathogens, *Mycobacterium abscessus, M. franklinii,* and *Sphingobacterium multivorum*. Together these data suggest that dysbiosis may be a viable pest control strategy for termites.

Mississippi Bug Blues – 2017-2018 Highlights. J. Sanders, J. Seltzer, and J. G. Hill

Mississippi Bug Blues (MBB) is an educational outreach program of the Mississippi Entomological Museum. Established in 2012, MBB has become the state's leader in invasive species awareness with emphasis on insect roles in biodiversity and conservation. Through partnerships with Starkville's award-winning YES! Program, local 4-H Leaders, The Mississippi Department of Wildlife & Fisheries, and other experts within the state's science community, 30,000 people were reached fiscal year 2017-2018.

Invitations to new events and schools including The Everything Garden Expo, Girls Scouts G.I.R.L. Event, Choctaw Indian Fair, and Redwater Elementary, have opened the door for MBB to not only reach additional audiences, but visit every Mississippi Choctaw Tribal school next year. Also, unique opportunities through partnership with the Mississippi State University (MSU) Student Association allowed MBB to both participate in the annual Trick-R-Treat on the Row event and co-host an Insect Movie Night featuring A Bug's Life.

In March 2018, MBB reached a program milestone by hosting its first solo event, The Mississippi State Insect Fair (MSIF). Showcasing the exceptional resources of the Entomology Programs at MSU, faculty and volunteers setup stations that toured 164 3rd graders through different areas of expertise within the department. Plans are now underway to host 750 students for MSIF 2019.

Next year looks even brighter for MBB and through each new challenge, partnership, and opportunity, our goal remains to educate the public in innovative and exciting ways, challenging them to view their surrounding world and the wonders it holds with more curiosity, care, and consideration.

Reduction of aflatoxin contamination in corn by formulating non-toxigenic isolates of Aspergillus flavus in a corn starch-based "bioplastic". Hamed K. Abbas, C. Accinelli, and W. T. Shier

Aflatoxins are a group of very stable, potent carcinogenic mycotoxins produced by Aspergillus species. Aflatoxins are toxic to humans and animals, and they affect many crops, such as peanuts, cottonseed, tree nuts, and especially corn, resulting in agronomic losses totaling millions of dollars annually. Biological control of aflatoxin contamination in harvested corn using non-aflatoxigenic isolates of A. flavus utilizes the principle of competitive displacement. We have developed a series of delivery methods in which non-aflatoxigenic isolates of A. flavus are formulated in granules, liquid, and seed treatments (film-coatings) that contain a corn starch-based material called "bioplastic". The bioplastic content of the formulations plays several key roles in the process of an effective application of non-aflatoxigenic A. flavus isolates, including (i) stabilizing spore preparations during storage before application; (ii) assuring a uniform distribution of spores during application; (iii) facilitating adherence of spores to the application site during and after application; and (iv) providing nutrients and physical protection during the expansion period after application during the phase in which competition with indigenous toxigenic A. flavus occurs. We have evaluated the three types of bioplastic formulations in the Mississippi Delta and in Northern Italy using two non-aflatoxigenic isolates of A. flavus, K49 (NRRL 30797) and Afla-guard (NRRL 21882). Inoculated granules applied to soil reduced contamination of harvested corn kernels up to 89.6%. A sprayable bioplastic formulation of non-aflatoxigenic A. flavus isolates reduced aflatoxin contamination of harvested corn kernels up to 80% in Northern Italy and up to 89% in the Mississippi Delta. Coating corn seeds with inoculated bioplastic reduced aflatoxin contamination of harvested corn kernels up to 79%. Bioplastic formulations of non-aflatoxigenic A. flavus isolates appear to be a safe and effective means of reducing aflatoxin when applied to corn by all three application methods. Preliminary studies indicate these bioplastic formulations may also be effective on other crops and with other fungi and bacteria.

