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Medical and Veterinary Importance of Grasshoppers, Katydids, and Crickets (Hexapoda: Orthoptera)

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INTRODUCTION

Grasshoppers, crickets, and katydids are not usually thought of as potentially hazardous or disease carrying insects. Often abundant in most terrestrial habitats, members of the Orthoptera are considered one of the most important groups of phytophagous insects. Indeed, many members of the group are considered serious pests of row and forage crops, and often are in direct competition with vertebrate grazers. In Africa, Asia, and North America, swarms of grasshoppers, called locusts, cause widespread devastation to crops, often resulting in severe economic losses.

While generally not medically important like some other arthropod groups, members of the order Orthoptera are not entirely innocuous. Most medical harm caused by the Orthoptera is a consequence of direct contact with the insects. Handling of individual orthopterans can result in bites and exposure to noxious defensive chemicals, and large populations of grasshoppers may also indirectly lead to an increase in blister beetle (Meloidae) populations and swarms of locusts can be responsible for allergic reactions and aggravation of asthma, as well as mechanical transmission of disease agents like cholera (Showler 1996). In addition, orthopterans may cause harm by serving as intermediate hosts for nematodes and several species of tapeworms and as possible reservoirs and vectors of vesicular stomatitis virus (Nunamaker et al. 2003). Table 1 is a comprehensive listing of the ailments caused by members of the Orthoptera.

Taxonomy

Insects in the order Orthoptera are characterized by having long hind legs modified for jumping. If winged, the forewings are coriaceous and cover the hind wings and abdomen when at rest and spread out in front of the hind wings when in flight. Orthopterans have mandibulate mouthparts and single segmented cerci. The Order Orthoptera is divided into two extant suborders, Caelifera and Ensifera. The Caelifera; commonly referred to as grasshoppers, grouse locusts or pygmy grasshoppers, and pygmy mole crickets; are characterized by having antennae shorter than the body, short ovipositors, and tympana on the thorax. Members of the Ensifera,

commonly referred to as crickets and katydids, are characterized by having antennae longer than the body, a long ovipositor, and tympana located on the forelegs.

Table 1. Summary of Orthoptera of Medical Importance	
Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Hexapoda
Order:	Orthoptera
Suborder:	Ensifera
Family:	Anostostomatidae
	Weta (several genera and species) - painful bites
Family:	Tettigoniidae
Subfamily:	Dectinae
	<i>Atlanticus</i> spp. - especially aggressive biters
Family:	Rhaphidophoridae
Subfamily:	Ceuthophilinae
	<i>Ceuthophilus</i> sp. - carrion feeding
Suborder:	Caelifera
Family:	Romaleidae
	<i>Romalea microptera</i> (Beauvois) - excretion of chemicals
	<i>Taeniopoda eques</i> - carrion feeding
Family:	Acrididae
Subfamily:	Gomphocerinae
	<i>Dichromorpha viridis</i> - Intermediate host of <i>Choanotaenia infundibulum</i>
Subfamily:	Cyrtacanthacridinae
	<i>Schistocerca americana</i> - carrion feeding
	<i>Schistocerca gregaria</i> - large swarms lead to outbreaks of allergies, asthma, and cholera. Wool feeding
Subfamily:	Melanoplinae
	<i>Melanoplus femurrubrum</i> - Intermediate host of the avian tapeworms (<i>Choanotaenia infundibulum</i> and <i>Tetrameres americana</i>)
	<i>Melanoplus sanguinipes</i> - possible reservoir and vector of vesicular stomatitis Virus

Biting

Perhaps the most overt consequence of direct interaction with orthopterans is the resulting defensive measures the insects take to escape a threatening situation. One such tactic employed by some orthopterans is using their powerful mandibles to inflict painful bites. In addition, some grasshoppers are capable of releasing noxious defensive chemicals to escape harm.

Members of the Orthoptera are primarily herbivorous; however, some are omnivorous while others are predaceous. As such, orthopterans are endowed with powerful mandibles for cutting and chewing plant and animal tissue. When captured, many species will immediately try to bite and often regurgitate a dark brown liquid. The bite, depending on the species, can be quite painful. A prime example is the wetas of New Zealand, which seldom bite, but are capable of drawing blood when they do (Salmon 1956). Another example is that of the North American katydid species *Atlantius gibbosus* Scudder of which Rehn and Hebard (1907) state: "It possesses greater strength in the jaws than any other North American Orthopteran insect known to us. A single bite can easily pierce the cuticle and cause blood to flow. In consequence the field collector quickly acquires a wholesome respect for their defensive abilities." When handling Orthopteran insects, particularly large species, it is best to hold them by the thorax and/or pronotum with the thumb and forefinger, as some species are capable of articulating their head to deliver a powerful bite. Many orthopteran insects regurgitate a brown liquid when they bite. The brown regurgitant is relatively harmless to humans, and can be easily washed off with soap and water; however if the regurgitant enters skin through the bite wound or a cut, mild irritation may result. Freeman (1968) demonstrated that as little as 2 μ l of *Locusta migratoria* L. regurgitant caused immediate distress when applied to the eyes of vertebrates. Jones et al. (1984) isolated *Listeria monocytogenes* (E. Murray et al.) Pirie from a bite wound on a cat that was inflicted by the common tree weta, *Hemideina crassidens* (Blanchard). Transmission of *Listeria* by the weta could not be verified, but it was suspected that the wound at least provided the *Listeria* a pathway for infection.

Chemical Defenses/Secretions

Specific glandular chemical defenses (not irritating regurgitants) are relatively rare in the Orthoptera, having evolved in just three separate grasshopper taxa, namely the Old World, Pyrgomorphidae and two species of the New World Romaleidae (Whitman 1990). Pyrgomorphid grasshoppers possess mid-dorsal abdominal glands that expel an odorous milky secretion that varies in content between species. Predators attacking these grasshoppers

are often wetted about the head by successive secretory salvos of this odorous and distasteful fluid (Whitman 1990). Several species of this family are apparently so repugnant that birds and reptiles will not eat them; spiders will cut them out of their webs, and army ants reject them (Fishelson 1960, Chapman and Page 1979). Predators that ignore these chemical warnings and consume the grasshoppers often become listless or timid, vomit and acquire a strong food aversion conditioning against future consumption of these grasshoppers. There are a few reports of guinea fowl and at least one human child dying after eating members of the Pyrgomorphidae (Descamps and Wintrebert, 1966, and Steyn 1962, Whitman 1990).

Grasshoppers in the family Romaleidae, commonly called lubbers, are capable of audibly discharging a repellent defensive secretion from modified metathoracic spiracles (Whitman et al. 1991). In the eastern lubber grasshopper, *Romalea microptera* (Beauvois), the secretion contains a mixture of chemicals such as various phenols and quinones, plant derived allomones, and the sesquiterpenoid, romallenone, but the exact mixture of these chemicals is variable among individuals (Jones et al. 1985, Whitman et al. 1992). This variability is due to the grasshoppers sequestering secondary plant chemicals, thus individuals eating different plants will (accordingly) sequester different chemicals. Interestingly, the ability to secrete defensive chemicals has apparently freed members of the Pyrgomorphidae and Romaleidae from significant vertebrate predation. This has allowed these families to develop large body sizes (ie. vertebrate predation selects against large size in insects), which in turn liberated them from significant invertebrate predation (Whitman and Vincet 2008).

Inhalent Allergies

Large populations of arthropods are often implicated as sources of significant allergens. Humans and other animals may become sensitized to proteins from cast skins, excrement, scales, and setae from caddis flies, may flies, cockroaches, and certain moths. The roles of dust mites and cockroaches in this phenomenon, in particular, have been well documented. In 2003, a plague of locusts was blamed for an epidemic of allergic attacks and asthma related illness in Sudan. At least 11 people died and thousands were hospitalized with what Sudanese officials called "lung eczema" (Bhattacharya 2003). In this case, a mating pheromone released by locusts was implicated, which purportedly has a strong effect on people with asthma. However, the effects of locusts on the local environment may have also been a factor, since after the locust swarms, the local vegetation was devastated resulting in increased airborne dust (Bhattacharya 2003). Given the known allergic effects of

various arthropod proteins on humans, it would not be surprising if body parts and excrement from thousands of grasshoppers could also cause respiratory problems.

Mechanical Transmission Of Disease Agents

Insects of all shapes and sizes from many diverse groups – even orthopterans – may occasionally be involved in mechanical transmission of disease agents. In Africa, locust plagues have been blamed for epidemics of cholera due to the massive quantities of decomposing locust carcasses that accumulate on beaches after swarms flew out over the ocean and drowned (Showler 1996). The cause of cholera is the bacterium *Vibrio cholera* Pacini, which naturally occurs in coastal waters. The bacteria attach to tiny crustaceans called copepods. These copepods feed on certain types of algae, whose growth may drastically increase due to nutrient influx resulting from decaying grasshopper corpses, thus more algae means more copepods and more cholera bacteria. Humans often become infected with cholera bacteria by eating raw or undercooked shellfish. Shellfish are filter feeders and thus concentrate the bacteria. Vesicular stomatitis virus is an important pathogen of livestock and is transmittable to humans and wildlife, perhaps mechanically by insects (Nunamaker et al. 2003, Rutledge and Gupta 2009). The disease is devastating in animals, producing vesicular lesions on the mouth, teats, and coronary bands, but in humans, it is often self-limiting, only producing fever, chills, and myalgia (Nunamaker et al. 2003, Rutledge and Gupta 2009). The transmission of vesicular stomatitis is poorly understood in nature, but it has been isolated from both biting and non-biting flies (Rutledge and Gupta 2009). Recently, it has been

hypothesized that the grasshopper *Melanoplus sanguinipes* (Stal) may become infected with the virus by ingesting grass contaminated by the fluids of infected cattle. Then cycle of transmission may be completed when uninfected cattle ingest the infected grasshoppers (Nunamaker et al. 2003, Rutledge and Gupta 2009). Humans may contract vesicular stomatitis by exposure to fluids and tissues of infected animals.

Opportunistic Carrion Feeding And Possible Disease Transmission

Many grasshopper species are actually omnivorous, and will opportunistically feed on a wide range of organic matter. The grasshoppers *Schistocera americana* (Drury) and *Taeniopoda eques* (Burmeister) have been observed feeding on mammal carrion (Hill 2007, Whitman and Richardson 2010) and a camel cricket belonging to the genus *Ceuthophilus* (Rhaphidophroidae) has been observed feeding on a dead toad (Fig 1) (JGH Pers. Obs). Whitman and Richardson (2010) also observed four adult female *T. eques* consuming a dead conspecific. In addition, orthopterans have been documented feeding on the feces of vertebrate and invertebrate organisms and this could lead to mechanical disease transmission (O'Neill 1985, Whitman and Orsak 1985, Bright et al. 1994, and O'Neill 1997). O'Neill (1985) observed grasshoppers burrowing into dried feces in closely grazed pastures for use as thermal refugia and then consuming the feces while inside. Interestingly, although rare in occurrence, *S. gregaria* has been observed consuming wool from the bodies of live sheep. (Husain and Mathur, 1936).



Figure 1. *Ceuthophilus* sp. feeding on recently deceased toad in Tennessee.

Parasitic Associations

The deleterious outcomes of interactions with members of the order Orthoptera are not limited to direct effects on vertebrate health. Some grasshopper species are known to serve as intermediate hosts of several avian parasites, and grasshoppers and crickets are intermediate host of horse-hair worms, of which several species have been reported as accidentally infesting humans (Cram 1931, 1932, 1937; Horsfall, and Jones 1937; Helfer 1972, McDougald 2003, Fink et al. 2005). The spiruid nematode, *Tetrameres americana* (Cram), is a common parasite of free-range chickens and other gallinaceous birds (Fink et al. 2005). The North American grasshopper species *Melanoplus femurrubrum* (DeGeer), *M. differentialis* (Thomas), and the Caribbean and South American species *Rhammatocercus cyanipes* (F.) are known to serve as natural vectors of *T. americana*, while the migratory locust, *Locusta migratoria* (L.), an African species has been experimentally infected with the nematode (Cram 1931, 1932, 1937; Fink et al. 2005). Eggs of *T. americana* are passed with the feces of the avian host, and are then ingested by the intermediate grasshopper host. The nematode larvae become infective after 42 days of entering the grasshopper and are found in all parts of the body. Infection of the avian host occurs when the birds eat the grasshopper or parts of it, whereupon larvae escape and infect the bird, the final host. Heavy infections of *T. americana* may cause anemia and weight loss (Mollhagen 1991). Many insects, including the grasshoppers *Dichromophus viridis* Scudder and *M. femurrubrum*, serve as intermediate hosts of the cosmopolitan poultry tapeworm, *Choanotaenia infundibulum* (Bloch) (Horsfall, and Jones 1937). Various species of *Melanoplus* as well as *Chorthippus longicornis*, and *Paroxya clavuliger* may serve as intermediate hosts of the tapeworm *Metroliasthes lucida* (Ransom), which is a parasite of turkeys and guinea fowl (Helfer 1972 and McDougald 2003).

Horse-hair worms (Gordiaceae) develop as parasites in the bodies of grasshoppers and crickets. When mature, these worms leave the host body to lay eggs in water. Ordinarily these worms are not medically important, as they are not parasites of vertebrates. However, there have been incidences where humans accidentally consumed them. In most of these cases the worms were vomited up shortly after being ingested, although in a few cases, the worms apparently survived in the intestines for several months before being expelled (Ransom 1921).

Population Booms And Blister Beetle Outbreaks

Less obvious problems associated with the Orthoptera are correlated with population booms and swarms of

grasshoppers. Large populations of grasshoppers may lead to a corresponding increase in medically important blister beetle (Meloidae) populations since the larvae of blister beetles prey on the eggs of grasshoppers. Grasshoppers experience population booms that are typically tied to weather conditions and food supplies. These troublesome outbreaks are primarily problematic for agricultural workers and livestock owners, not only due to the direct effects of their phytophagous nature, but also from the related population rise of blister beetles (Meloidae), larvae of which predate the eggs of grasshoppers. The body fluids of blister beetles contain the terpene, cantharadin, a substance that often causes blisters when applied to the skin, and can cause illness and even death in livestock when adult beetles are consumed. When exposed to skin, the body fluids cause blisters that may last 24 hours, which may be accompanied by tingling or burning sensations. These may progress into vesicular dermatitis with itching and oozing lesions (Krinsky 2009). Agricultural laborers working among crops, or other people who frequent areas infested with blister beetles, are at higher risk of coming in contact with the beetles.

CONCLUSIONS

Generally, members of the Orthoptera have not been typically thought of as medically important insects. However, given the various ailments directly or indirectly associated with orthopterans discussed here, maybe that view should be reconsidered.

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Quality Assurance Of Weather Parameters For Determining Daily Evapotranspiration In The Humid Growing Environment Of The Mid-South

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ABSTRACT

Producers increasingly rely on irrigation to enhance yields and improve return on investment. The greater demand for ground water to support irrigation in the Mississippi River Alluvial Flood Plain has resulted in a decline in the aquifer, and a subsequent implementation of more stringent regulations for well permits. Given the concerns of ground water depletion, producers can clearly benefit from a tool that would indicate when they need to irrigate and how much. However, no easy to use irrigation scheduling tools have been developed and calibrated for the humid, high-rainfall environment of Mississippi. Researchers at USDA-ARS and Mississippi State University are developing a daily irrigation scheduling tool that calculates reference evapotranspiration (ET) from weather data to establish a crop water balance which will indicate when irrigation is needed. The weather parameters required for the calculation of ET include temperature, vapor pressure (determined from relative humidity and temperature), wind, and solar radiation. Rainfall and irrigation are also needed to track water balance in the field. Accurate determination of ET requires weather data that are consistent, accurate, and reliable. Errors in archived weather records are introduced from several sources, including sensor limitations and failures, instrument siting and deployment issues, lack of timely cleaning or re-calibration of instruments, data logger failures or programming errors, data transmission problems, and human errors. Further errors in the calculation of ET can result from mixing units in the calculations (e.g, degrees Fahrenheit and Centigrade), incorrectly converting units, or failing to adjust wind measurements to a common height. Since the archived data has not undergone any systematic assessment of data quality, potential users must conduct their own rigorous quality assurance before using the data to calculate ET. The research described here identifies common sources of errors in the available Mississippi weather station data, and develops statistical and range limit tests to identify erroneous records. Such quality assessment and control procedures are essential to ensure that values produced by the daily irrigation scheduling tool are reasonable and useful for decision support. The protocols described here will establish accurate data needed for calculation of reference crop ET for irrigation scheduling and crop management. Developing technologies to manage agricultural water resources of the humid Mid-South United States will provide means for agricultural producers to increase water use efficiency and mitigate ground water depletion.

INTRODUCTION

There is a growing and substantial need for water management technologies for crop production in humid areas. Historically, humid regions have had plentiful ground water resources and rainfall with some locations receiving precipitation in excess of 100 cm (40 inches) per year. While rain-fed agriculture has been profitable in the past, yields and profits from non-irrigated crops are typically lower than for irrigated fields (Wesley et al., 1993; Pringle and Martin, 2003; Balkcom et al., 2007). Increasing economic risks have enhanced the reliance on supplemental irrigation to secure adequate yields and reduce production risks (Gollenhon and Quinby, 2006; Vories and Evett, 2010). Irrigated acres have increased steadily for nearly all farm sizes over the past 15 years, resulting in nearly one-fourth of all Mississippi farms being irrigated (NASS, 2009).

Increasing use of agricultural irrigation, particularly in the Mississippi Delta, has resulted in extensive drawdown of the alluvial aquifer. As a result, implementation of water conservation measures for permits on new wells is required (YMD, 2010). Beginning in January, 2011, new and renewal well permit applications require implementation of water conservation measures or permission to withdraw water may be terminated. One acceptable water conservation measure is documented use of an irrigation scheduling program.

Water management practices and irrigation scheduling tools have been extensively developed for arid regions in response to water shortages. While some of these tools and practices are relevant to humid areas, most have not been developed and calibrated for the unique environmental conditions and crops in the area. As a result, methods of scheduling irrigation based on crop water use have not been used regularly in Mississippi.