Invasive Insect Surveys Protecting Mississippi. A. Hendon, J. Seltzer, J. Sanders and J. G. Hill

For the last three years, thousands of hours, specimens and traps have been spent, studied and set in an effort to protect Mississippi from invasive insect threats. Almost every area and county of the state has been researched looking for potential survey locations in order to monitor points of entry for dozens of invasive species that could cause harm to the state's infrastructure, environment, and industry.

Two surveys looking for Asian Defoliating and Palm Weevil species have proven successful and even resulted in 6 confirmed positives for the American Palm Cixiid. Also, many partnerships with the Mississippi Department of Wildlife and Fisheries as well as countless farmers, state officials, business owners, and property holders have proven invaluable to trapping efforts. These partnerships have led to the development of even more surveys monitoring Solanaceae, forest, and other crop pests for the continued protection of Mississippi's most precious ecological and commercial resources.

As more opportunities become available, new discoveries and lessons learned are helping to expand surveying efforts throughout Mississippi. This has led to greater protocol improvement, new trapping techniques, and enhance laboratory methods for specimen retrieval. These surveys as well as strong partnerships, are vital to Mississippi's natural resources and every citizen who values them.

Undergrad Poster Competition

Functional Role of Tick α-D-galactosidase in Carbohydrate Metabolism and Red Meat Allergy. A. Mohamed, C. Cox, G. Crispell, and S. Karim

Tick-borne meat allergy is an emergent allergy, increasing widespread in tick endemic areas in the United States of America, and worldwide. Bites from the lone-star tick (Amblyomma americanum) are believed to be involved as the source of the sensitization of humans to the oligosaccharide galactose-α-1,3-galactose (alpha-gal or a-gal), which is found in most mammalian derived food products, including gelatin, broths, and red meat. The purpose of this study is to functionally characterize the lone-star tick α-D-galactosidase (AGS) enzyme and assess its role in α-gal synthesis. This enzyme cleaves terminal alpha-galactose moieties from glycoproteins and glycolipids. Hence, we hypothesized that silencing of AGS in the lone-star tick will impair the tick's ability to synthesize α-gal and overall carbohydrate metabolism. A reverse genetic approach was utilized to characterize the functional role of α-D-galactosidase in carbohydrate metabolism, and to discover its link to red meat allergy. Our results from AGS gene silencing revealed a significant increase in tick weight, supporting a critical functional role in energy utilization. Furthermore, we are currently conducting experiments in order to further elucidate the role of alpha-D-galactosidase in tick-host interactions and the possible involvement in the newly described "Red Meat Allergy".

Palm Weevil Survey—2018 Highlights. A. Hendon. J. G. Hill, J. Seltzer, and J. Sanders

Although Mississippi lacks large pockets of naturally occurring palm trees, its location creates key travel points and pass through routes for palms throughout the state. Many coastal nurseries also keep palms as many residents and businesses throughout the state use them as decorative landscaping elements. With these factors in mind, the Mississippi Palm Weevil Survey seeks to monitor and advise several of the most threatening invasive palm weevil species currently threatening the United States including the American Palm Cixiid, Coconut Rhinoceros Beetle, and the South American Red Palm Weevil.

Over the course of 2 Years, nearly 300 traps placed in 4 counties on Mississippi's Gulf Coast have led to 6 confirmed positives of the American Palm Cixiid. With this information, plans are in

place to expand the palm survey further next season dedicating more time to resources to a known invasive species in Mississippi.

Also, due to the nature of the traps themselves, many opportunities have appeared in redevelopment of trapping protocols as well as improving the traps themselves. Because these traps are placed in varied locations and include many private businesses, providing a trap that does not interfere with the customer experience is paramount to maintaining partnerships. Therefore, improvements to the bucket traps as simple as placing food bait in reusable mesh bags has created a more convenient and less tedious experience for the surveyor while also aiding in specimen retrieval and laboratory cleanup.

As this survey continues, many eyes will be on the continued search for the American Palm Cixiid and the rapid response required for containment. In addition, efforts will continue to be made to ensure that should a Palm Weevil species threat occur, the proper steps will be taken to keep Mississippi and its surrounding neighbors safe.

Effects of advanced aging on immune gene regulation in Aedes aegypti. J. Masters, A. Drury, E. Moen, J. G. King

Aedes aegypti is a mosquito that vectors several arboviruses of public health significance, including Chikungunya virus, Dengue virus, and Yellow Fever virus, among others. Identified by white markings on its legs and a lyre on the upper surface of the thorax, A. aegypti is found in tropical and temperate regions alike throughout the world, including the United States. Only the female mosquitoes take a blood meal, a necessary component for laying eggs. Few studies have been published on accurately aging A. aegypti. These studies have relied on morphological techniques as well as costly next generation sequencing based methods. These studies have suggested that immune cells and the general function of the immune system changes with some predictability as mosquitoes mature. The goal of this ongoing study is to obtain accurate data with which to age-grade mosquitoes, with a starting point of studying immune genes of mosquitoes reared in a standard laboratory setting. The study presented observes changes of eight immune genes in A. aegypti as the population ages. Two separate groups of mosquitoes were reared under standard laboratory conditions, with one group having a blood meal at day 5 of the rearing sequence and the other group having only a 10% sugar solution throughout the rearing period. All immune genes were measured using SYBR green qRT-PCR. Several genes of interest include VIR-1, PIWI4, and PPO1, which all change in variable amounts as the mosquitoes age. Specifically, PIWI4 increases throughout the experiment in the blood-fed population. Additional results will be presented.

Asian Defoliator Survey—3 Years Covered. A. Hendon, J. G. Hill, J. Seltzer, and J. Sanders

With the increasing threat of invasive lepidopteran species spreading throughout the United States, The Mississippi Asian Defoliator Survey has been the first line of defense to detection within the state for the last three years. Under the guidance of Dr. JoVonn Hill, traps targeting the most destructive species including the Gypsy Moth, Rosy Gypsy Moth, Xylina, *Dendrolimus punctatus* and *Dendrolimus pini-sibiricus*, were placed throughout the state in an effort to increase detection and aid in enhance rapid response protocols.

Because these species lay their egg sacs on vehicles including RVs, travelers to Mississippi may unknowingly introduce and spread the pest throughout the state. Therefore, Mississippi's State Parks were chosen because they provide centralized and easy to find locations that take on many travelers during the summer months. Using an average of two-week rotations, traps were set within wooded areas, generally surrounding campgrounds, and were tracked using video recordings, GPS coordinates, and brightly colored string as noticeable markers.

Partnerships with both the Mississippi Department of Wildlife and Fisheries, as well as our surrounding states are key to the success of such trapping efforts. Constant communication must

be maintained and positive ids in other states can change where trapping efforts are concentrated as more travel patterns emerge.

By the end of our surveying efforts, nearly 3,000 traps had been set averaging close to 1,000 traps per year. Fortunately, no positive samples of any of the invasive moth species listed above have been found. Adhering to USDA protocols, and because there have been no positive IDs, trapping efforts for Asian defoliating species will be suspended for a short time to focus on potential pest species with another 3-year rotation set for the near future.

Comparative Analysis of Vigor and Pollinator Appeal in Black Belt Prairie Forb Seeds Versus Seeds from a Non-Local Supplier. B. S. Dunaway