Many methods have been developed to determine crop water use for scheduling irrigation. Direct measurements rely on sensors placed in the soil or on the plant to track soil or crop water status through the growing season. This requires calibration, installation, and regular maintenance of the instrumentation followed by downloading and interpretation of the information by the end-user. Alternatively, crop water use can be estimated from calculations of reference evapotranspiration (ET) from weather parameters. The reference ET calculated from weather data is then adjusted for the specific crop of interest with a crop coefficient. As an example, the Arkansas Scheduler has been developed for humid growing conditions, using regressions from daily climatic data at six locations throughout the Mid-South to estimate ET from maximum temperature (Vories and Tacker, 2006). The Arkansas Scheduler has been used for more than twenty years, but requires users to input data and perform model runs to track crop water use for irrigation scheduling, limiting its utility for many producers.

Several algorithms have been developed to estimate ET from weather parameters. The modified Penman-Montieth (MPM) has been established as the standard equation for calculating ET from weather parameters for estimation of crop water use (Allen et al., 1998; ASCE-EWRI, 2004). This robust algorithm requires inputs of air temperature, vapor pressure, solar radiation, and wind speed.

Researchers at the USDA Agricultural Research Service and Mississippi State University have developed a daily irrigation scheduling tool for Mississippi crop producers based on the modified Penman-Montieth algorithm. In order to apply this algorithm, accurate, reliable, and complete weather data for each irrigation site is needed (Allen, 1996).

Weather networks and quality assurance procedures have been established in other states for collecting and quality assuring weather data for agricultural production (Shafer et al., 2000; Fiebrich et al., 2010). These procedures consist of a series of checks and tests to insure that sensor readings are consistent, reliable and accurate. Because each sensor responds to climatic conditions and degrades in a different fashion, separate procedures are required for the different sensors. The automated assurance procedures flag potentially erroneous entries, which are then further checked by meteorologists. The net result is an accurate and detailed record of daily climatological conditions that can be used for multiple purposes.

The Delta Research and Extension Center of Mississippi State University in Stoneville, MS has been collecting weather data since the early 1900's (DAWC,

2011). As sensor technologies advanced, additional climatological parameters were measured and weather stations were installed in more locations. The weather information has been used for tracking crop growth and maturity (growing degree days, e.g. DD50's, DD60's; Pringle and Ebelhar, 2009), modeling and decision support tools for agricultural crop production (e.g. Gossym/Comax; McKinion et al., 1989), and management of natural resources (e.g. AnnAGNPS; Bosch et al., 1998). The USDA NRCS has also implemented a series of weather stations throughout Mississippi through their Soil Climate Atmosphere Network (Hu et al., 2002; NRCS, 2012). However, there has not been a systematic, published assessment of the entire DAWC or SCAN data set gathered in Mississippi to determine if the available weather data is of sufficient quality and continuity to support accurate calculations of ET using the MPM algorithm.

The research reported here describes the weather data available in Mississippi for use in agricultural decision support tools, in particular the MPM calculations of ET; assesses the availability, consistency, reliability, and accuracy of the reported data; and delineates the most critical and accurate measurements that are needed. Establishment of quality control and quality assurance procedures for measuring and processing weather data is a necessary preliminary step, and will contribute substantially to agricultural production and water management.

METHODS

Data Sources

Historical weather data was downloaded from the Delta Agricultural Weather Center (DAWC, 2011) and the NRCS SCAN web site (NRCS, 2012) for weather stations located throughout the state (Figure 1). Standard procedures have been developed for establishing mesoscale weather collection networks, and for assessing data quality (Allen, 1996; Fiebrich et al., 2010). However, the process of quality assuring weather and climate data is an expensive and laborious process, requiring not only continuously running algorithms to flag suspicious or missing data, but frequent critical assessment by scientists familiar with the phenomenology, sensors, networks, and IT aspects of weather and climate data archives. Costs are significant and ongoing, and very few funding agencies are willing to support data quality assurance or even data archival efforts. Consequently, with the exception of a few research networks (e.g., the Oklahoma Mesonet, and the Department of Energy's ARM/CART sites), data quality assurance is not conducted routinely. It is a safe assumption that the majority of weather and climate data

available via internet has not been quality assured. This state of affairs is well known within the weather and climate communities, and initial data quality assurance is a necessary preliminary step for all research and development. Unfortunately, other research communities that are now seeking out weather and climate data are often not aware of the potential problems, and too often erroneous data is used with bad results.

Proper site selection is a critical aspect of network creation to ensure representative weather data. The weather stations installed and maintained by the DAWC and NRCS are all located in agricultural areas, most with minimal neighboring disturbance that would interfere with sensor readings. The sensors used are standard meteorological instruments and the stations are maintained and sensors calibrated regularly. A metadata analysis of the recorded data was performed using Excel to establish the integrity of each data set by station and year. All recorded entries were counted and the percent of data entries recorded were determined for each year.

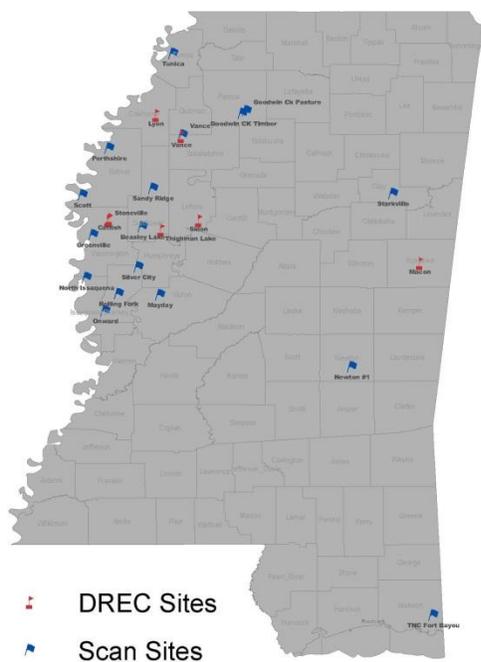


Figure 1. Map of locations of DREC-MSU Delta Agricultural Weather Center and the NRCS Soil Climate Atmosphere Network stations in Mississippi.

Data Checking

Following the initial tests for data availability, quality

assurance tests were performed on daily data from all years and all locations to assess data consistency and reliability (following Fiebrich et al., 2010). These include a sensor range test, climate range test, step (spike or dip) test and persistence test, which flagged potentially incorrect values. Thirty-one years of data from Stoneville were used as the standard, as this weather station has received the longest and most extensive sensor calibration and quality control efforts. Maximum and minimum values, standard deviation, and coefficient of variation were determined for all measured data. Erroneous data were determined as that outside of the physically acceptable ranges. The flagged values were manually inspected and erroneous data removed based on established ranges or statistical deviation from normal. Once climate range limitations were identified for the Stoneville location, these were used as a baseline to correct the data from other stations.

Identification of steps (spikes or dips) in the data was performed by taking the difference between the current reading and the reading on the preceding day. Readings that exceeded one standard deviation were eliminated (Hubbard et al., 2005). Maximum and minimum differences between consecutive days were averaged across all years for each sensor and used for the maximum and minimum limits of the step test. The Stoneville location was used as the standard, averaging across the thirty-one years of data for temperature, wind speed, and solar radiation. Fifteen years of data were used for the relative humidity test. The temporal variability of rainfall (i.e., air always has a temperature, but most days are rain-free) precluded development of a step test function for rainfall data.

The revised records were then recounted to determine the percentage of days of data available at each location. Climate range tests were established for each location from the corrected data. These climate range tests will be used in quality assurance of future weather for estimation of crop reference ET with the irrigation scheduling tool

RESULTS

Weather Data Sources

The Weather Center in Stoneville has historical weather data on precipitation dating back to 1915 (Pringle and Ebelhar, 2009; DAWC, 2012). In 1930, addition of temperature measurements allowed determination of DD50 and DD60 for plant growth tracking. In 1959, soil temperature, wind speed, solar radiation, and pan evaporation were added, although pan evaporation, recorded manually, was only measured during the growing season. Relative humidity measurements were begun in 1996. The Delta Agricultural Weather Center supports eight weather stations that are automatically

downloaded to the station and upload through the MSUCares webpage for public use (Figure 1). All sensors are maintained, cleaned, and calibrated yearly or as needed. Because the information is used by crop producers, all recordings are reported in English units of measure. We have continued that convention here for consistency.

Additionally, the Center assists personnel from NRCS in maintaining the NRCS SCAN weather stations. In 1991, the Natural Resources Conservation Service (NRCS) established the Soil Climate Analysis Network (SCAN) to provide nationwide assessment of soil and climate information (NRCS, 2012). The data are used to support natural resource assessments and conservation activities, primarily concentrated in agricultural areas. In Mississippi, the NRCS maintains 15 SCAN weather stations, fourteen of which are still active (Figure 1). The SCAN stations use the same sensor technologies as the DAWC weather stations.

Most of the agricultural production in Mississippi is in the alluvial flood plain colloquially referred to as the Delta. The rich, alluvial soils of this region and flat topography make it ideal for crop production. Production in the region relies on the relatively shallow alluvial aquifer for ground water resources for agricultural irrigation. Most of the well permits in the state are located in the Delta region (Wax et al., 2009). The extensive agricultural activities concentrated in the Delta have led to the establishment of most of the weather stations in this region of the state as well.

The current weather stations use data loggers and sensors from Campbell Scientific (Logan, UT). Data loggers (CR10X) take measurements every 2 seconds. Rainfall and solar radiation are summed hourly; temperature and relative humidity are averaged hourly. Rain gauges record each tip of the “bucket”, an increment of 0.01”. Data are then summarized or averaged daily, and reported on the website. Hourly information is available on the SCAN sites, and for the DAWC stations by request. Temperature and relative humidity are measured with a Vaisala HMP45C in a solar radiation shield (Table 1). The temperature sensor is a platinum resistance temperature detector and can be reported in either degrees Fahrenheit or Centigrade. The relative humidity sensor is

a HUMICAPR 180 capacitance relative humidity sensor, and is reported as percent relative humidity. Wind speed is measured with a 3-cup anemometer; a wind vane records wind direction (03002 Wind Sentry Set). Prior to March 21, 1997, wind speed was reported in knots. Currently, total wind run per day is measured in miles per hour and reported in miles per day. Hourly wind data is reported as miles per hour. Wind speed is measured in 15 min increments at certain sites for use in estimating agricultural chemical drift information for aerial applicators. Rainfall is measured using TE525 Texas Electronics tipping bucket rain gauges with a 6” orifice. Rainfall is recorded in hundredths of an inch or millimeters, depending on the station, and summed for each day (Table 2). A silicon photovoltaic detector mounted in a cosine-corrected head (LI200X) is used to record total incoming solar radiation, and reported in total Langley’s/day. The pyranometer is calibrated for the daylight spectrum (400 to 1100 nm). By positioning the sensor to view the entire sky, the instrument measures incoming direct solar radiation and diffuse sky (solar) radiation.

For establishing the procedures to determine reference crop evapotranspiration with the MPM, the datasets must be robust. For the purposes of irrigation scheduling, robust data sets contain accurate daily climatic information from all of the parameters needed in the calculation: maximum and minimum temperature, vapor pressure deficit (can be measured directly, or calculated from temperature and relative humidity), wind speed, and solar radiation (Table 2). Precipitation and irrigation is not needed in the MPM, but is essential to track water balance in the field. Of the required parameters, the most common parameter not recorded is relative humidity (Table 2). Several of the SCAN stations also do not report solar radiation. The DAWC stations generally have the most complete and robust historical data records, but several of the SCAN sites also have lengthy and reasonably complete records. Additional SCAN sites have been added recently in agricultural areas near Mayday, North Issaquena, Onward, Perthshire, Sandy Ridge, Starkville, Scott, Silver City and Tunica. While these have fewer than 10 years of historical records, they will be useful in establishing climatic variables for crop management.

Table 1. Summary of weather station details for the DREC-MSU Delta Agricultural Weather Center and the NRCS Soil Climate Atmosphere Network stations.

Weather Station DAWC-AMS	Location			Location Description	Start Date	End Date	Years Reported
	Latitude	Longitude	Elevation				
Catfish (Stoneville)	33° 27'	-90° 54'	121'	grass, catfish pond	9/14/1996	present	14
Lyon	34° 13'	-90° 33'	172'	grass, ag field	5/11/1997	present	13
Macon	33° 7'	-90° 34'	178'	grass, ag field	9/29/2001	present	8
Sidon	33° 25'	-90° 14'	123'	grass, ag field	8/19/1998	present	12
Stoneville	33° 26'	-90° 55'	127'	grass, ag field	1/1/1996	present	15
Stoneville	33° 26'	-90° 55'	127'	grass, ag field	1/1/1980	12/31/1995	16
Thighman Lake	33° 21'	-90° 30'	115'	grass, ag field	3/6/1998	present	13
Tribbett	33° 21'	-90° 48'	118'	grass, ag field	4/23/2001	present	10
Verona	33° 12'	-90° 43'	321'	grass, ag field	7/26/2000	present	10
Weather Station NRCS SCAN	Location			Location Description	Start Date	End Date	Years Reported
	Latitude	Longitude	Elevation				
Beasley Lake	33° 23'	-90° 39'	115'	grass, ag field	9/20/1999	present	11
Goodwin Creek Pasture	34° 15'	-89° 52'	320'	grass	1/27/1999	present	9
Goodwin Creek Timber	34° 14'	-89° 54'	320'	grass, near trees	1/29/1999	present	11
Mayday	32° 52'	-90° 31'	108'	grass, ag field	9/23/2005	5/10/2011	5
Newton	32° 20'	-89° 05'	300'	grass, ag field	1/1/1997	7/7/2003	4
North Issaquena	32° 60'	-91° 4'	112'	grass, ag field	2/10/2004	present	6
Onward	32° 45'	-90° 57'	100'	grass, ag field	11/4/1997	present	9
Perthshire	33° 58'	-90° 54'	200'	grass, ag field	4/18/2002	5/6/2011	8
Sandy Ridge	33° 40'	-90° 34'	138'	grass, ag field	9/24/2005	present	5
Scott	33° 37'	-91° 6'	165'	grass, ag field	8/14/2002	4/5/2011	8
Silver City	33° 5'	-90° 31'	115'	grass, ag field	2/10/2004	present	7
Starkville	33° 28'	-88° 47'	340'	grass, ag field	4/21/2002	4/26/2011	9
TNC Fort Bayou	30° 28'	-88° 44'	43'	grass, near trees	1/1/2004	present	7
Tunica	34° 41'	-90° 25'	260'	grass, edge of field	9/17/1999	present	9
Vance	34° 4'	-90° 21'	150'	grass, ag field	9/18/1999	present	11

Table 2. Summary of station sensors used, degrees reported, and complete years' data available. Height of wind sensor is recorded in m. Summary of station sensors used, units reported, and number of years of complete data in the archive. Height of wind sensors is reported because all wind data will need to be normalized to a reference height.

Weather Station DAWC-AMS	Parameter							
	Air Temperature		Relative Humidity (%)	Precipitation (inches-day ⁻¹)	Wind Speed			Solar Radiation (Langley-day ⁻¹)
	HMP45C			tipping bucket	3-cup anemometer			pyranometer
	Years	Units	Years	Years	Years	Sensor Height (m)	Units	Years
Catfish (Stoneville)	14	⁰ F	14	12	14	2.13	miles/day	14
Lyon	14	⁰ F	9	14	14	1.68	miles/day	14
Macon	8	⁰ F	8	8	8	3.00	miles/day	8
Sidon	11	⁰ F	10	11	11	2.74	miles/day	11
Stoneville, 1996 - present	15	⁰ F	15	15	15	2.0 & 10.0	miles/day	15
Stoneville, 1980 - 1995	16	⁰ F	16	16	16	2.0 & 10.0	miles/day	16
Thighman Lake	12	⁰ F	11	12	12	3.26	miles/day	12
Tribbett	9	⁰ F	9	9	9	3.29	miles/day	9
Verona	10	⁰ F	9	10	10	1.74	miles/day	10
Weather Station NRCS SCAN	Parameter							
	Air Temperature		Relative Humidity (%)	Precipitation (inches-day ⁻¹)	Wind Speed			Solar Radiation (Langley-day ⁻¹)
	HMP45C			tipping bucket	3-cup anemometer			pyranometer
	Years	Units	Years	Years	Years	Sensor Height (m)	Units	Years
Beasley Lake	11	⁰ F	11	11	9	2.93	miles/day	9
Goodwin Creek Pasture	8	⁰ C	NA	6	8	3.68	avg mph	NA
Goodwin Creek Timber	11	⁰ C	NA	5	10	3.68	avg mph	NA
Mayday	5	⁰ F	5	5	5	3.00	miles/day	5
Newton	6	⁰ C	NA	3*	NA	NA	NA	NA
North Issaquena	7	⁰ F	7	7	7	2.87	miles/day	7
Onward	9	⁰ F	9	9	8	3.00	miles/day	9
Perthshire	9	⁰ F	9	9	9	3.28	miles/day	9
Sandy Ridge	5	⁰ F	5	5	5	3.07	miles/day	5
Scott	8	⁰ C	8	8	8	2.93	miles/day	8
Silver City	7	⁰ F	7	7	7	2.90	miles/day	7
Starkville	9	⁰ F	9	9	8	2.84	miles/day	9
TNC Fort Bayou	6	⁰ C	NA	6	6	3.25 & 8.23	avg mph	NA
Tunica (1999-2004)	4	⁰ C	5	5	3	2.74	miles/day	3
Tunica (2005 - present)	5	⁰ F	5	4	5	2.74	miles/day	5
Vance	11	⁰ F	11	11	9	2.74	miles/day	9

* Newton reports precipitation accumulated since first day of year.
 Stoneville began reporting relative humidity in 1996.
 Tunica changed from reporting temperature in Centigrade in 2004.

Identification and Elimination of Erroneous Entries

Error checking of the reported weather data is critical to identify erroneous data. However, care must be taken to prevent the elimination of good readings due to incorrect identification of extreme values as erroneous (Hubbard et al., 2005).

To quickly identify potential problems in data records, the number of entries recorded were counted and averaged across all years for each location (Table 3 & 4). Duplicate daily data entries were apparent from recorded counts in excess of 365 (or 366 in leap years) resulting in recorded percentages in excess of 100% (e.g., at Verona, Newton, and TNC Fort Bayou). A common problem with the SCAN sites was insertion of a duplicate record on September 30. In some years, duplicate daily entries were negated by missing data from other days. To insure removal of all duplicate entries, daily records were checked against calendar days. Another infrequent error occurred when entire blocks of records were duplicated. For example, at the Thighman Lake station, the entire period from May 27 through June 14 was reported twice in 2010. This type of error more likely results from a problem with the downloading and transfer to the web page rather than a system error at the weather station.

The quality assurance procedures outlined in Table 5 quickly correct common errors, such as entries of -99.9 or -6999 commonly entered as flags to indicate faulty or missing sensor readings (Hu et al., 2002). These readings are obviously outside of the range of either the sensor or the climate. The sensor and climate range limit tests identified additional errors such as temperature readings of 257°F. More subtle errors also exist, such as a recorded temperature of 9°F, which is possible but unlikely in Mississippi. Performing a step test on the temperature data from previous and subsequent days indicated that this temperature reading fell outside the acceptable range and it was concluded that the value was erroneous.

When a value is flagged, it is important to examine the entire climatic record for weather patterns that may explain the apparent error. In determining if a particular point measurement is erroneous, it is helpful to determine if the reading fits in with the rest of the weather pattern during that period. The temporal shifts in weather patterns

may account for seemingly high or low readings. For example, a recorded value of RHmin = RHmax = 100% for 11/22/04 at Beasley Lake was flagged as a possible error. Examination of RH values from previous days showed that RHmin values were as low as 39%. However, the entire climatic record showed that rain began four days previously and by November 24th, 1.4 inches of rain had been received. The rain continued for several more days. The reported RHmin of 100% was therefore realistic. Conversely, a high standard deviation flagged an RHmax reported value at the Catfish weather station in 2004. Examination of the record showed that 1.8" of rain had been received the previous day and another inch of rain was received that day. Low solar radiation levels corroborated the rainy weather, indicating that the RHmax = 51% was probably wrong. Closer examination revealed that RHmax dropped abruptly on day 95, and remained low through day 138, even though significant rainfall was received (Figure 2).

Extreme weather events lead to other problems with recorded data. Some of the sensors are susceptible to extreme weather, especially in the humid, high rainfall environment of Mississippi. The relative humidity sensors are particularly error-prone (Table 3 & 4). Rain also interferes with the solar radiation sensor, giving artificially low or high readings. Discrete weather events, such as thunderstorms, can often interrupt all sensors, possibly through electrical activity. Error checking should include a specific component to examine the integrity of all sensors during and after extreme and discrete weather events. If one sensor is reporting erroneous data, it is more likely that other sensors are also reporting incorrect values. Strong storms can interrupt data delivery, either through damage to the sensors, data logger, or the communications equipment. Occasionally, communication between the SCAN master station located in Stoneville, MS (one of only three in the U.S.) and individual SCAN stations is disrupted; for example, the master station has been hit by lightning. This is seen quite dramatically in the 2011 growing season when four weather stations were knocked out of service during severe spring storms (Table 1). The weather station at Mayday also had to be removed because of the flood hazard associated with the rising Mississippi River. These stations are being repaired and brought back on line.

Table 3. Average values over 8 common years (2002-2009) of key statistics from quality controlled weather information available from DAWC weather stations. These 6 stations had the highest percentage of reported data. The other DAWC station in Mississippi (Macon and Tribbett) had insufficient time continuity to be used in this analysis. *Temperature and relative humidity not included for 2009 because of insufficient data during the growing season

Weather Station DAWC-AMS	Catfish (Stoneville)	Lyon	Sidon	Stoneville	Thighman Lake*	Verona
T_{\max} °F	maximum	99	101	101	101	99
	minimum	30	28	32	31	30
	standard deviation	16	17	16	17	16
	% valid readings	99	96	100	100	99
T_{\min} °F	maximum	77	78	76	78	76
	minimum	19	17	20	18	15
	standard deviation	15	16	15	16	16
RH _{Max} Percent	maximum	98	101	100	99	99
	minimum	66	65	66	66	58
	standard deviation	5	6	5	5	6
	% valid readings	98	96	99	98	99
RH _{Min} Percent	maximum	94	99	100	94	93
	minimum	18	16	18	16	15
	standard deviation	16	17	17	17	16
Wind run Miles-day ⁻¹	maximum	426	352	353	335	295
	minimum	39	14	9	15	9
	standard deviation	77	64	70	60	56
	% valid readings	100	97	100	99	100
Sunlight Langley-day ⁻¹	maximum	663	730	672	691	725
	minimum	19	17	21	15	20
	standard deviation	171	189	173	178	183
	% valid readings	100	97	100	100	100
Precipitation inches-day ⁻¹	maximum	4.04	3.13	3.58	4.01	3.23
	minimum	0.00	0.00	0.00	0.00	0.00
	standard deviation	0.40	0.34	0.38	0.42	0.38
	% valid readings	99.66	96.61	99.62	100.00	99.90

Table 4. Average values over 8 common years (2002-2009) of key statistics from quality controlled weather information available from NRCS weather stations in Mississippi. These 4 stations had the highest percentage of reported data. The other NRCS stations in Mississippi (Goodwin Creek (pasture and timber), Mayday, Newton, North Issaquena, Sandy Ridge, Scott, Silver City, TNC Fort Bayou, and Tunica) had insufficient time continuity to be used in this analysis.

Weather Station NRCS SCAN		Beasley Lake	Perthshire	Starkville	Vance
T_{\max} °F	maximum	100	99	98	99
	minimum	30	28	33	28
	standard deviation	16	16	15	16
	% valid readings	99	95	88	96
T_{\min} °F	maximum	76	77	77	76
	minimum	19	18	18	17
	standard deviation	15	15	15	15
RH _{Max} Percent	maximum	100	100	99	99
	minimum	63	61	61	62
	standard deviation	6	6	5	6
	% valid readings	99	95	87	96
RH _{Min} Percent	maximum	95	94	93	93
	minimum	15	16	13	16
	standard deviation	17	17	16	16
Wind run Miles-day ⁻¹	maximum	358	363	254	302
	minimum	19	24	20	22
	standard deviation	69	67	41	52
	% valid readings	99	95	90	96
Sunlight Langley-day ⁻¹	maximum	692	695	672	694
	minimum	19	17	18	17
	standard deviation	177	182	162	176
	% valid readings	97	95	88	96
Precipitation inches-day ⁻¹	maximum	3.27	3.33	4.00	3.49
	minimum	0.00	0.00	0.00	0.00
	standard deviation	0.39	0.39	0.42	0.39
	% valid readings	99.42	94.21	86.92	95.38

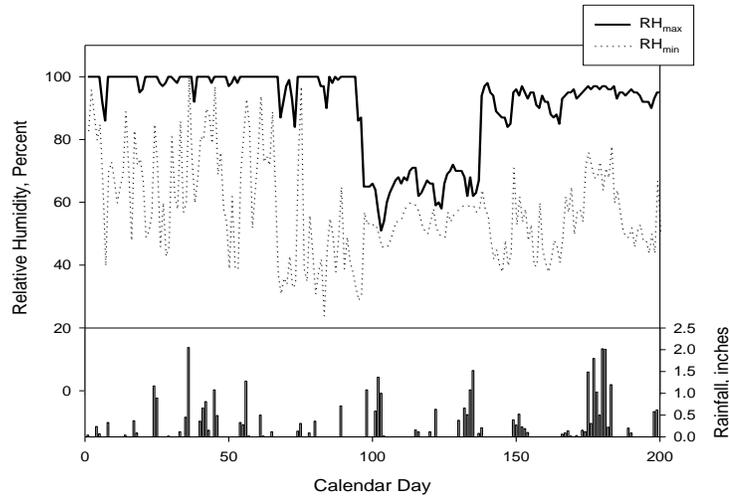


Figure 2. An example of a sensor integrity error (roughly day 95 through 140), possibly the result of storm-related damage to the sensor, data logger, or reporting network.

Instrument error can also result in incorrect readings. Incorrect calibration of a sensor can lead to recording incorrect values (Figure 3). Alternatively, drift in instrument calibration slowly introduces error into the recorded data, making frequent and complete calibration of instrumentation critical. This is particularly important for the relative humidity and solar radiation sensors, which seem most prone to calibration error and drift. To check for accuracy of the solar radiation readings, the recorded solar radiation values were compared to the maximum possible clear-sky values based on latitude and day of year (Figure 4). The solar radiation values recorded in spring and fall that rise slightly above the calculated maximums are the result of increased scattering from intermittent, bright clouds. Long periods of low solar radiation may indicate that the sensor dome has become dirty or clouded, or that the interior of the dome has accumulated moisture (Fiebrich et al., 2010). Degradation of a pyranometer was evident by the declining solar radiation values over several years (Figure 5). After recalibration, however, the solar radiation readings were greater than those possible based on latitude and clear-sky conditions. This could have resulted from improper calibration or positioning of the pyranometer.

Another type of error apparently results from calculation errors in data logger programming (Figure 6).

In this instance, the recorded solar radiation increases ten-fold on 7/14/04 and remains high for several months. The month-to-month trend in the data follows readings expected from the annual change in total sunlight, though at a level ten times that previously recorded. The recorded value falls abruptly after 11/30/2005. An examination of the historical record indicates no sensors recorded during the time period from 11/30/05 – 12/12/05, after which time the correct solar radiation was regained.

Errors that are more difficult to detect can result from poor or improper placement of the weather station. Large trees or other obstructions can shade the radiation sensor, and greatly alter the wind dynamics. These obstructions may be temporary, such as a crop or agricultural implement. Seasonal changes can also greatly impede proper collection of weather data, such as locating a weather station too near an irrigation system, resulting in irrigation water accumulating in the rain gauge and being recorded as precipitation. Human and animal activity near the weather station can also impact weather data collection. One particularly high temperature reading led to the discovery that a neighboring field of wheat stubble had been burned, melting the wind sensor. These errors can best be identified by regular site visits; barring that, continuous application of quality assurance algorithms is the next best line of defense.

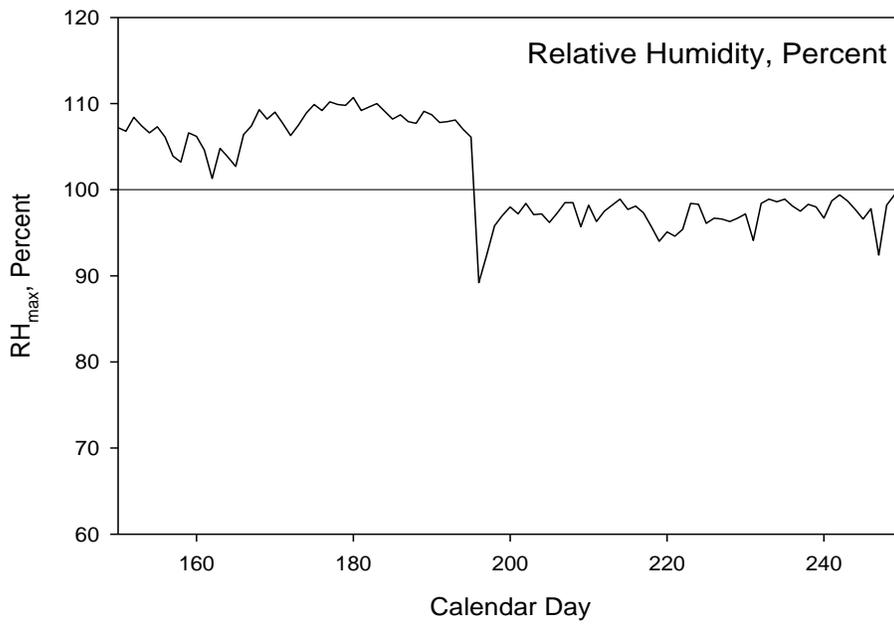


Figure 3. An example of erroneous data before recalibration (day 196) of the humidity sensor

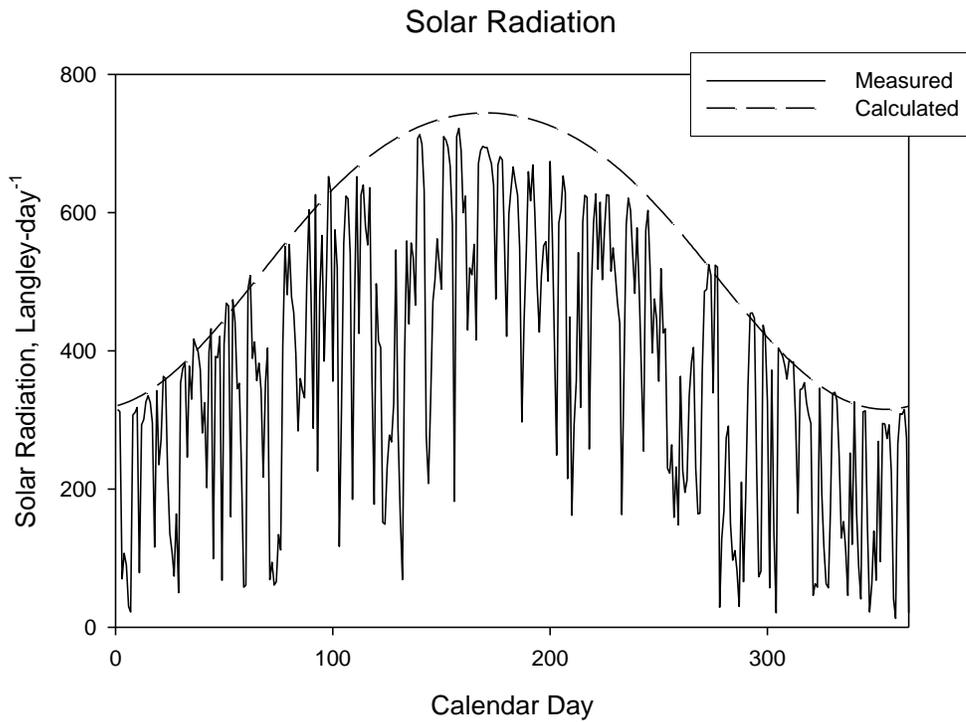


Figure 4. Error checking of solar radiation by comparison of measured solar radiation against maximum clear-sky solar radiation calculated for latitude and time of year.

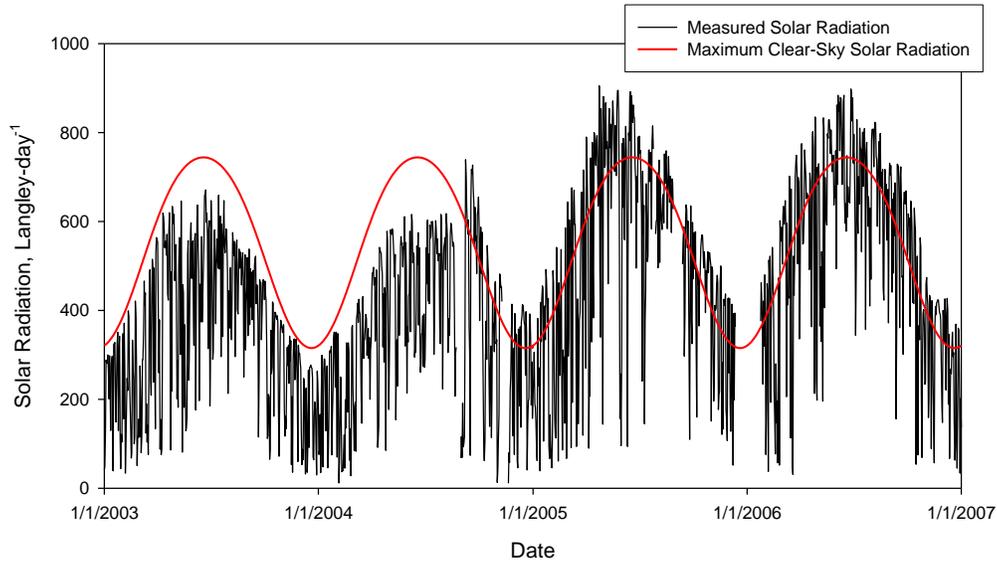


Figure 5. Solar radiation sensor prior to and following recalibration, and maximum clear-sky radiation.

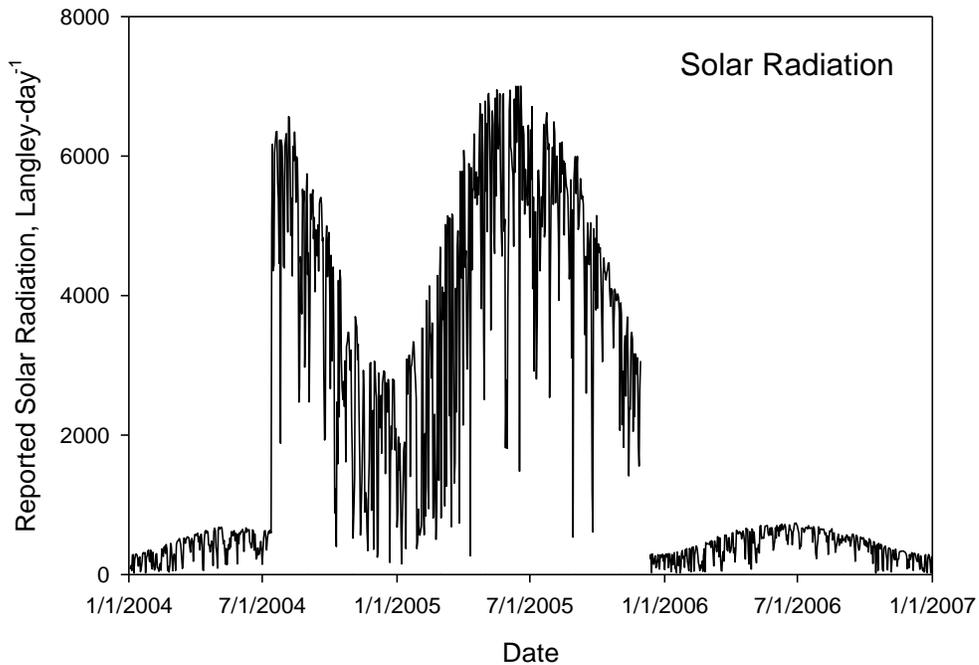


Figure 6. Apparent data logger error of solar radiation multiplication constant

Consistency Checking and Error Correction

After careful examination of all weather records from all sites, erroneous entries were removed based on the statistical variance. Quality assurance tests were then

established by defining the climate range limits and step limits from the extremes in recorded, correct values (Table 5). While broad, the climate range limits give the maximum and minimum values for each of the

parameters. The step limit is the most extreme one-day change observed for a particular value. This limit is used to identify dip or spike records in data. The persistence test identifies when a sensor has stopped responding but is reporting a value within acceptable range without varying.