Those who work in grasslands or wildflower restoration may find that plant materials and genotypes sourced outside of their local ecoregion can result in plants that do not perform well in local soils and climates, do not exist on-site long-term, or do not bloom at times that match the needs of local pollinators. Replacing these with the same species but sourced from within the local ecoregion can create a more ecologically stable plant community that supports biodiversity with time and proper management. In cooperation with Prairie Wildlife of Clay County, Mississippi, we will run field trials to compare the germination, growth, and bloom times of species from locally-collected seeds versus the same or similar species purchased from Roundstone Native Seed Company. Local seeds will be sown in situ on several prepared plots next to their out-of-region counterparts grown on similar plots. Hypothesized results should show that while germination is less consistent in local seed sources, long-term vigor of plantings may be superior to bought seeds. Locally acquired plant materials should also bloom to match the seasonal patterns of local pollinator species, whereas bought seeds may be out of sync with more specialized pollinators. It may be observed that Roundstone plants bloom at an earlier age than those from local populations. Slight advantages may initially reveal themselves when growing Roundstone seeds, however, the overall vigor and pollinator appeal should be greater in plants from local sources. Those working to restore native ecologies should consider these qualities when sourcing their plant materials.

Effect of Selenium on Honey bee Gene Regulation and Survivorship. K. Smith, M. Alburaki and S. Karim

The honey bee *Apis mellifera* L. is a major pollinator insect indispensable for agriculture production and the ecosystems. Bee populations are currently in decline due to multiple factors that affect their health and survival. Honey bees provide many products which have beneficial medical applications such as honey, venom and propolis that provide a source of anti-inflammatory agents, antioxidant, and stimulates immunity. Selenium (Se) is a metalloid easily found in the soil and flowers of the environment. Although this element is considered a nutrient in trace amounts, higher concentrations can be toxic and induce harmful behavioral and physiological effects to honey bees. In this study, we tested the effect of Se-enriched diets on honey bee behavior, determined lethal concentrations of Se for honey bees, and examine the transcriptional expression of antioxidant genes in honey bee. One-day old bees were fed varying concentrations of Se through tainted sugar syrup for 8 days. Syrup consumption and bee mortality were recorded for each concentration. Samplings of ten bees were collected every two days throughout the experiment. RNA extractions were performed on those samples at different tissue levels, and multiple antioxidant genes were studied using qRT-PCR. Our results showed that selenate is more toxic to bees than selenite at similar concentrations. Selenate concentrations (60, 600) µg/mL are over lethal and killed all bees in less than 24h, while bees survived (6, 0.6) µg/mL concentrations throughout the experiment. Catalase was down-regulated in bee heads at day 2 of exposure to Selenate, and up-regulated in their thorax only at day 8. Analysis of other genes are still ongoing.

M. S. Poster Competition

Effects of Novaluron on Tarnished Plant Bug Population Dynamics. B. Catchot, F. Musser, J. Gore, N. Krishnan, R. Jackson, S. Stewart, G. Lorenz, N. Seitzer, and S. Brown

Tarnished plant bug (TPB), *Lygus lineolaris* (Hemiptera: Miridae) is the most economically important pest in cotton in the Mid-South region. Tarnished plant bugs are polyphagous insects and widely distributed in North America. Field studies, small and large plots, greenhouse, and lab research has been conducted trying to determine the population dynamics of this pest. Insect growth regulators (IGR) like Diamond (novaluron) provide excellent control. Novaluron has the greatest potential to protect cotton yield when applied during peak adult migration even though it is known to kill nymphs and not adults. Laboratory studies exposing adult TPB to novaluron through the diet has shown reduced egg hatch. When looking at single and joint sex exposure of adults there was a significant reduction in egg hatch in the treated when compared to the untreated. In a field study, no differences in fecundity between adults exposed to novaluron and the untreated control were found, yet fewer eggs hatched in the treated versus the untreated control, resulting in fewer nymphs per female per day in novaluron treated plots. Novaluron applied during adult migration is effective. It reduces nymph populations through reduced hatch rate, and those nymphs that still hatch are immediately exposed to novaluron residues, further increasing the impact of novaluron on TPB populations.