After correction, the station parameters were recounted for completeness and counts averaged over all complete years of data available (Tables 3 and 4). The most complete and robust data sets have been recorded at the DAWC weather stations. While less complete, the agriculturally based SCAN sites will also be useful in providing weather parameters for calculating the reference crop evapotranspiration.

Additional rules are suggested to improve the error-checking process:

- RH_{\min} must be $< RH_{\max}$
- T_{\min} must be $< T_{\max}$

- If there is evidence that a measurement from a sensor is bad on a particular day, all other measurements from that sensor on that day are discarded.
- If a sensor records more than a threshold number of days of erroneous data, all subsequent data from that sensor should be flagged until the sensor is checked and the data are cleared by a technician.
- In the event of an extreme weather event (e.g. high rainfall), flag all sensor readings until the data are cleared by a technician.

For the purposes of the irrigation decision support tool, algorithms will need to be written and applied to daily data to flag and remove erroneous or questionable data as identified in the procedures outlined above, properly convert units, and adjust sensor readings to a common reference height before daily calculations of ET can be performed.

Table 5. Quality assurance tests established for range limits of sensors, climate, single day step increase or decrease, and day-to-day persistence.

Quality Assurance Test	Sensors									
	Air Temperature Degrees F		Relative Humidity Percent		Precipitation inches		Wind speed miles/day		Solar Radiation Langley/day	
Sensor Range Limits										
Maximum	140 F		100%		NA		100 mile/hr		258,120*	
Minimum	-40 F		0		0.01		0		0	
Climate Range Limits	winter	summer	winter	summer	winter	summer	winter	summer	winter	summer
Maximum	86.0	106.0	100	100	601.0	743.0	265	192	350	782
Minimum	1.0	42.0	14.0	11.0	0	0	2	1	3	35
Step Test										
Maximum	31 F		68%		NA		224 mpd		630	
Minimum	-49 F		-75%		NA		-179 mpd		-607	
Persistence Test										
Minimum	0.1° in 60 min		0.1% in 360 min**		NA		0.1		0.1 Langley in 14 hrs	

* The listed solar radiation sensor maximum limit represents the upper limit for sensor response, and is several orders of magnitudes larger than would actually be observed. ** Because of the high relative humidity common to the Mid-South, the persistence test for relative humidity is based only on the minimum reading.

DISCUSSION

Development of timely, accurate crop management decision support tools requires consistent, reliable, accurate and complete information on climatic conditions to simulate crop growth and water use. Weather data is particularly susceptible to errors. Identification of errors and establishment of a protocol to flag and correct weather data will improve the ability to simulate crop development and the related water balance for irrigation decision support tools.

The environmental conditions in Mississippi make measurement of relative humidity particularly challenging. The high humidity conditions and frequent rain events erode sensor integrity, particularly that of the relative humidity sensors. While vapor pressure is needed to perform the MPM calculation of ET, a better approach may be to estimate this parameter from the minimum temperature (Allen et al., 1998).

The most critical parameters for accurate estimation of ET and crop water balance are T_{\max} , T_{\min} , precipitation, and irrigation. To develop a reference ET calculation that can be used by crop producers throughout Mississippi, missing data points and data from locations not near weather stations will both need to be interpolated. Interpolation of temperature across space and time is feasible. However, precipitation varies greatly in space and time, and interpolation methods produce less than satisfactory results. For this parameter, a more realistic measure may be the fine-scale daily precipitation radar data product developed by the National Weather Service (2012) from radar observations. This will provide daily rainfall data at the field scale for calculating a water balance for irrigation scheduling.

The online irrigation scheduler under development will require monitoring and error correcting of real-time weather data on a daily basis. The range tests and statistical limit tests developed here will be implemented in an automated error checking procedure to correct weather data prior to determination of reference ET for irrigation scheduling.

Developing reliable and accurate crop management tools for farmers is critically dependent on the quality of the data input. Developing an irrigation scheduling tool will be challenging based on the quality and continuity of the sparsely available weather data. By incorporating the error identification and correction protocols outlined here, the accuracy of the simulation can be greatly improved. Future studies will explore the spatial variability of weather parameters and develop interpolation protocols for realistic and feasible estimates of climatic conditions at remote locations. Additional research will explore

alternative methods of measuring weather parameters and possible use of multiple sensors at each site (Allen, 1996). Although irrigation primarily occurs in the Delta region, interest in irrigation in other areas of the state necessitates addressing the paucity of weather information from other regions in Mississippi. This information will enhance the productive capacity of Mississippi agriculture.

DISCLAIMER

Mention of a trade name or proprietary product does not constitute an endorsement by the U.S. Department of Agriculture. Details of specific products are provided for information only, and do not imply approval of a product to the exclusion of others that may be available.

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Field Evaluation Of Vetiver Grass As A Barrier Against Formosan Subterranean Termites (Isoptera: Rhinotermitidae)

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ABSTRACT

A field trial was conducted to assess the effectiveness of vetiver grass, *Vetiveria zizanioides* Nash, as a physical soil barrier against the Formosan subterranean termite, *Coptotermes formosanus* Shiraki. Vetiver grass was planted in field plots to serve as a barrier between a termite inoculation site and a potential food source. Results showed that the termites were able to penetrate the grass roots and reach the food source on the other side.

INTRODUCTION

The Formosan subterranean termite, *Coptotermes formosanus* Shiraki, is one of the most destructive pests of structures where it occurs. A species native to east Asia, this termite is now established in many parts of the world. In the United States, Formosan termite infestations have been reported from 11 states (Lee et al., 2009). The economic impact of Formosan termites in the U. S. is estimated to be approximately one billion dollars annually (Meepagala et al. 2006).

Soil termiticides are often chosen by pest control officers and homeowners to protect structures from subterranean termite infestation (Lewis 1996). These pesticides must be applied at very high rates in order to provide an effective barrier against termite entry. Often this barrier is broken by leaf litter, untreated soil, rocks, and landscaping material, necessitating re-application at regular intervals. Public concern about chemicals released into the environment has led consumers and scientists alike to consider alternative termite prevention methods.

A relatively new trend in the fight against subterranean termites is the use of naturally occurring pesticides that have little environmental impact and are nontoxic to mammals (Meepagala et al. 2006). One example is vetiver grass, *Vetiveria zizanioides* (L) Nash (Graminales: Poaceae), an extremely fast-growing plant native to India (National Research Council, 1993). Vetiver grass forms a thick hedge when planted close together, and has a rapidly growing deep root system (Rostedt 2004). This plant has been successfully used throughout the world in soil and water conservation efforts (Dabney et al. 1999, Rostedt 2004, Truong et al. 2003, Truong 2000, Ash and Truong 2003, Chen et al. 2004). Extracts of essential oils from vetiver grass roots, such as vetiver oil and nootkanone, have been shown to alter feeding habits of insects and

serve as natural insecticides (Chomchalow and Chapman 2003, Maistrello et al. 2001, Zhu et al. 2001a, Zhu et al. 2001b, and Henderson et al. 2007). This discovery has led to various studies that evaluated vetiver grass extracts for repellent and toxic effects against Formosan subterranean termites, with promising results (Henderson et al. 2007, Maistrello et al. 2001, Nix et al. 2006, Zhu et al. 2001a and b, Zhu et al. 2003).

Many homeowners in areas plagued with Formosan subterranean termite infestations are familiar with the potential benefits of vetiver grass as a termite deterrent, and are interested in incorporating the plants in the landscape around their homes as a barrier against termites (Nix et al. 2006, LSU Ag Center News Release 2007). In the current study, vetiver grass was evaluated for efficacy as a barrier against Formosan termites.

METHODS

Trials were carried out on the grounds of the Mississippi State University South Branch Experiment Station in Poplarville. Four field test plots (8 feet square x 4 feet deep) were excavated and lined on the sides and bottom with fine stainless steel mesh. Soil for the plots was prepared by sifting topsoil through a 1/8" screen to remove any seeds and cellulosic material. Osmocote, lime fertilizer, and sand were mixed in to the soil, with sand comprising about 15% of the mixture. After heating 24 hours at 104° C, the soil mixture was added to the plots, followed by planting of mature vetiver grass in a tightly spaced row 1 foot from side of each plot (Figure 1). Plant rows were oriented along the east, south, west, and north facing edges of each plot (Plots A, B, C, and D, respectively). Root balls were rinsed with tap water before planting. Grass was planted to an average depth of 9.5" and spaced as closely together as possible to eliminate gaps between root balls. Plots were watered thoroughly immediately after planting to remove air

pockets in the soil.

Weathered yellow pine stakes (1" x 18") were dried 24h at 104° C and weighed. Sixteen stakes were placed 2 feet apart around the inner perimeter of the plots and buried at a depth of 16 inches. Five of the stakes were located behind the grass plants (Figure 1).

Formosan subterranean termites (74-84 g) from a single colony collected in Poplarville, MS were used for the study. After termites were allowed to enter moistened

12" diameter cardboard rolls, an infested roll was placed in an approximately 12" diameter x 8" deep hole in the center of each plot, which was then covered with soil. Plots were wetted down as needed over the course of the study, with the mesh lining preventing escape of the termites while allowing for soil drainage. Stakes were removed and visually inspected for termite damage 30 days after inoculation, and then every 60 days for one year. Stakes were placed back in their original location after inspections.

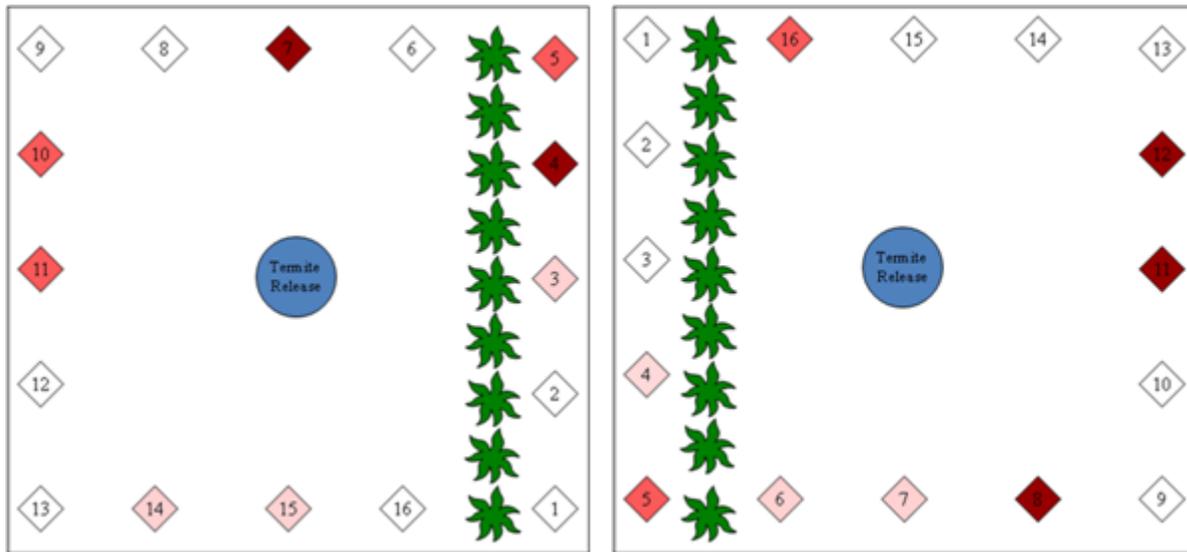


Figure 1. Illustration of Plots A (left) and C (right), with diamonds indicating wooden stake placements. Shaded diamonds indicate stakes with termite damage after 1 year. Darker shading indicates greater termite damage. Termites penetrated grass roots of these two plots and damaged stakes on the other side.

RESULTS AND DISCUSSION

New damage to stakes was observed throughout the study, indicating that the termites survived and remained robust. After 30 days damage was observed on at least one wooden stake for all plots, with the exception of plot B which showed damage after 60 days. Approximately 330 days after inoculations, termite damage was discovered in three wooden stakes located behind the grass barrier in plot A, and two stakes behind grass in plot C (Figure 1). This indicated that the termites were able to penetrate grass roots and reach the food source on the other side.

This study evaluated the potential of live vetiver grass plants to serve as a physical or repellent barrier against Formosan subterranean termites. Laboratory studies have reported that root extracts from vetiver grass have a

repellent effect on this species (Zhu et al. 2001a and b, Zhu et al. 2003). The results of the current study indicate that Vetiver grass plants alone will not provide adequate protection for homeowners against Formosan termite infestations.

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Resistance Of Nontraditional Landscape Mulches To Infestation By Formosan Subterranean Termites (Isoptera: Rhinotermitidae)

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INTRODUCTION

Mulches are often used to improve the appearance of a landscape and maintain the health of landscape plants (Pinzon et al., 2006). Traditional mulches benefit plants by retaining moisture in the soil and providing insulation against temperature extremes (Long et al. 2001), as well as reducing weed growth. However, traditional mulch products provide a suitable environment for subterranean termites by providing the insects with food as well as appropriate soil moisture and temperature (Myles 2008).

Landscape mulches are often placed next to dwellings and other structures, which in turn may make the structure more susceptible to termite infestation. Concerns about traditional mulches serving as a food source and habitat for subterranean termites have motivated studies to identify alternative mulch products that are not palatable to termites and impede long term survival of the insect (Pinzon et al. 2006).

The present study tested resistance of seven nontraditional mulches and weed blocks to Formosan subterranean termite workers (*Coptotermes formosanus* Shiraki). Products used in no-choice tests were mulch mat (made from recycled tires), rubber mulch, coir mulch block (made from coconut husk), weed block (made from recycled paper), WeedBlock Natural® (made from corn), cocoa bean shell mulch, and traditional landscape mulch factory infused with pesticide. There were six replicates per mulch type. Southern pine block wafers were used as a control.

Mulching materials were cut, weighed, and placed in soft plastic containers (5” diameter x 3” high). Two hundred fifty termites were added to each container. The containers were misted with distilled water and stored loosely covered at 28° C at 85% humidity. After 6 weeks, surviving termites were removed and counted. Mulch materials were air dried and loose debris removed with a watercolor brush, and the mulch reweighed for determinations of average weight loss (Table 1).

For two inorganic mulch products (rubber mulch and mulch mat from rubber tires) and an organic mulch (cocoa bean shell), 100% mortality occurred by 4 weeks.

Negligible mass loss was measured for both rubber mulch and the rubber mulch mat. For cocoa bean shell mulch, 6.4% average mass loss was recorded. However, fungus overgrowth on this mulch may have been a feeding stimulant or influenced mortality. Other mulch products tested had surviving termites after 6 weeks (Table 1). For mulch infused with pesticide, most termites were dead at the conclusion of trials, with 2.7% average mulch mass loss. Arenas with WeedBlock Natural and coir mulch block similarly showed high mortality, with little or no mass loss. Paper mulch had significant mass loss. Mortality for paper mulch was low, comparable to the wood control.

While rubber mulch and rubber weed block had negligible mass loss and 100% mortality at the conclusion of trials, these products may leach toxins and cause elevated soil temperature and decreased soil moisture, factors that may cause damage to landscape plants. Cocoa bean shell mulch poses a danger to household pets if eaten. Of the materials tested, WeedBlock Natural and coir mulch showed the most effective combination of resistance to termites, low toxicity, and providing favorable growing conditions for garden plants.

Table 1. Formosan termite mortality and mulch weight loss after 6 weeks

Product tested	Percent mortality after 6 weeks*	Percent weight loss after 6 weeks*
Mulch mat (made from rubber tires)	100**	0
Rubber mulch	100**	0
Cocoa bean shell mulch	100**	6.4
Mulch infused with pesticide	93.6	2.7
WeedBlock Natural® (from corn)	87.6	0
Coir mulch block (from coconut husk)	71	1.1
Weed block mat (from paper)	15	18.7
Wood (control)	12.8	***

* average from six laboratory arenas

** all termites were dead after 4 weeks

*** no data

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Behavioral and Socio-Demographic Determinants and Correlates of Adult Overweight/Obesity and Diabetes Prevalence in Mississippi

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ABSTRACT

Objectives: To identify the socio-demographic and behavioral determinants and correlates of overweight/obesity and diabetes in Mississippi. **Methods:** We used data from the combined 2007-2009 Mississippi Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS, established by CDC is an ongoing state-based surveillance system that uses a telephone survey to collect prevalence data on risk behaviors of non-institutionalized civilian adult ages 18 years and older. Chi-square tests were used to detect the subgroup differences among the estimates. Multivariate logistic regression models were used to investigate factors, such as socio-demographic, behavioral and other selected covariates associated with overweight/obesity and diabetes. All analysis used specialized subroutines of STATA 10 to account for the complex survey design of BRFSS. **Results:** Overweight/obesity and diabetes prevalence differed by sex, race, age, educational level, marital status, employment status, and physical exercise. After adjusting for other selected factors, we found only race, age, educational level, and physical exercise were associated with the high prevalence of overweight/obesity and diabetes. **Conclusions:** Blacks, older people, and those with less educational level and who did not have any physical exercise were more likely to be overweight/obesity and diabetic.

INTRODUCTION

The increasing prevalence of adult and childhood overweight/obesity and diabetes in the United States (US) has long reached an epidemic proportion [1]. Both health conditions are major causes of morbidity and mortality [2-3]. In the US, obesity causes 110,000 deaths annually [4]. Diabetes being the seventh leading cause of death in US was responsible for 71,382 deaths in 2007 [3].

Since 2001, when the US Surgeon General commented on the health-related consequences of obesity prevalence in the US, the increasing rates have not reversed despite several concrete initiatives put in place by private and public sectors to tame the epidemic [4]. At present, two-thirds of adult Americans and one in every three children and teens are either overweight or obese with greater risk of developing more than 20 other chronic diseases [2,4-6]. Similarly, diabetes has been reported as a risk factor in other health conditions such as heart disease and stroke, hypertension, blindness and eye problems, kidney and nervous system disease [7-8].

Most worrisome is the high prevalence of obesity which has been reported as the biggest public health challenges the country has ever faced after tobacco. This development has posed one of the most serious public health challenges of the 21st century as it threatens the future health of most Americans [1, 6, 9-11]. Furthermore, an unmitigated rise in the prevalence of obesity in the US is a threat to the survival of the country

as the world's leading economic and military power as an obese population will be too unhealthy to drive the engine of economic development and unfit for serious engagement in military assignments and combat [4]. The ultimate implication is national insecurity!

While the national prevalence rates of obesity and diabetes continue to challenge public health science, the rates for Mississippi, particularly that of obesity is overwhelmingly worrisome [10]. For three consecutive years, Mississippi has been ranked the most obese¹ state in the US [10]. Similarly, the 2011 report of the Trust for America's Health (TFAH) and the Robert Wood Johnson Foundation (RWJF) has ranked Mississippi as first and third highest in obesity and diabetes prevalence, respectively [4]. The state's prevalence rates of these health conditions continue to be on the rise and significantly higher than the national averages. For example, in 1995, the state reported the highest rate of obesity prevalence in the country, which stood at 19.4 percent [4]. In 2010, the state continues to lead the country in obesity prevalence which stands at a disturbing rate of 34.5 percent [4, 12]. Furthermore, in 2010, while the national prevalence rates of overweight and obesity stand at 63.8 percent, the rate for Mississippi stands at a higher rate of 68.8 percent. Similarly, the state's diabetes prevalence is higher than the national rate. While the

¹ Obesity defines an adult who has a body mass index (BMI) of 30 or higher.

national rate is 8.7 percent, that of Mississippi stands at 12.4 percent [4, 12].

The troubling disparities in these health conditions also exist by race/ethnicity, gender, region, socioeconomic status (SES) and age [4, 13-17]. For example, in 2009, the prevalence rates of overweight and obesity for white Mississippians stood at 35.6% and 31.0%, while the rates for their black counterparts were 32.5% and 44.4%, respectively. Similarly, diabetes rates for white and black Mississippians in the same year were 10.3% and 14.4%, respectively. In terms of rates by sex, overweight and obesity were 39.9% and 34.8% for male and 30.2% and 36.0% for female, while the rates for diabetes were 11.3% for male and 11.9% for the female.

The attributable burden of the epidemics of obesity and diabetes on the resources of US public health systems due to their associations with other adverse health conditions such as heart diseases, cancer, hypertension, stroke, asthma, and depression is enormous [1, 9-10, 18]. Similarly, the epidemics exert severe burden on the lean public health resources of Mississippi, the poorest state in the US. With the current economic recession, which portends declining state financial resources to address the surging prevalence of obesity and diabetes, it has become necessary to identify the determinants and correlates of adult overweight/obesity and diabetes to help inform public health policies, programs, and interventions that aim to address and mitigate the surge in prevalence of these epidemics [9, 18-20]. Furthermore, the co-occurrence of these epidemics with other chronic health conditions has been less frequently analyzed [16, 20]. The objectives of this study are to (1) identify the socio-demographic and behavioral determinants and correlates of overweight/obesity and diabetes in the state of Mississippi, and (2) examine whether there are any differences between the determinants and correlates of the two health conditions.

METHODS

Data for this study come from the 2007-2009 Mississippi Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS, established by CDC, is an ongoing state-based surveillance system that uses a telephone survey to collect prevalence data on risk behaviors and preventive health practices that affect the health status of non-institutionalized civilian adult Americans ages 18 years and older. The administration of the survey was conducted by the Mississippi State Department of Health (MSDH) with technical and methodological assistance from the Centers for Disease Control and Prevention (CDC). The BRFSS questionnaires constitute standardized core modules for collecting demographic and socioeconomic data from participating individuals. A detailed description of the survey methodology has been provided elsewhere [21-

23]. Variables included in the analytical dataset were self-reported diabetes status, height and weight, demographic and socioeconomic variables, including race/ethnicity, sex, age, education level, marital status, employment status, public health region, and behavioral factors.

Measures

Two health conditions (overweight/obesity and diabetes) are used as the health outcome measures in the analysis. Data on self-reported weight and height were used to calculate body mass index (BMI). BMI is calculated as weight measured in kilograms divided by height in meters squared (kg/m^2). The calculated BMI was categorized as a binary variable with BMI less than 25 ($\text{BMI}<25$) representing normal weight and BMI greater or equal to 25 ($\text{BMI}\geq 25$) representing overweight/obese individuals. Diabetes was considered present if the subjects reported that they have ever been told by a doctor that they have diabetes.

We used two broad categories of predictor variables in model estimation, namely socio-demographic and behavioral/lifestyle factors. Socio-demographic variables include race/ethnicity, sex, age, educational level, marital status, employment status, region of residence and healthcare coverage. Nutrition and physical exercise variables were used to represent behavioral and lifestyle choices. The race/ethnicity variable represents two race/ethnic categories, which include White (Non-Hispanic) and Black (Non-Hispanic). The other race/ethnicity categories were small and hence excluded from this analysis. The sex of the respondents is assessed as male or female. The age variable measured in years was evaluated in six categories (18-24, 25-34, 35-44, 45-54, 55-64 and ≥ 65 years, respectively). Marital status is a three-level variable that includes married, divorced/widowed/separated and never married. The region of residence was assessed through aggregation of the state's Public Health Districts as follows: Northern Region includes Northwest (District I), Northeast (District II), Delta/Hills (District III) and Tombigbee (District IV); Central Region includes West Central (District V) and East Central (District VI); and the South Region includes Southwest (District VII), Southeast (District VIII) and Coastal Plains (District IX), respectively.

We used level of education attained, employment status and healthcare coverage to assess the socioeconomic status of respondents. Four levels of completed education were used to assess educational attainment, including those that did not graduate from high school, those who graduated from high school, those that attended college or technical school and those that graduated from college or technical school. To evaluate employment status, we combined responses in three levels--- those who worked for wages and self-employed

were categorized as “employed”; those out of work for more than one year and those out of work for less than one year were classed as “unemployed”; and homemakers, students, retired and unable to work were classified as “not in the labor force”. Finally, healthcare coverage was assessed to determine if respondents 18+ years of age have any form of health care coverage or do not have health care coverage.

Nutrition/diet variable represents whether participating subjects consumed more or less than five servings of fruits or vegetables per day. Finally, a two-level measure of physical activity of whether or not respondents reported participating in either moderate physical activity defined as 30 or more minutes per day for 5 or more days per week, or vigorous activity for 20 or more minutes per day on 3 or more days. All “don’t know/not sure/refused/missing” responses were treated as missing values in analyses.

Data Analysis

All analyses were conducted with specialized subroutines of STATA 10 [24, 25] to account for the complex nature of the survey design of BRFSS. Final sampling weights were applied in all analyses to correct for differences in the probability of selection due to non-response and non-coverage errors, adjust demographic variables between sample and the entire population, allowing generalization of findings [23], and improve precision of the standard errors of parameters in subpopulation analyses [24]. We specified the sampling plan of BRFSS to STATA 10 using the `svyset` command and the following sets of weight variables: sample weight variable (`FINALWT`), first-stage stratification variable (`STSTR`), and the primary sampling unit variable (`PSU`). Mean proportions for each variable and prevalence rates of obesity and diabetes by selected factors were estimated using the `svy: proportion` command.

In this study, sequential modeling approach was used in logistic model development process to assess the relationship between the two health conditions (obesity and diabetes prevalence) and selected covariates [26]. First, Chi-square tests were used to detect the subgroup

differences among the estimates. Second, bivariate logistic regression, models overweight/obesity and diabetes as dichotomous outcomes were used in models with race/ethnicity variable. Then we added socio-demographic variables in the model in addition to race/ethnicity. In the multivariate model, we controlled for all selected behavioral and lifestyles factors to identify the significant determinants and correlates of overweight/obesity and diabetes prevalence. The multivariate model allows the determination of which covariates are associated with overweight/obesity and diabetes. It also assesses the hypothesis that minority groups, particularly black Mississippians, are at a higher risk of overweight/obesity and diabetes compared to their white counterparts.

RESULTS

Sample Characteristics

Summary statistics of the sampled adult participants in the 2007-2009 Mississippi BRFSS (n=26,961) are provided in Table 1. More than half of the participants were female (52.4%). About sixty-two percent (62.3%) were white. Blacks constituted only thirty-four percent (34%) of the cases. The distribution of the participants’ age category was relatively uniform, except in the middle age category (35-54 years) that contributed about thirty-six percent (36.4%) to the sample. Early adulthood (18-34 years) and older adults (>=55 years) contributed about thirty-two percent (32%) each to the total sample. More than half of the participants (52%) attended or graduated from college or technical school. The remaining forty-eight percent (48%) had less than a high school or graduated from high school. Marital status of the sample included married (58%), divorced, widowed or separated (20%) and never married (22.8%). The majority of the participants were employed either for wages or self-employed (fifty-six percent), while only about eight percent (8%) and thirty-seven (37%) were unemployed (out of work for less or more than one year) and not in the labor market (unable to work, retired, homemaker or a students) during the survey periods.

Table 1. Characteristics of the Participants, Mississippi BRFSS, 2007-2009

Characteristics	Unweighted Count	Weighted % ^a
Sex		
Male	9,106	47.6
Female	17,855	52.4
Race/Ethnicity		
White	17,747	62.3
Black	7,977	33.7
Age Group (yrs)		
18-24	881	12.4
25-34	2,370	19.5
35-44	3,638	17.2
45-54	5,231	19.2
55-64	5,964	14.6
65+	8,877	17.1
Educational Level		
Less than high school	4,654	15.7
High school graduate	8,835	32.3
Attended college/technical school	6,798	26.7
Graduated college/technical school	6,643	25.2
Marital Status		
Married	14,190	57.5
Divorced/widowed/separated	9,276	19.7
Never married	3,453	22.8
Employment Status		
Employed	12,018	55.8
Unemployed	1,409	7.5
Not in the labor market	13,498	36.8
Healthcare Coverage		
Yes	23,163	80.5
No	3,736	19.5
Nutrition		
Consume < 5 times per day	15,316	82.5
Consume ≥ 5 times per day	3,219	17.5
Physical Exercise		
Yes	5,978	38.5
No	11,598	61.5
Region		
North	11,567	37.7
Central	6,566	30.2
South	8,633	32.1

Source: Computed from combined MS 2007-2009 BRFSS data

^aFinal survey weights were applied in the computation of proportion of population estimates, expressed in percentages.

Health coverage was not an issue among the surveyed participants as eighty percent of them had some health care coverage, including health insurance, prepaid plans, such as HMOs, or government plans, such as Medicare. About 20% had no health care coverage at all during the

survey periods. In terms of nutrition/diet requirements, eighty-three percent (83%) consumed less than five servings of fruits or vegetables per day. Similarly, majority of them (62%) did not participate in either moderate or vigorous physical activity. About thirty-eight

percent (38%) of the participants came from the northern part of Mississippi, while 30% and 32% of them came from the central and southern parts of the state, respectively. About sixty-nine percent (69%) of the adults were overweight or obese ($BMI \geq 25.00 \text{ kg/m}^2$) and twelve percent (12%) were told by a doctor or healthcare professionals that they had diabetes.

Prevalence of Adult Overweight/obesity and Diabetes

Table 2 presents the prevalence rates and 95% confidence intervals (CI) of adult overweight/obesity and diabetes in Mississippi by selected characteristics of the sampled participants. The prevalence rate for males (73.1%) was significantly higher than for females (64.4%, $p < 0.001$). The diabetes prevalence for males (11.1%) was significantly lower for females (12.5%, $p = 0.0042$). As with recent national studies [4, 13, 15, 16], the percentage of overweight or obese black adults in Mississippi is significantly higher than that of whites (75.4% for black vs. 65.1% for white). Similarly, the percentage of blacks in Mississippi who have been told by doctors or health professionals that they have diabetes is significantly higher than that of whites (14.5% for black vs. 10.6% for white).

The rates of both overweight/obesity and diabetes differed by age (see Table 2). Overall, as age increased, the prevalence of adult overweight or obese and diabetes increased. While the proportion of overweight or obese adults peaked at age group 55-64 years (75.1%), that of diabetes peaked at age 65 years and older (24.4%). The prevalence of overweight or obesity among adults that graduated from college or a technical school (66.1%) was significantly lower than the rates of those with a lower level of education. Similarly, for diabetes, the prevalence rate for adults that graduated from college or technical school was 8.9%, while it was 18.7% for those with less than high school education. It is interesting to note that the association between education and the prevalence of overweight/obesity and diabetes indicate an inverse relationship, with higher levels of education associated with lower rates of overweight/obesity and diabetes (Table 2).

The prevalence of both obesity and diabetes differed by marital status. Whereas there was a small difference in the prevalence of overweight or obesity between married and divorce/widowed/separated adults (71.1% for married vs. 68.6% for divorced/ widowed/separated, etc), there was a bigger difference in the prevalence of their diabetes status (11.9% for married vs. 18.8% for the divorced/widowed/separated). The percentage of never married adults in the overweight or obese category (62.6%) and those with diabetes (5.7%) was lower compared to either the married and divorce/widowed/separated adults, respectively. Also, there was a significant difference in the prevalence of overweight or obesity between employed, unemployed and adults not in the labor market. Likewise, the difference in the prevalence of diabetes between employed and unemployed adults was small, but the percentage of adults not in the labor market that were diabetic was substantially higher (19.6%) compared with that of either employed (7.2%) or unemployed (8.2%), respectively. The difference in the percentage of overweight or obese status by healthcare coverage was not significant, but the difference in diabetes status by healthcare coverage was significantly higher for adults with health coverage compared with those without coverage (12.9% for those with coverage vs. 7.9% for those without coverage).

More than two-thirds (70%) of adults that were overweight or obese reported consuming less than five servings of fruits and vegetables daily. There was no significant difference in the prevalence of adult diabetes by consuming fewer or greater than five servings of fruits and vegetables. The percentage of adults reporting lack of participation in moderate and vigorous physical exercise was higher among people who were overweight or obese (72.1%) and diabetes (14%). There was no significant difference in the prevalence of adults overweight or obesity and diabetes by public health region.

Table 2. Prevalence and 95% Confidence Intervals of Overweight/Obesity and Diabetes by Selected Factors, Mississippi BRFSS, 2007-2009

Characteristics	Overweight/Obesity		Diabetes	
	Weighted percent (95% CI)	P-value	Weighted percent (95% CI)	P-value
Sex		<0.0001		0.0042
Male	73.1 (71.7,74.5)		11.1 (10.4,11.9)	
Female	64.4 (63.3,65.5)		12.5 (12.0,13.1)	
Race/Ethnicity		<0.0001		<0.0001
White	65.1 (64.1,66.2)		10.6 (10.1,11.2)	
Black	75.4 (73.7,76.9)		14.5 (13.6,15.4)	
Age Group (yrs)		<0.0001		<0.0001
18-24	50.4 (46.3,54.6)		1.6 (0.9,2.7)	
25-34	68.0 (65.7,70.3)		4.0 (3.1,5.0)	
35-44	73.9 (72.1,75.6)		7.5 (6.4,8.7)	
45-54	74.3 (72.8,75.8)		12.2 (11.2,13.3)	
55-64	75.1 (73.8,76.5)		21.3 (20.0,22.6)	
65+	65.3 (64.1,66.5)		24.4 (23.3,25.5)	
Educational Level		0.0123		<0.0001
Less than high school	69.4 (67.0,71.7)		18.7 (17.3,20.3)	
High school graduate	69.9 (68.3,71.4)		12.4 (11.5,13.2)	
Attended college/technical school	69.1 (67.2,70.8)		10.0 (9.2,10.8)	
Graduated college/technical school	66.1 (64.6,67.7)		8.9 (8.1,9.8)	
Marital Status		<0.0001		<0.0001
Married	71.1 (70.1,72.0)		11.9 (11.3,12.6)	
Divorced/widowed/separated	68.6 (67.1,70.0)		18.8 (17.8,19.9)	
Never married	62.6 (60.0,65.2)		5.7 (4.9,6.6)	
Employment Status		<0.0001		<0.0001
Employed	70.2 (68.9,71.4)		7.2 (6.7,7.8)	
Unemployed	69.7 (65.9,73.2)		8.2 (6.8,9.9)	
Not in the labor market	66.1 (64.8,67.3)		19.6 (18.8,20.5)	
Healthcare Coverage		0.6028		<0.0001
Yes	68.8 (67.9,69.7)		12.9 (12.3,13.4)	
No	68.1 (65.8,70.4)		7.9 (6.9,9.0)	
Nutrition		0.0154		0.4862
Consume < 5 times per day	70.0 (68.9,71.2)		11.9 (11.3,12.6)	

Consume >= 5 times per day	66.4 (63.6,69.1)		11.4 (10.2,12.8)	
Physical Exercise		<0.0001		<0.0001
Yes	66.1 (64.3,67.9)		8.5 (7.7,9.3)	
No	72.1 (70.7,73.3)		13.9 (13.2,14.7)	
Region		0.1443		0.3339
North	69.4 (68.1,70.6)		11.9 (11.2,12.6)	
Central	67.4 (65.6,69.1)		11.4 (10.5,12.4)	
South	69.2 (67.6,70.7)		12.3 (11.5,13.2)	

Source: Computed from combined MS 2007-2009 BRFSS data

Determinants and Correlates of Adult Overweight/obesity and Diabetes

The summary of adjusted odds ratios and their 95% confidence intervals (CIs) for behavioral, socioeconomic and demographic factors of overweight or obesity and diabetes prevalence among the adult population in Mississippi is displayed in Table 3. The odds of adult males being overweight or obese is 1.73 times the odds of the females (OR=1.73, p<0.001). There was no significant gender difference in the odds of diabetes. Adult blacks were about twice as likely to be overweight or obese compared with adult whites (OR=1.99, 95% CI=1.75, 2.27). Similarly, adult blacks were about 67% more likely to have diabetes compared with the adult whites (OR=1.67, 95% CI=1.46, 1.91).