Survey of Butterflies at the Noxubee National Wildlife Refuge. J. L. Gesell and J. G. Hill

The Mississippi Entomological Museum is surveying the Sam D. Hamilton Noxubee National Wildlife Refuge to collect detailed information on its butterfly fauna (Lepidoptera: Papilionoidea Latreille, 1802). The primary aim is to produce a comprehensive checklist of all species within Refuge bounds. In addition to this, we are collecting data on flight periods and associations with local plant communities. Butterfly abundance surveys are being conducted to assess seasonal habitat use across 6 major habitat classes. Diversity surveys in pine habitat are occurring in stands at various stages of management for Red-cockaded woodpecker (*Picoides borealis*). We intend on comparing habitat usage data among the different stages to determine whether these management strategies will simultaneously improve local butterfly diversity.

Analysis of morphological characters useful for identifying boll weevils (*Anthonomus grandis grandis*) and thurberia weevils (*Anthonomus grandis thurberiae*). R. J. Whitehouse

The species *Anthonomus grandis* has two subspecies *A. g. grandis*, the boll weevil, and *A. g. thurberiae*, the thurberia weevil, that can be very difficult to tell apart. Burke (1968) made a list of the morphological characters that were useful for identifying these two subspecies and these characters are reviewed here. It was determined that Burke's characters are able to be used to separate the two subspecies, with the pronotal setae class and the scutellar index being some of the more useful traits. The shape of the spermatheca was also determined to be useful in separating the subspecies. An objective way to analyze the different morphological characters as a whole was also developed to aid in identification of these two subspecies.

The Impact of artificial diets on survivorship, development, and color pattern on *Zerene cesonia* (Lepidoptera: Pieridae). E. A. Shelby, and B. A. Counterman

The development of artificial diets for Lepidopteran species allows for better rearing, which makes progress in experimental butterfly research possible. In this study, we test the ability to rear Zerene cesonia, (Pieridae) on artificial diets containing varying amounts of two plant species: *Dalea purpurea* and *Trifolium pratense*. We evaluate the quality of each diet based on survivorship, developmental timing, and analyses of larval and adult color patterns. This study concludes that artificial diets with large amounts of D. purpurea are the best for rearing Z. cesonia based on survivorship and the ability to capture the natural variation in color patterns that exists in the wild.

A Survey of Haemosporidians Within Mississippi Black Flies. J. Aycock, T. Nations, J. Goddard, and D. Outlaw

Within the last few decades, there has been a resurgence of research on haemosporidians (Order Haemosporida), the causative agent of malaria. Despite this, much of this research is biased toward human infecting haemosporidians. Leucocytozoon spp. are common haemosporidians within poultry and other avian species. Currently, black flies are the sole vectors of Leucocytozoon spp. These dipterans have yet to be surveyed for haemosporidians in most parts of the United States, including Mississippi. This survey identified haemosporidians within black flies captured in various areas of Mississippi. Black flies were identified as either *Simuliim meridionale* or *S. jenningsi*, and a polymerase chain reaction amplified haemosporidian DNA within pooled samples. Several Leucocytozoon spp. were identified within these samples including species which greatly diverged from known, New World Leucocytozoon spp. In addition, the phylogeny showed several samples closely related to species throughout the New World. These sample may be a result of the Mississippi flyway migration pattern.

Saproxylic invertebrate diversity and relationships with blue stained wood. Kristy McAndrew

Invertebrate impacts within the forest decomposition food web remain understudied. The need to understand invertebrates as decomposers is growing due to uncertainties associated with climate change. Recent studies have found a strong association between subterranean termites, both native and non-native, to wood infected with various blue stain fungi. This relationship with termites alone, especially in bark beetle outbreaks, could have important impacts on the carbon cycle and brown food web. To better understand this interaction, it is vital to unearth other arthropod species engaged in this interaction or affected by it. Sections of loblolly pine trees were either artificially infected with blue stain fungi or left uninfected immediately prior to project deployment. Half of the logs in both treatments above (bluestained and non-stained) were covered from above in fine wire mesh to exclude aboveground macroinvertebrates, such as secondary bark beetles, that may vector additional blue stain fungi. After leaving logs in the field between 1- and 2-years invertebrates were reared from the study logs. Once reared, invertebrates were sorted by order and morphospecies. Orders known to contain saproxylic individuals were further classified. It was then possible to compare arthropod abundance and diversity among treatments as well as between termite presence and absence. This information can be used to formulate future research endeavors into saproxylic invertebrates and has already contributed to the funding of an ongoing project exploring the relationship between subterranean termites, as well as other arthropods, and blue stain fungus in various climate regions.

Ph. D. Poster Competition

Tick-pathogen interactions: Connecting the dots between innate immunity and redox signaling pathways. F. Tahir and S. Karim

Dietary selenium, through its incorporation into selenoprotein, plays an important role in immunity and inflammation responses due to its crucial roles in regulating reactive oxygen species and redox status in almost all tissues. In previous studies, it has been shown that selenophosphate synthetase 2 (SPS2), a homologue of selenophosphate synthetase (SelD) identified in mammals, is essential for selenoprotein biosynthesis. Relish, a homologue of nuclear factor-kappa B (NF-kB), in the immune deficiency signaling pathway, regulates the expression of microplusin, an antimicrobial peptide (AMP). In this study, we hypothesize that silencing of SPS2 and Relish will cause an increase in *Rickettsia parkeri* level in infected *A. maculatum* ticks. To define the functional role of SPS2 and Relish in hematophagy and pathobiome colonization, an RNAi approach was utilized to deplete target genes expression in pathogen infected ticks. The transcriptional expression of target genes was confirmed in the knockdown tissues of both SPS2 and Relish. A significant decrease in replete weight, and a marked increase in distress in the host provided evidence for the critical role of target genes during feeding of knocked down ticks. A

qPCR and 16s rRNA diversity assays showed that the gene-silenced ticks had significant increase in *R. parkeri* load than the control, proving that SPS2 and Relish play a role in the maintenance of tick pathobiome. Interplay between redox signaling and innate immunity pathways will be discussed in the context of tick-pathogen interactions.

Where did you come from, where did you go? Rearing climate can alter predator foraging rates in novel environments. C. J. Speights, A. L. Catchot and B.T. Barton

Global warming has been driven largely by increased temperatures during the nighttime rather than daytime. However, most warming experiments disproportionately warm during the daytime and it is unclear if the timing of warming matters. When warming occurs could have important ecological implications, as increasing daytime temperatures may have different physiological and behavioral effects on an organism than increasing nighttime temperatures. Therefore, we investigated the impacts of four different warming regimes (ambient, constant, day, night) on development and predation rates of *Harmonia axyridis* feeding on *Acyrthosiphon pisum.* Egg hatching success was reduced by half in the day warming treatments compared to the other treatments. Development time to first, second, and third instar was accelerated in the night and constant treatments compared to day and ambient treatments. Day and night warming adult beetles weighed significantly more than constant and night warming beetles. When acclimated to a constant environment, ambient reared lady beetles consumed significantly more aphids than day reared lady beetles. Additionally, ambient reared lady beetles consumed significantly more aphids than day and constant reared lady beetles when acclimated to a day warming environment. Overall, our results suggest that rearing environment may produce different conclusions about the net effects of climate warming and therefore should be considered when performing climate research.