Compared with the age group 18-24 years, the odds of overweight or obesity and diabetes increased with successive age categories, but only to decrease among age group 65 years and older. The highest odds of overweight or obesity and diabetes were associated with the age group 55-64 years (Table 3). Compared with college or technical school graduates, the odds of overweight or obesity were 27% and 26% higher for respondents that graduated from high school and those that only attended college or technical school, respectively. Respondents with less than a high school education or graduated from high school had higher chances of having diabetes compared with college or technical school graduates.

Table 3. Adjusted Odds Ratios and 95% Confidence Intervals for Adult Overweight/Obesity and Diabetes in Mississippi, 2007-2009, BRFSS

Characteristics	Overweight/Obesity OR (95% CI)	Diabetes OR (95% CI)
Sex		
Male	1.73*** (1.54,1.93)	1.07 (0.95,1.20)
Female	1.00 (referent)	1.00 (referent)
Race/Ethnicity		
Black	1.99*** (1.75,2.27)	1.67*** (1.46,1.91)
White	1.00 (referent)	1.00 (referent)
Age group (yrs)		
18-24	1.00 (referent)	1.00 (referent)
25-34	1.91*** (1.46,2.51)	3.22** (1.43,7.25)
35-44	2.59*** (1.98,3.39)	5.72*** (2.61,12.5)
45-54	2.71*** (2.08,3.54)	10.2*** (4.70,22.2)
55-64	2.78*** (2.12,3.65)	16.9*** (7.74,36.7)
65+	1.83***	15.9***

	(1.39,2.43)	(7.28,34.9)
Education Level		
Less than high school	1.15 (0.96,1.38)	1.54*** (1.27,1.88)
Graduated high school	1.27*** (1.11,1.45)	1.29** (1.10,1.53)
Attended college/ technical school	1.26*** (1.10,1.44)	1.13 (0.96,1.35)
Graduate college/ technical school	1.00 (referent)	1.00 (referent)
Marital Status		
Divorced/widowed/separated	0.83** (0.73,0.93)	1.02 (0.90,1.15)
Never married	0.84 [0.69,1.01]	0.94 [0.75,1.19]
Married	1.00 (referent)	1.00 (referent)
Employment Status		
Unemployed	1.08 (0.85,1.39)	1.39* (1.04,1.86)
Not in the labor market	1.00 (0.88,1.14)	1.82*** (1.57,2.10)
Employed	1.00 (referent)	1.00 (referent)
Healthcare Coverage		
No	0.98 (0.82,1.16)	0.73** (0.60,0.90)
Yes	1.00 (referent)	1.00 (referent)
Nutrition		
Consume < 5 times per day	1.04 (0.91,1.19)	0.93 (0.80,1.08)
Consume >= 5 times per day	1.00 (referent)	1.00 (referent)
Physical Exercise		
No	1.26*** (1.13,1.40)	1.29*** (1.13,1.48)
Yes	1.00 (referent)	1.00 (referent)
Region		
Central	0.92 (0.81,1.04)	0.88 (0.77,1.01)
South	1.05 (0.93,1.19)	1.09 (0.95,1.24)
North	1.00 (referent)	1.00 (referent)

Exponentiated coefficients; 95% confidence intervals in brackets

Notes: Computed from MS BRFSS data, 2007-2009

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Divorced, widowed or separated adults had significantly lower odds of being overweight or obese compared with married couples (OR=.83). The unemployed respondents (those out of work for less than one year or greater than one year) and those not in the labor market (home maker, students, retired and unable work) had greater odds of being diabetic compared with those employed (employed for wages or self employed). Respondents without any kind of health care coverage, including private health insurance, prepaid plans, such as HMOs, or government insurance programs had lower odds of being diabetic. The odds of overweight or obesity and diabetes were significantly higher for adults who

reported non-participation in either moderate physical activity (defined as 30 or more minutes per day for 5 days per week) or vigorous activity (defined as 20 or more minutes per day on 3 or more days per week) compared with those that participated in physical activities as specified (Table 3).

DISCUSSION

Using data from Mississippi's BRFSS, covering years 2007 through 2009, our results show that socio-demographic and lifestyle (behavioral) factors were significantly associated with the prevalence of adult overweight/obesity and diabetes in Mississippi. This

finding confirms the results of several previous studies across the nation [4-6, 11, 19, 27-37].

Specifically, our results show both racial/ethnic and gender disparities in the prevalence of these two health conditions [2, 13, 16-17]. Males have a higher rate of overweight and obesity, but a lower rate of diabetes compared to their female counterparts. Furthermore, adult blacks are at greater risks of overweight or obesity and diabetes compared to their adult white counterparts. Several possible reasons might account for the differences in the prevalence of these epidemic health conditions. For instance, racial/ethnic populations, including males and females might differ in their behaviors, genetic composition, socio-cultural factors, economic status and access to, and use of health resources that contribute to weight gain/loss and elevated/decreased blood sugar level [13, 38]. For example, compared with whites, minorities are generally less likely to be physically active and consume fewer servings of fruits and vegetables. This variation is also reported to follow gender lines where non-Hispanic white men and women have a greater chance of consuming fruits and vegetables five or more times per day and engaging in regular physical activities compared to their minority counterparts [39]. Our finding on racial/ethnic and gender differences in the prevalence of obesity and diabetes calls for a paradigm shift in public policy programming and implementation. The need to adopt the approach of “health-in-all policies” as opposed to “one-size-fits-all” in the formulation of public policy to address social and economic problems in the country must be emphasized [40].

Our results indicate that the prevalence rates of obesity and diabetes increased with age of participants, but decreased with educational level after adjusting for other covariates as similarly found in related studies [4, 19]. The direct relationship between age and prevalence of obesity and diabetes can be explained by the fact that the aging process is a natural phenomenon that may limit active participation in vigorous physical activities and reductions in effective performance of physiological activities of human body systems. The inverse association between increasing educational attainment and the prevalence of the two health outcomes could be accounted by two main reasons. First, it could be that individuals with higher education are mostly likely to be predisposed to better sources of health information, and may have the financial ability to consume better healthcare and recreation compared to those with less education. Second, individuals with higher education are most likely to engage in healthful behaviors compared to those with lower education, who may increasingly engage in risky and unhealthy behaviors.

As expected, participants that consumed more than five servings of fruits and vegetables and participated in

moderate to vigorous physical activities were significantly less likely to be overweight or obese compared to their counterparts that consumed fewer servings of fruits and vegetables and failed to participate in moderate to vigorous physical activities. Even though statistically insignificant, those individuals that consumed more servings of fruits and vegetables and participated in moderate to vigorous physical activities had lower rates of diabetes compared to those that consumed fewer servings of fruits and vegetables per day and didn't engage in moderate to vigorous physical activities as confirmed in other studies [11, 30]. This finding is significant from a public health policy perspective as it calls for population-based and community-focused health education and promotion strategies that stimulate and encourage participation in physical activities on a regular basis.

The finding of our study that socio-economic status (SES), as measured by the level of educational attainment and other socio-demographic factors, are significant determinants and correlates of overweight/obesity and diabetes among the adult population in Mississippi is consistent with findings from other studies [2, 5-6, 17, 20, 27-29, 41-51]. The odds of both epidemics increase with age and adults with lower levels of education are predisposed to higher chances of the diseases compared with college or technical school graduates. In this context, interventions aimed at mitigating the escalation of the epidemics must take into account the socio-demographic profiles of the target population. In particular, obesity and diabetes management interventions must focus on aging adults with lower socioeconomic status who are most vulnerable to the epidemics because of sedentary living and inactive lifestyles that come with aging.

Our finding that adults not participating in moderate or vigorous physical exercise are 1.26 and 1.29 times more likely than their participating adults to be overweight/obese and diabetic is not particularly surprising, as adult Mississippians continue to maintain a number one position in the national ranking of the reported percentage of physical inactivity and number two in consumption of fewer servings of fruits and vegetables [4]. Yet, several research studies have reported that participating in physical exercise at appropriate levels, coupled with consumption of adequate quantities of fruits and vegetables as part of healthful behaviors, is necessary for weight and diabetes management [4, 11, 31-32, 36, 40, 42-43]. Furthermore, that Mississippi remains the poorest state, with the highest percentage of a black minority population in the country, with less access to healthy foods, physical activity/recreational facilities and resources, and safer neighborhoods that are significant predictors of overweight/obesity and diabetes underscore the significant association between adult overweight/obesity and the diabetes prevalence and

behavioral factor as measured by participation/nonparticipation in moderate or vigorous physical exercise in our study [27, 30]. Individuals that are unable to purchase healthy foods and participate less frequently in physical activities are most likely to be unhealthy as characteristic of Mississippi adult population.

To effectively address the escalating epidemics of overweight/obesity and diabetes in the adult population in Mississippi, the underlying socioeconomic imbalances in the state that keep the minority population at low income levels must be properly addressed at the level of legislation. If such legislations are put in place, they must be backed up with political will for effective implementation to achieve the intended goals. It is understandable that poor individuals are less likely to make positive health-enhancing decisions and choices in the face of economic hardships. Furthermore, the need to urgently restructure and redesign the local food environment so as to encourage healthful choices of foods to buy or consume cannot be overemphasized. The positive correlation between close proximity to fast-food restaurants and convenience stores and escalation of obesity and diabetes prevalence has been reported [52]. Therefore, to lessen the burden of obesity and diabetes epidemics in Mississippi, state and local lawmakers and policymakers must initiate and enact public policies that will make healthy foods more readily accessible. Such policies must include healthy food financing [4], placing limit on permits for establishment of fast-food restaurants in low-income communities and neighborhoods [52], attaching participation in WIC to purchases of recommended healthy foods, increasing construction of walk and bicycle trails and recreation parks, and reducing crime rates in black communities and neighborhoods [4, 52].

This study had a few limitations that must be noted. The health outcomes examined in the study are self-reported with high potential for biases, underestimation and overestimation, and recall errors. For example, the overweight and obesity prevalence reported in this study is most likely to be underestimated, as participants in the BRFSS survey may have overstated their heights and underreported their weights used to calculate the BMI [38, 53-54]. In addition, the BRFSS survey excludes persons without landline telephones even when evidence has shown that adults living in wireless-only households tend to be younger, to have lower incomes, and to be members of minority populations, which might result in either underestimation or overestimation. Finally, because of the limited number of other racial and ethnic groups in Mississippi, we could not estimate valid prevalence rates for those population subgroups in the present study. Notwithstanding these study limitations, an important strength of our study is the understanding that, to the best of our knowledge, this is the first study that has

simultaneously identified the determinants and correlates of overweight/obesity and diabetes prevalence among the adult population in Mississippi using a large-scale dataset.

SUMMARY AND CONCLUSIONS

In Mississippi, adult overweight and obesity and diabetes prevalence remains significantly high. Behavioral health factors such as nonparticipation in moderate and vigorous physical exercise is a risk factor in both overweight/obesity and diabetes prevalence in the adult population. The prevalence of overweight/obesity and diabetes varies by socioeconomic status, health behaviors and lifestyles, race/ethnicity, gender and other socio-demographic correlates. The high prevalence of these conditions, coupled with their variations by different predictor factors and correlates, underscores the importance of implementing targeted policies and effective intervention strategies that are culturally competent in the general population [10, 20, 51]. Health services providers and advocates must continue to emphasize the need to restructure and redesign the food environment and underlying socioeconomic imbalances that perpetuate poverty among minority populations that make access to healthy foods and positive behavioral lifestyle changes impracticable [4-5, 29].

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Ecological Observations On Two Mysis Species, *Taphromysis Louisianae* Banner And *T. Bowmani* Bacescu From The Upper Reaches Of Davis Bayou, Jackson County, Mississippi

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ABSTRACT

During an eleven month ecological study of the mysids of the hypohaline upper reaches of David Bayou, Jackson County, MS., most samples were collected with fine mesh (0.5-1.0 mm) dredge nets in shallow (1-2 m) sites. Initially an epibenthic sled was employed for deeper water sites; however, due to apparent anoxic bottom conditions sampling was discontinued at these sites. *Taphromysis louisianae* Banner and *T. bowmani* Bacescu were found to be dominant throughout the sampling period, with the sporadic occurrence of two euryhaline and mesohaline species, *Americamysis almyra* and *A. bahia* which were not treated in this study. The more oligohaline to freshwater occurring species *T. louisianae* was found to be in greater numbers compared to euryhaline species *T. bowmani*, especially in the up-stream stations where salinities were often near 0 ‰. Both species, however, occurred throughout the study area to varying degrees apparently depending largely on the salinity. Mysids appeared to be more abundant at sites where submerged aquatic vegetation (e.g. *Ruppia maritima*) was present. Reproduction occurred year round with ovigerous females in nearly all the samples collected during the study. During the warmer months the numbers of brooding and immature females were considerably higher, but the numbers of eggs in their marsupial pouches were fewer than for females collected during late winter and early spring. Due to the shorter development time stage I embryos were observed far less frequently than those of stages II and III.

INTRODUCTION

Mysids, (Crustacea, Mysidacea) are important trophic commandants of coastal and estuarine communities in North America and throughout the world (Tattersal, 1951, Beck, 1977, Stuck et al, 1979, Perice, 1982, and Takahashi, et al, 2004.). Shallow water bays and estuaries serve as major habitats; mysids use these areas as nurseries. Although extensive studies on mysids exist, but due to difficulty in quantitative sampling because of demersal habitats and lack of uniform distribution, gaps exist on information regarding mysids (Daly et al, 1986). The current study provides some information on seasonal abundance, population composition, structure and life histories of two species of mysids, *T. louisianae* and *T. bowmani* in small tidal bayou system, which opens into Biloxi Bay near the city of Ocean Springs, MS. The sampling stations where sufficient mysid collections were made are characterized by sand/silt or muddy bottoms with abundant plant detritus.

Study Area

The study was carried out in the upper beaches of Davis Bayou, Southern Mississippi, Jackson County, located between lower site (30°24'91"N, 88°44'17"W and upper site (30°24'54"N, 88°45'72"W). The parts of the upper reaches of the Davis Bayou under study are extended to 1.5 km with average width of 15-20 m. Five collecting stations were selected along the study area. Davis Bayou is considered to be a mesohaline to

hypohaline system (VanderKooy et al, 2000). During the study salinities at sampling sites were markedly low (0 to 1‰), apparently the area under study is strictly Hypohaline. Tidal submerged vegetation at lower two stations comprised *Ruppia maritima* and *Vallisneria americana* while at the upper three stations *Junkus rumariana* and *Spartina aleterniflora* were dominant.

MATERIALS AND METHODS

Samples were taken monthly, initially using sledge net (35 x 12 cm mouth size, 1 mm mesh openings). The sledge net was towed of 200 meters, at a depth of 1-4 m along a shore line in the midstream zone using a small boat at speed of 1-2 knots. These samples contained only few or no mysids, possibly due to low contained drastically low number of mysids; as a result a different collection method was employed using hand held kicknet (50 x 25 cm mouth area, and 1 mm mesh openings). The kicknet was towed 10-15 m along the shoreline.. The samples were preserved immediately using 5% buffered formalin for biological analyses. The surface salinity and temperature were taken with a refractometer and centergrade thermometer. The mysid specimens were separated into different taxonomic groups and each group was sexed. Standard length (distance between base of eyestalks and mid-posterior margin of sixth abdominal segment) was used as measure of body length using stereoscope microscope. Based on the development of the oostegites (brood plates) and male copulatory stylet,

females and males, respectively, and other criteria were categorized as juvenile below 3.0 mm and between 3 and 4.9 mm as immature and o above 4.9 mm as mature males measured between 5.0 to 8.5 mm and mature females between 5.00–10.00 mm, *Taphromysis bowmani* mature males measured between 5.0-8.5 mm and mature females between 5.0-9.0mm. The developmental stages of the embryos were observed and categorized by stage. In stage I, the embryo is in the egg membrane, but has developed rudimentary antennae. During Stage II, the embryo hatches, with further development of the antennae, appendages, and later development of recognizable pigmented eyes. The Stage III goes through further growth and has developed stalked eyes before being released from the marsupium

RESULTS

Temperature And Salinity

Monthly surface water temperature peaked in June 2009 and showed a minor peak in October, 2009 (Figure 1). Surface temperature varied from lowest, 16° C in January, 2009 to highest 28 °C on 19 June 2009. The Seasonal and temporal fluctuations in water temperature were quite significant, while surface salinities remained lower and stable, ranging from 0‰ to 1‰ throughout the study period due to continuous freshwater inflow. Because we only made relatively few measurements, there may have been peaks of higher salinities that were missed.

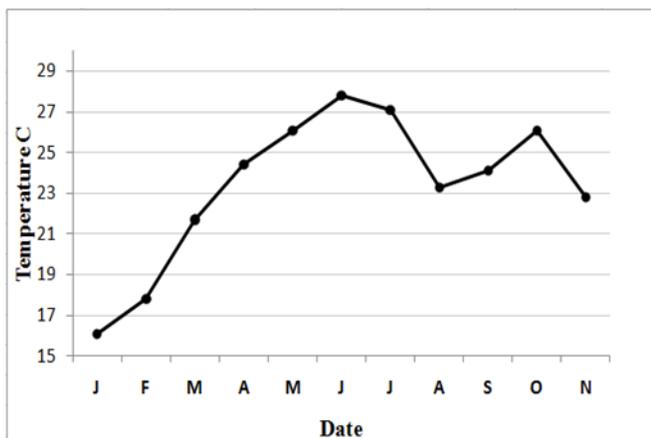


Figure 1. Seasonal changes in surface temperature in Davis Bayou, MS

Relative Abundance

Over 2400 specimens representing both the species were individually measured and categorized based upon their sexual maturity. The monthly collections showed consistent appearance of *T. louisianae* and *T.*, throughout

the sampling period. *Americamysis bowmani almyra* and *A. bahia*; however, only occurred twice in our samples on 1 January 2009, and 26 March 2009, and were not used for detailed analysis. *Taphromysis* species showed significant fluctuations in seasonal abundance, during monthly collections. *T. bowmani* peaked in May and maintained significant abundance in May and June and in January. *T. louisianae* peaked in June and showed relatively higher monthly values as compared to *T. bowmani* during the major part of the study period. *T. louisianae* varying between 82 to 325 with mean as 130, and *T. bowmani* varied between 10 to 265 with mean of 101 during the study period (Figure 2). The seasonal pattern of abundance for both species of *Taphromysis* during the study period was synchronous.