Optimizing forest management practices to minimize economic and environmental impacts of *Sirex noctilio.* K. Wagner and J. Riggins

The European Woodwasp (Sirex noctilio Fabricius) was detected in North America in 2004. Thus far in North America, *S. noctilio* has not caused major tree mortality, compared to its ability to cause >70% mortality in poorly managed stands in its introduced range in the Southern Hemisphere. *Sirex noctilio* effects trees via physical attack, a phytotoxic mucus and a nutritional fungus (*Amylostereum areolatum*). Previous studies in 2014 examined various forest stand types and stand density. These studies indicated that *Sirex nigricornis* F. abundance in Mississippi, United States is greatly dependent on forest management practices (e.g. harvesting stand density, stand age). The objectives of this study are to determine how drought conditions and basal area interact to influence native and exotic woodwasp abundance, and to develop forest management recommendations to minimize exotic woodwasp outbreak potential. We will examine *Sirex noctilio* population levels throughout its native and non-native ranges to compile a comprehensive understanding of *Sirex noctilio* population ecology on a global scale, including population levels and contributing environmental factors. Research locations will include sites in Europe, Argentina, Canada, and the USA to represent *Sirex noctilio* native, non-native, invasive and non-invasive ranges. Throughout these regions, locations will be selected based on drought conditions using Palmers Hydrological Drought Index, selecting sub regions of wet/normal conditions, and drought conditions. Locations will also be selected based on high and low basal area, >90ft2/ac and <90ft2/ac, respectively. With the completion of this project, we will better understand the effects of drought and forest management techniques (i.e. stand thinning, species composition, etc.) on *Sirex noctilio* populations and outbreak potential.

Functional characterization of glycine rich proteins in *Amblyomma americanum*. S. Sharma and S. Karim

Glycine rich proteins (GRPs) found in many organisms are functionally diverse and found to be involved in a variety of cellular processes and structures. Ticks secrets variety of glycine rich

proteins, many of these proteins are vital for attachment of ticks to the host skin by forming cement cone, establishment of the blood pool, and prevention from the host immune response. Exact role of GRPs in salivary glands of ticks have not been fully understood. Various reports suggest that GRPs purely play a role in the formation of the cement cone; however, new evidence is opening an emerging line of study into other roles the GRPs. In this study we adopted RNAi approach to deplete GRPs in in *A. americanum* adult females. Indeed, no significant phenotypic change in ticks was detected however cement cone analysis of Aa 41539 depleted ticks showed significant reduction in cement cone modulus. Furthermore, transcriptional expression analysis in silenced tick salivary gland showed increase in other GRPs; Aa 40863, Aa 39259 as high as ~9-fold.

General Session Posters

A Simplified Genetic Assay for Discriminating Native from Imported Fire Ants. D. C. Cross and M. A. Caprio

Imported fire ants (IFA), comprised of *Solenopsis invicta* Buren, 1972, *S. richteri* Forel, 1909, and their hybrid, have been able to competitively exclude comparably sized native *Solenopsis* species in most environments in the southeastern states. For more arid regions, such as where IFA has been more recently been colonizing in NM, CA, and west TX, there may be a diminished competitive edge against the natives. For these instances and for regions with recent introductions, a means of sorting out which type is present would be of value both for interactions with people and the management of natural areas. Unfortunately, advanced training is required for distinguishing species using morphological characters. A simple single-step genetic assay would allow a reasonably quick answer and provide wider accessibility. We sequenced a novel 1300 base pair gene fragment with moderate levels of polymorphism among the *Solenopsis* species of interest present in the southern and western U.S. states. Oligo-nucleotide primers were designed to distinguish IFA from native *Solenopsis* species. Thus far this assay shows 100% accuracy for separating the two species groups.

Mississippi Bug Blues – 2017-2018 Highlights. J. Sanders, J. Seltzer, and J. G. Hill

Mississippi Bug Blues (MBB) is an educational outreach program of the Mississippi Entomological Museum. Established in 2012, MBB has become the state's leader in invasive species awareness with emphasis on insect roles in biodiversity and conservation. Through partnerships with Starkville's award-winning YES! Program, local 4-H Leaders, The Mississippi Department of Wildlife & Fisheries, and other experts within the state's science community, 30,000 people were reached fiscal year 2017-2018.