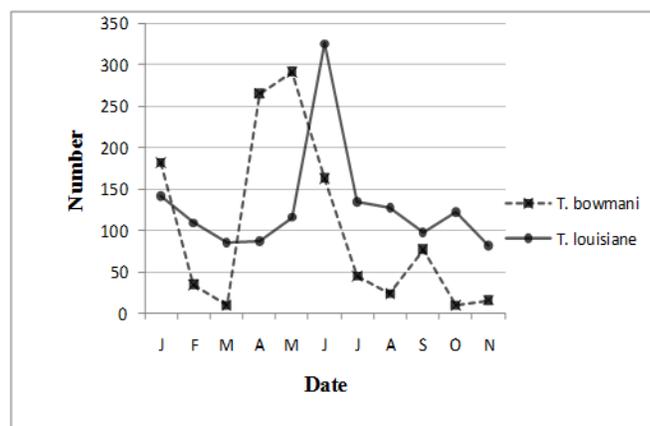


Figure 2. Seasonal and relative abundance of *Taphromysis louisianae* and *T. bowmani* in Davis Bayou, MS

The sledge net collections made in the subtidal zone yielded significantly fewer numbers of specimens as compared to shoreline collections indicated intertidal habitats in Davis Bayou Estuary were more favorable to mysids.

Growth And Development

Based on the development of the oostegites in the females and the copulatory stylet in males below 3.0 mm SL immature specimens were considered to have standard lengths between 3 and 4.9. Males of *Taphromysis louisianae* with fully developed copulatory stylets were considered as mature and measured between 5.0 to 8.5mm. Mature females of *T. louisianae* between 5.0–10.0 mm.

As in *T. louisianae* the length of mature males for *T. bowmani* was between 5.0–8.5 mm. In mature females the length range was between 5.0– 9.0 mm. Thus the maximum size observed for *T. bowmani* females was 1.0 mm less than the largest female of *T. louisianae* observed.

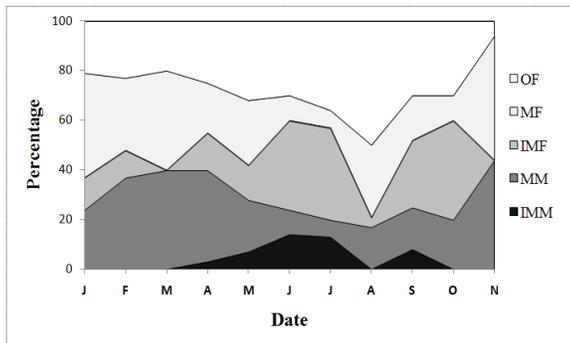
The females of both *T. bowmani* and *T. louisianae* species less than 5 mm in length lacked fully developed brood plates (oostegites). In contrast a majority of the females with standard lengths greater than 5.0 mm had fully developed, interlocking, brood plates. The smallest incubating female observed was 5.0 mm SL, with the majority of the ovigerous females observed being 6 mm SL or greater.

The largest males of *T. bowmani* and *T. Louisiana* measured 8.5 mm. The fourth male pleopod showed early differentiation in endopod and exopod at sizes above 4.0 mm. Besides the difference in the number of inter-furcal spines on the telson, the two species of *Taphromysis* can be distinguished with *T. louisianae* having each anterior margin of its carapace armed with a small spine, a character lacking in *T. bowmani* (Stuck, et al 1979) On the fourth male pleopod of *T. bowmani*, the shorter flagellum is distally bifid and distinctly shorter than the other flagellum; whereas, on *T. louisianae* the tips of both flagella are simple and flagella are subequal in length and pincer-like (Bacescu, 1961, Stuck, et al, 1979). The sympod on the antennules of adult males was characterized development of soft sensory setae (see both species, after attaining size 6.0 mm, the immature males mysids, less than 5 mm in size lacked the setae.

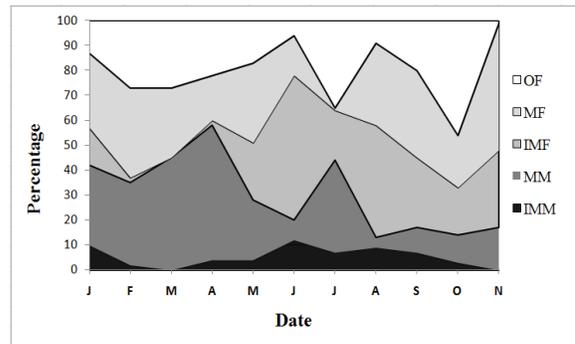
Population Composition And Structure

The monthly changes in the population structure were analyzed on percent basis (Figures 3A and 3B) The immature males (IM) of *T. louisianae* varied from 0% to 12% with mean of 5.27%, that of mature males (MM) from 10% to 54% with mean of 25%, that of immature females (IMF) from 0% to 58% with mean of 22.1%, that of mature females (MF) from 1% to 51% with mean of 27.36, that of Ovigerous females (incubating) from 1% to 46% with mean of 20.27%.

A. *Taphromysis bowmani*



B. *Taphromysis louisianae*



Figures 3A and 3B). Seasonal variations in population composition and structure of *Taphromysis louisianae* and *T. bowman*

The immature males of *T. bowmani* varied from 0% to 14% with mean of 4.1%, that of mature males 7% to 44% with mean of 24.9%, that of immature females 0% to 40% with mean of 17.9%, that of mature females 7% to 50% with mean of 25.5%, that of ovigerous females from 6% to 50% with mean of 27.6 The overall sex ratio including immature, mature and ovigerous mysids of *T. Louisiana* was 28.2% males to 71.78% females, and that of *T. bowmani* was 29.1% males to 70.9% females, indicating males are significantly fewer in number in Davis Bayou Estuary.

Brooding Females And Brood Size

Ovigerous females of *T. louisianae* and *T. bowmani* were present in samples throughout the study period. The numerical seasonal abundance varied markedly but because of year round presence of immature mysids and ovigerous females the study indicates reproductive activities continue year-round (Figs., 3A&B). Large ovigerous females were observed from February to May 2009; whereas, the average size of ovigerous females decreased from June to August apparently due to females becoming reproductively more active resulting in increase in number but smaller in body size (brood size larger in winter, and smaller in summer). Body size of the brooding females increased with advancing developmental stages of embryos, also noted in other studies (Mauchline, 1973, Takahashi, 2004 and Hanamura, et al, 2008). The samples contained post brooding mysids with fully expanded marsupium but no embryos present. The maximum number of eggs found in *T. Louisianae* was 21 and in *T. bowmani* was 25 during February, and in April, 2009. The egg developmental and larval stages of both species of *Taphromysis* under study had similar size measurements. The eggs and stage I larvae of both *Taphromysis* species measured 0.5 to 0.6 mm. Because of

the more rapid development and shorter duration time, the presence of stage I embryos, which are enveloped in an egg membrane, was less often observed. The maximum number of stage II embryos in any female observed were 25, measured 1.0 to 1.2 mm, and had pigmented eyes. The stage III embryos had stalked eyes and well-developed appendages measured 1.3 to 1.7 mm. The maximum number of embryos the females carried were 13 (*T. louisianae*) and 12 (*T. bowmani*) during the study period. The present study noted the embryos within the same marsupium were at the same stage, except rarely stage II embryos got admixed with stage III, also reported by other studies possibly due to “adoption” of the embryos from another female (Mauchline 1973).

DISCUSSION

This study focused on *Taphromysis louisianae* and *T. bowmani*, which co-occurred as year round residents and the most prevalent species of the upper reaches of Davis Bayou. On two occasions two other mysids *Americamysis almyra* and *A. bahia* occurred in our samples at down the stream stations (Figures 1 and 2). Ecological observations on *Americamysis* species were not made because of their rare occurrence in our samples. Both species of *Taphromysis* treated here represent geographical isolate of the mysid populations of coastal estuaries and shallow water areas of Northern Gulf of Mexico (Price 1978; Daly 1986; Reeder 1992; Heard et al., 2006). Originally mysid sampling in Davis Bayou estuary was carried by an epibenthic sledge that resulted in poor samples. The shoreline intertidal collections, designed later, yielded considerably higher number of mysids. This study showed shoreline habitat was highly suitable for *T. louisianae* and *T. bowmani* also compared favorably to other studies with *Mesopodopsis orientalis* in Mangrove Estuary and *Heteromysis riedii* in near-shore areas in Malaysia (Wittman, 2000 and Hanamura et al., 2008).

Our limited seasonal observations on the abundance of *Taphromysis louisianae* indicated that it is generally hypohaline species with its abundance peaking in June; whereas, that of the more euryhaline *T. bowmani* was highest during May (Figure 2), but the seasonality pattern showed similar trend (Figure 2). The temperature fluctuations (Figure 1) clearly affected the seasonal abundance and reproductive activities. The specimens (females) of *T. louisianae* and *T. bowmani* were larger in winter months (January to March, 09) with grand average size as 7.1 and 6.9 mm; respectively (Table 1). In contrast in warmer months (April to July 2009) the grand average for *T. louisianae* and *T. bowmani* was 4.6 and 5.0 mm; respectively (Table 1). The study noted similar seasonal pattern in male standard length as compared to

females. *T. louisianae* male, had grand average 6.5 mm in winter (January to March, 2009) and 4.8 mm in warmer months (April to July, 2009) and that of *T. bowmani* male, had 6.9 mm in winter and 4.5 mm in warmer months.

This study indicates that temperature appears to be directly related to seasonal abundance and to fair degree inversely related to average body size. Higher temperatures appeared to cause an increase in reproductive activities with an apparent decrease in average body size (Mauchline, 1980; Wittman, 1984; Johnson et al, 2001). Present study also noted relationship in total body size of females and related fecundity. The brooding females of both species of *Taphromysis* species with greater body size (Table 1) in winter months had higher fecundity; and in summer months the gravid females with smaller body size had lower fecundity (Moldin, 1993).

Table 1: Seasonal variations in average body size (mm) of *Taphromysis louisianae* and *T. bowmani*

Date	<i>T.Louisiana</i>	<i>T.bowmani</i>
1/9/09	7.0	6.7
2/26/09	7.2	7.1
3/26/09	7.5	7.1
MEAN:	7.1	6.9 (Jan-March)
4/14/09	6.1	5.9
5/27/09	5.3	5.6
6/19/09	4.0	4.1
7/7/09	4.4	4.6
MEAN:	4.6	5.0 (Aprl- July)

The surface salinity was markedly low (0-1 ‰) throughout the study period and no effect was noticed across the spectrum of developing stages or the reproductive activities. We were not in a position to sample bottom salinities which may have been higher. The year round presence of brooding females and immature mysids in most monthly samples (Fig.3, A &B) clearly indicate *T. louisianae* and *T. bowmani* are residents and that they are sexually active throughout the

year round in our study area of Davis Bayou.

Although there are extensive studies on the Mysids available, literature dealing with ecological parameters and productivity remains limited. Mysids are important source of estuarine food for many fishes and invertebrates and even as human food in southeastern countries (Mauchline, 1980). The present study presents data with the population composition, structure, abundance, fecundity and reproduction; further work to enhance the information on ecological parameters and productivity will continue.

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Errata Sheet

Cellular and Molecular

Thursday, February 23, 2012 Poster Session

A MODIFIED AND SENSITIVE PROTEIN ASSAY FOR DILUTE BIOLOGICAL SAMPLES

Rajiv Heda[^], Upasana Kunwar*, Dominique Robinson*, Ghanshyam D. Heda*

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There are a variety of protein assays that can measure the protein concentrations in biological samples at microgram levels. However, protein assays measuring the nanogram quantities in dilute biological samples is a rarity, except the recent surge in use of nanoparticles in the measurement. In this study, we aimed to improve and modify a protein assay that was originally described by Schaffner and Weissmann (Anal Biochem, 56, p 502-514, 1973). Our newly developed protein assay is rapid, reproducible, cost effective, and more importantly sensitive. Dilute protein samples of various concentrations were applied to the nitrocellulose membrane using a dot-blot apparatus and TCA precipitated. Precipitated protein spots were stained either with amido black alone or in combination with other protein stains. The combination staining of protein spots with amido black and colloidal gold (BioRad Laboratories) produced a synergistic effect, allowing us to measure the protein concentrations in nanogram range. The linearity of assay was confirmed by salt-elution of protein spots and analyzing with NanoDrop 1000 spectrophotometer (Thermo Scientific) at OD630, and/or by photo-scanning the stained protein spots and obtaining the pixel counts using Quantity One[®] analysis software (BioRad Laboratories). The validity of this assay at the microgram measurement levels was confirmed with the commonly used Biorad Protein Assay that is based on the principles of Lowry et al (J Biol Chem, 193, p 265-275, 1951). This newly developed protein assay will be useful in measuring protein concentration in minute biological samples prior to their biochemical analysis such as in comparative proteomics. We will be employing this protein assay in measuring the concentrations of low abundance proteins in endocytic vesicles that are immunopurified from mammalian cells expressing wild type and mutant CFTR. A mutated CFTR is responsible for the genetic disease cystic fibrosis.

Chemistry

Meeting at glance:

1. PLENARY SESSION I: the affiliation of Dr. Joseph Emerson will be "Mississippi State University".

Thursday, February 23, 2012 Plenary Session I

11:30-11:45

MOLECULAR RECEPTORS FOR FULLERENES

Andrzej Sygula

Department of Chemistry, Mississippi State University

The development of novel synthetic methodologies to construct molecular clips and tweezers capable of forming supramolecular assemblies with fullerenes is reviewed. A special emphasis is given to the molecular receptors with bowl-shaped pincers derived from buckybowls such as corannulene. Stability of tweezers-fullerene complexes depends heavily on π - π interactions. Since rational design of efficient molecular receptors hinges on accurate theoretical prediction of their binding potential, the performance of computational models in describing π - π stacking interactions between conjugated carbon networks is briefly reviewed and critically assessed. Many uses of "buckycatchers" have been envisioned, e.g. as novel stationary phases in liquid chromatography for the separation of fullerenes or photovoltaic devices assembled from buckycatcher-fullerene complexes with the most important applications yet to be imagined.

Chemistry Division Student Awards: Sponsored by the Department of Chemistry and Biochemistry at Jackson State University

Health Sciences

Thursday, February 23, 2012 Poster Session I

HYDRAULIC CONDUCTIVITY OF PODOCYTE CELLS

Ahmed Abdelrahman and Joel M. Henderson

Tougaloo College, Jackson, MS and Boston University/ Boston Medical Center, Boston, Massachusetts

The kidneys maintain homeostasis in the body by regulating solute concentration in the blood, pH of the blood, water retention, and waste removal. Podocyte cells surround the capillaries of the glomerulus and filter through slits between the foot processes. Lysophosphatidic acid is known to cause podocyte cells to contract. The focus of this study is to compare the hydraulic conductivities of vehicle treated human podocyte cells and lysophosphatidic acid treated human podocyte cells. Hydraulic conductivity is the measure of

the ease of which a liquid flows through a porous membrane. In this study, an in vitro model of the glomerular capillary wall was created by growing normal human podocyte cells on a synthetic permeable PTFE membrane, which was chosen to mimic the properties of the glomerular basement membrane (GBM). A custom designed flow chamber was constructed to allow the cellularized membrane to be perfused under pressurized conditions similar to those found in vivo. The hydraulic conductivity of the model was tested using the classical constant-head method and compared against measurements obtained using a clean membrane. Since the hydraulic conductivity depends on the flow rate of the system, the results from the experiment were inconsistent due to varying flow rates. The conclusion from the results is that the membrane experiences a change over time in the system that causes flow rate variances. Also the presence of collagen appears to stabilize the flow rate of the membranes. Comparing the results of the vehicle treated podocyte cells and lysophosphatidic acid treated podocyte cells there appeared to be no difference most likely due to being unable to obtain a confluent monolayer of human podocyte cells. Traction force microscopy was used to take images of the confluency of the cell-plated membranes.

Thursday, February 23, 2012

Symposium 2:00-4:00 Conference Room

**INNOVATIVE HEALTH PROFESSIONAL
EDUCATION: THE CHALLENGES OF
INTEGRATION**

1Francis I. Achike, 1John Jones, 2Rob Rockhold, and
2Ralph Didlake

1William Carey University, College of Osteopathic
Medicine, Hattiesburg, MS 39401

2University of Mississippi Medical Center, Jackson, MS
39216

The Flexner report of 1910 represents a watershed moment in the history of modern medical / health professional education. It set the foundation for what is today referred to as the traditional medical curriculum. The report not only emphasized on the need for integration of the clinical and basic medical sciences, it also laid the foundation for the recognition, growth and development of the various disciplines that make up scientific medicine. By the middle of the 20th century, the various disciplines had grown enormously, many beyond their traditional boundaries into novel disciplines (or sub-disciplines). This geometric growth in knowledge, aided by silicon chip technology, created an unprecedented ease of information dissemination and

concomitantly, changes in medical concepts. Despite these factors, the American medical school curriculum remains fixed at 4 years of training, leading to a need for innovative curricular approaches. The doctor/ health professional of tomorrow will need to cope with rapid changes in medical knowledge and attitudes. He must be equipped with knowledge, attitudes and skills for integrating the rapid advances in medical sciences into clinical practice. He should be well-adjusted to an increasingly medically aware and litigious public. Modern innovative medical/ health professional curricula are geared toward producing graduates with these characteristics, including communication and information and communication technology (ICT) skills.

In this workshop we shall discuss the what, how and why of innovative medical / health professional curricula, comparing same with the traditional curriculum. We shall explore the underpinning pedagogic principles, and elaborate on the challenges in achieving these objectives with inputs from faculty in the two medical schools (William Carey University College of Osteopathic Medicine and the University of Mississippi Medical Center) in the state of Mississippi, USA.