Invitations to new events and schools including The Everything Garden Expo, Girls Scouts G.I.R.L. Event, Choctaw Indian Fair, and Redwater Elementary, have opened the door for MBB to not only reach additional audiences, but visit every Mississippi Choctaw Tribal school next year. Also, unique opportunities through partnership with the Mississippi State University (MSU) Student Association allowed MBB to both participate in the annual Trick-R-Treat on the Row event and co-host an Insect Movie Night featuring A Bug's Life.

In March 2018, MBB reached a program milestone by hosting its first solo event, The Mississippi State Insect Fair (MSIF). Showcasing the exceptional resources of the Entomology Programs at MSU, faculty and volunteers setup stations that toured 164 3rd graders through different areas of expertise within the department. Plans are now underway to host 750 students for MSIF 2019.

Next year looks even brighter for MBB and through each new challenge, partnership, and opportunity, our goal remains to educate the public in innovative and exciting ways, challenging them to view their surrounding world and the wonders it holds with more curiosity, care, and consideration.

Laboratory and field investigations on compatibility of *Beauveria bassiana* spores with a sprayable bioplastic formulation for application in the biocontrol of tarnished plant bug in cotton. M. Portilla, H. Abbas, C. Accinelli, R. Luttrell.

Two isolates of *Beauveria bassiana* (Balsamo) including the commercial strain GHA and the Mississippi Delta native NI8 strain, and two emulsifiers, tween-80 and a starch-based sprayable bioplastic, were evaluated in the field for pathogenicity and infectivity against the tarnished plant bug, (TPB), *Lygus lineolaris* (Palison de Beauvois). The effect on fruit damage based on within-season cotton plant mapping also was evaluated. Plots sprayed with *B. bassiana* showed at least a 2-fold decrease in TBP adults 3-d after treatment compared to control plots. Little or no variations were found in TPB nymph populations between treated and untreated plots, suggesting that *B. bassiana* will not affect early stages of TPB. Within-season plant mapping provided clear evidence of the damage caused by TPB to cotton. The highest percentage retention of all first position fruiting structures was observed in plots treated with NI8+tween-80 (93.41±1.51[SE]) followed by NI8+bioplastic (90.25±1.52[SE]). Both were significantly different when compared with GHA+tween-80 (82.89±2.26[SE]) and GHA+bioplastic (70.48±3.19 [SE]), where both GHA formulations did not differ from water-control (63.61±2.96[SE]). Overall, these results indicated that *B. bassiana* application resulted in >50% decrease survival of TPB regardless of the isolates by direct spray or by contact. However, the superior performance of the Mississippi Delta native strain NI8 was observed in all treatments applications and times of evaluation. The compatibility of bioplastic obtained in all treatments should make this product an attractive alternative to use with native *B. bassiana* for TPB control.

Ants (Hymenoptera: Formicidae) of Mississippi. J. A. MacGown, J. G. Hill, and R. L. Brown

The first faunal surveys of ants in Mississippi were done by Marion Smith from the early 1920's through the early 1930's. Smith made signification contributions to our knowledge of Mississippi's ant fauna by finding many new state records and discovering several new species. As a result of these surveys, Smith reported 136 taxa of ants from Mississippi including 103 species and 33 additional subspecies and varieties. However, since Smith's time there have been numerous taxonomic changes, and the 136 taxa reported by Smith now represent only 108 species. It was not until 2001, when the Mississippi Entomological Museum (MEM) began faunistic surveys for ants in Mississippi, that the ants of Mississippi were revisited. As a result of these recent surveys and other revisional works by various researchers, 191 species (plus the hybrid fire ant *Solenopsis invicta* X *richteri*) in 9 subfamilies and 40 genera are now known to occur in the state. Most of the species in Mississippi are native, with 30 being exotic. Our largest percentage of species are Myrmicinae (56%), followed by Formicinae (24%), Dolichoderinae (6%), Ponerinae (5%), Proceratiinae (3%), Dorylinae (2%), Pseudomyrmicinae (2%), Ectatomminae (1%), and Amblyoponinae (1%).