Friday, February 24, 2012 Exhibit Hall A

8:45 am

**ATTITUDE TOWARD DISCLOSURE OF CLINICAL
ERRORS AND UNPROFESSIONAL CAREGIVER
BEHAVIOR AMONG STUDENT AND PRACTICING
NURSES**

1Nedah Nemati and 2Ralph H. Didlake, M.D., FACS

1Millsaps College and 2University of Mississippi Medical
Center, Jackson, MS 39216

Medical and surgical errors are directly responsible for at least 45,000 deaths in American hospitals each year. A growing body of literature indicates that dysfunctional communication among physicians, nurses, and other caregivers is the primary contributing factor associated with events that lead to patient harm. An important element of effective inter-professional communication within the clinical environment is the willingness of care-team members to disclose error, patient safety issues, and report disruptive or unprofessional staff behavior. In order to better understand this issue, the attitudes of student and actively practicing nurses toward disclosure were measured using a 24-question survey. Data were gathered using a paper questionnaire from 214 attendees of the 2011 Mississippi Nurses Association's annual meeting. Analysis revealed that 59.1% of nursing students and 64.5% of practicing nurses would "definitely" or "probably" disclose unprofessional behavior. No statistically significant

difference in attitudes toward disclosure was found between students and actively practicing nurses. The findings of this study indicate strong support within the nursing profession for disclosure of unprofessional, disruptive or unsafe clinical behavior.

Friday, February 24, 2012

Poster Session III

A COMPARISON OF TESTOSTERONE WITH PROSTATIC ACID PHOSPHATASE AND PROSTATE SPECIFIC ANTIGEN FOR THE SERODIAGNOSIS OF PROSTATE CANCER IN ADULT MALES

Annie Chu, Hannah Rice, James T. Johnson, Sabrina Bryant, Cynthia Handley, Anna Swann, Caroline Henderson, and Margot Hall

University of Southern Mississippi, Hattiesburg, MS 39406

Prostate cancer is the second most common cause of death from cancer in men. The American Cancer Society has estimated that there will be 240,890 newly diagnosed cases in 2011 and 33,720 deaths from prostate cancer. Diagnosis of this disease has traditionally been done by measuring prostate specific antigen (PSA) levels through sero-chemical testing. This test was found to have a 58.31% efficiency due to the amount of false positive and false negative results. Thus, a diagnosis of prostate cancer can be seen with low PSA levels. The purpose of this study is to compare testosterone levels to PSA levels and Prostatic Acid Phosphatase (PAP) in the advent of new and more accurate technology. This study shows that testosterone was not efficient in correctly diagnosing those with prostate cancer. It had a sensitivity of 0% compared to PSA at 30.12% and PAP at 20.73%. However, the percentage of true negative results in those without prostate cancer was significantly higher than PSA or PAP testing. It had a specificity of 98.67% versus PSA at 72.00% and PAP at 93.46%. Possible explanations for 0% true positives may be due to skewed results from patients already receiving treatment. The reference values for this test may also require revision. The manufacturer's suggested reference ranges were used in this study and may not properly represent the patient demographic.

A COMPARISON OF PROSTATIC ACID PHOSPHATASE, WITH TESTOSTERONE, AND PROSTATE SPECIFIC ANTIGEN FOR THE SERODIAGNOSIS OF PROSTATE CANCER IN ADULT MALES

Hannah Rice, Annie Chu, James T. Johnson, Caroline Henderson, Cynthia Handley, Sabrina Bryant, Anna Swann, and Margot Hall

University of Southern Mississippi, Hattiesburg, MS 39406

Cancer is a hyperplastic cellular malignancy that affected 1436 people in the United States last year. The top three most frequent forms of cancer were lung, prostate, and breast. Oncogenesis is associated with both genetic predisposition and environmental onslaught, with a mixture of the two being required for the malignancy to progress. Tumor markers, circulating serum factors, are used in the diagnosis of cancer. Prostate cancer is one of the most prevalent forms of this malignancy, affecting 230,110 men in 2004 alone. Diagnosis of prostate cancer is currently performed using results of an assay for prostate specific antigen (PSA). However, the theory has been made that either prostatic acid phosphatase (PAP) or testosterone may be a more accurate tumor marker than PSA. This experiment examines the efficacy of all three of these tests and specifically compares a PAP assay to the current standard exam for PSA. A Diagnostics Automation, Inc. enzyme immunosorbent assay was used to measure prostatic acid phosphatase in 100 healthy adult males and 300 adult male patients. Predictive values were determined for PAP and compared with those of the PSA assay performed on the same samples. The results were as follows: diagnostic percent sensitivity was (20.73, PAP); (0.00, Testosterone); (30.12, PSA), the diagnostic percent specificity was: (72.00, PAP); (98.67, Testosterone); (93.46, PSA), and the diagnostic percent efficiency was: (58.31, PAP); (72.31, Testosterone); (75.76, PSA). From these data, we concluded that the test for prostate specific antigen is the most accurate and efficient screen for prostate cancer.

Geology

Thursday Evening, February 23, 2012

6:30-8:30 Poster Session

Rescheduled

02.14 Rescheduled to Poster Session

THE EFFECTS OF STATINS ON LARVAL SHEEPSHEAD MINNOW AND ZEBRAFISH

Stephanie Taylor, Robert Griffitt

Withdrawal

P2.08 THE ROLE OF REACTIVE OXYGEN SPECIES (ROS) IN INDUCING PUMA(P-53 UP REGULATED MODULATOR OF APOPTOSIS) DEPENDENT APPTOSIS IN NEUTROPHILS

Justin Thornton, Perceus Mody

Retraction

P2.13 EFFECT OF METHYL PARATHION EXPOSURE ON ANTIOXIDANT EXPRESSION LEVELS IN HUMAN LIVER CARCINOMA CELLS

Amber Shaffer, Falcia Edwards

P2.14 EFFECT OF PARATHION EXPOSURE ON ANTIOXIDANT EXPRESSION LEVELS IN HUMAN LIVER CARCINOMA CELLS

Diva Whalen, Falcia Edwards

Friday, February 24, 2012

Abstract Withdrawn

9:30 am

LAND USE AND LAND COVER CHANGE ALONG THE MISSISSIPPI GULF COAST: 1985–2009 –

George Roedl

ABSTRACTS SUBMITTED LATE-

Received March-April-2012

COMPARATIVE ANALYSIS OF PARENTAL ATTACHMENT AND EMOTIONAL EXPRESSIVITY OF THOSE IN A RELATIONSHIP AND THE UNCOMMITTED

Tia L. Caston*, Madhu Singh, PhD, Tougaloo College, Tougaloo, MS 39174

Early attachment appears to be an indicator of later emotional expressivity in relationships. according to Collins, Van Dulmen, Roisman, and colleagues (2005). There is limited research on how parental bonding affects an individual's emotional expressivity in later relationships This research looked at how bonding with the mother and the father affected emotional expressivity of 80 college students, 40 of whom were in a relationship and 40 who were uncommitted.. The Parental Bonding Instrument (Parker, 1989) and the Emotional Expressivity Scale (Kring, Smith & Neale, 1994) were used. It was expected that emotional expressivity would be greater among those in a romantic relationship as compared to the unattached, however those not in a relationship were more expressive ($t(78)=.890; p= 0.40$) . There were no differences in bonding with either parent among the two groups. Correlational analysis revealed a significant negative correlation ($r=-.392; p< .01$) between care and overprotectiveness of the mother and a positive correlation ($r=.403; p< .01$) for the father, indicating that parental bonding takes on different aspects for the parents. Further research is called for to explore these dimensions of attachment and their relationship to the expressivity of the children. The study did not look at the nature of the relationship of those who said they were involved and understanding these dynamics would help

explain the lower expressivity demonstrated in this sample.

SEXUAL BIAS: PHYSICAL ATTRACTIVE PREFERENCES

Christopher Thomas*, Shaila Khan Ph.D., Tougaloo College, Tougaloo, MS

Every individual has a "list" of what they do and do not want in a partner. For some people, love is the top of the list, followed by honesty and physical attractiveness. For others, it may be the social status, monetary wealth, and the ability to reproduce offspring. This research was conducted on 80 African American college students (40 males; 40 females). Each participant was asked to complete a demographic sheet, a mate selection survey, list six desirable traits in choosing a mate, and asked to choose the most preferable celebrity among six pairs of celebrities based on four traits. It was hypothesized that males would be more likely to report choosing a long-term mate based on physical attractiveness compared to females. Results of a 2 X2 Chi Square test revealed that 46.3.% of males chose physical attractiveness as a significant factor when choosing a long term mate in comparison to 37.5% of the females ($\chi^2= 4.501; p= .034$). Other significant factors for mate selection between gender was chastity ($\chi^2= 20.00; p= .000$), social status ($\chi^2= 11.67; p= .001$), mutual love and attraction ($\chi^2= 3.91; p= .048$), good health ($\chi^2= 12.75; p= .000$), and education and intelligence ($\chi^2= 10.14; p= .001$). Physical attractiveness was also listed by males as one of the most desirable factors among six traits. Finally in selection of celebrity for both males and females physical attractiveness was the top criteria for their selection followed financial security, personal liking and social status.

THE RELATIONSHIP OF EXERCISE, DIET, AND HEALTH LOCUS OF CONTROL TO OBESITY

Antionette McKay* and Gary Chong, Ph.D., Tougaloo College, Tougaloo, MS

Obesity has been a significant public health problem in the United States since the 1970's (The Journal of the American Medical Association, 2008). The purpose of this study was to understand the relationships of three predictor variables, exercise, diet, and Health Locus Of Control (HLOC) to the dependent variable of obesity. Of the 90 African- American college student participants, 45 of them were females and the 45 were males. Their ages ranged from 18 to 24 years, and their academic classifications ranged from freshman to senior. All participants were asked to complete three surveys that assessed exercise frequency, dietary concerns, and health locus of control. Data on obesity was obtained using the Body Mass Index (BMI) for each participant. The surveys were administered in classroom and dormitory settings. The first hypothesis predicted that students who engage in physical activity will be less likely to be obese. The second hypothesis predicted that students who are engage

in physical activity will be more likely to have greater internal health locus of control. The third hypothesis predicted that high Eating Attitudes Test (EAT) scores would be associated low on exercise scores. A multiple regression analysis revealed no significant relationships between the predictor variables of exercise, diet, and HLOC and the dependent variable of obesity ($F=.044$, $p=.98$). R-squared indicated that only 3.8% of BMI variance was accounted for by the predictors model.

THE RELATIONSHIPS OF PARENTING STYLES TO AGGRESSION AMONG AFRICAN-AMERICAN COLLEGE STUDENTS

Angela Hodges* and Gary Chong, Ph.D., Tougaloo College, Tougaloo, MS 39174

Numerous studies have examined the connection between parenting styles and aggression in children and adolescents. According to Sandstrom (2007) authoritarian and permissive parenting styles are more likely to be associated with aggressiveness than the authoritative parenting style. Limited research has been done, however, to determine if relationships between these variables are similar among African-Americans. This study examined the relationships between three types of parenting styles, as predictor variables, and aggressive characteristics. It was hypothesized that authoritarian and permissive parenting would be associated with higher levels of aggressiveness compared to the authoritative parenting style. Data was collected from 80 African-American college students; 33 males and 47 females. There were two questionnaires administered; the Parental Authority Questionnaire (PAQ) and the Aggressiveness Questionnaire (AQ). A multiple regression analysis was used to compare participants' aggressiveness to their perceptions of the parenting styles they had experienced. Results of the analysis indicated that none of the predictor variables were significantly associated with aggressiveness. The overall model was also not significant ($R^2=.30$, $F(.786)$ $p < 1.000$), and only accounted for 3% of the variance for the dependent variable. An ANOVA revealed no significant differences between the means of the scores for parenting styles. Thus, the results from this study suggest that aggressiveness among African-American college students is not significantly related to parenting styles.

ATTITUDES AND BELIEFS OF ABORTION AMONG AFRICAN AMERICAN MOTHERS AND YOUNG ADULT WOMEN

Marnise Webb * Shaila Khan Ph.D., Tougaloo College, Tougaloo, MS

The current study investigated the attitudes and beliefs of abortion among African American mothers and young adult women. An attitudes and beliefs of abortion questionnaire were administered to 90 women with and without children. If the participant had a low score in this

scale, this would indicate that this person has pro-life beliefs and the high score would indicate pro-choice beliefs. First, it was hypothesized that African American mothers would have a negative view of abortion (pro life believer), second it was hypothesized that participants who did not have an abortion would have a negative view of abortion and participants who were not in support of those who had an abortion would also have a negative view of abortion. The t-test showed the mean for African American women without children was higher ($M=41.78$; $SD=8.45$) than those with children ($M=26.40$, $SD=9.46$) with $t(88) = -8.133$; $p= .000$. T-test showed that the mean for those who had had an abortion was also higher ($M=35.8000$; $SD=11.82$) than those who did not ($M=33.99$; $SD=11.86$) with $t(88) = .332$; $p= .741$. Finally the t-test showed that the mean for participants who were in support of those who had an abortion was higher ($M=43.08$; $SD=8.78$) from those who were not in support ($M=27.97$; $SD=9.78$), $t(88) = 6.009$; $p=.000$. The first and third hypothesis was accepted while the second of the hypothesis was not.

THE DIFFERENCE IN SELF-ESTEEM OF TEEN MOTHERS FROM SINGLE AND DUAL PARENT HOMES

Charity Thompson, Madhu Singh, Ph., Tougaloo College, Tougaloo, MS 39174

There has been a rise in teen pregnancy among African Americans in Mississippi (McLauren, 2010). Research also indicates that teen pregnancy occurs more in single parent homes than in homes with dual parents, and is associated with self-esteem issues (Bonell, Strange, Oadley, Copas, Johnson & Stephenson, 2006). The present study looked at the self-esteem of 80 African American teen mothers from single and dual parent homes from two college campuses. It was expected that there would be more teen mothers from single parent homes, and their self-esteem would be lower than that of mothers from dual parent homes. It was also expected that they would be more aware of the whereabouts of the local Family Planning Clinics, services offered, and would utilize them more both prior and during pregnancy. The Rosenberg Self-Esteem Scale (1960) was used as a measure of self-esteem, and a Socio-Demographic questionnaire inquired about family planning awareness. Frequency analysis revealed that there were slightly more teen mothers from dual (41) than single (39) parent homes. No difference in self-esteem was found. However, teen mothers from single parent homes did have significantly greater knowledge about the locations of the Family Planning Clinic compared to dual parent homes ($t(78)=2.42$; $p=.02$), they visited the Family Planning clinics more often ($t(78)=2.48$; $p=.02$); and also visited the clinics more often prior to pregnancy ($t(78)=3.04$; $p=.00$). This research provides some insight into factors prior to, and during teen pregnancy.

DIFFERENT TYPES OF CYBER BULLYING AMONG AFRICAN AMERICAN COLLEGE STUDENTS

Keyaira Johnson* Shaila Khan Ph.D., Tougaloo College, Tougaloo, MS

The purpose of this study is to examine the knowledge and prevalence of cyberbullying as well as different types of media ((e.g. text messaging; pictures/video clips; phone calls; email; chat rooms; instant messaging; and social networking sites) used for cyber bullying among African American college students. A questionnaire on cyber bullying was administered to 80 participants (40 males and 40 females). The hypothesis investigated was: First, females would be more likely to be victims of cyber bullying compared to males. Second, there will be a gender difference in the type of media commonly used for cyber-bullying. Third, Text Messaging will have the highest use as a means to cyber-bully others. Fourth, there will be gender differences on awareness of cyber bullying taking place through the different types of media commonly used for cyber bullying. An independent sample t-test revealed that males were more likely to be victims of cyber bullying with $t(78) = 2.115$; $p=.038$; thus, rejecting the first hypothesis. No gender differences in the type of media commonly used for cyber-bullying were found. Text Messaging had a higher mean compared to the use of Mobile Phone Calls as a means to cyber-bully others with $t(79) = 2.063$; $p=.042$. Seven chi-square analyses reveal that in all instances females were found to be more aware of cyberbullying taking place through the various types of media commonly used for cyber bullying. The findings of this study should be used as a means of prevention and intervention for cyber bullying.

THE ECHO READING STRATEGY AND ITS EFFECT ON THE ORAL READING FLUENCY OF FIRST GRADE STUDENTS

Kiara Burton*, Gary Chong, Ph.D., Tougaloo College, Tougaloo, MS 39174

Reading is the foundation for all learning. The No Child Left Behind Act instigated major accountability factors for school districts, schools, administrators and teachers as it pertains to reading instruction. With such accountability, all stakeholders have become focused on improving reading components where students are not performing well. Reading fluency is a component of skilled reading that is often neglected in the classroom. The purpose of this study was to examine how a reading fluency program would affect oral reading scores. Forty first grade students participated in this study which used the Echo Reading Strategy (ERS) as an intervention to improve reading fluency. Following a baseline phase, the ERS was administered over a ten-week time span. Each participant's reading fluency was tested with their scores compared to reading benchmarks and indicators of risk. Data analyses were conducted using T-test. The winter

semester mean baseline score ($M=31.40$, $SD= 25.86$) $t=(2.79)$ $p<.01$ was significantly lower than the final mean score for the spring ($M=49.88$, $SD=31.88$) $t=(1.96)$ $p=.05$ which indicated that reading fluency increased significantly after application of the ERS. Data collected from non-ERS classes indicated that more students from the targeted ERS classrooms met or exceeded benchmark status, further supporting oral reading fluency programs to strengthen reading achievement.

ATTITUDES OF AFRICAN AMERICANS TOWARDS INCARCERATED PERSONS

Gabrilie Sanders*, Madhu Singh, PhD., Tougaloo College, Tougaloo, MS, 39134

In the United States punishment for breaking a law often ends in prison sentences. These prison sentences can affect both the individual being imprisoned as well as other whom interact with those individuals (Haskins & La Fon, 2001). This study evaluated the attitudes of 80 African Americans towards prisoners; 40 from a HBCU, between the ages 18-25, and 40 from a local Baptist church ages 35 and above. The hypotheses were that 1. Younger adults will have more positive attitudes towards prisoners, and 2. Females will have more positive attitudes towards prisoners, and 3. Individuals with high school level education will have a more positive attitude than individuals with more advanced degrees. These were tested by administering the Attitudes toward Prisoners Survey (ATP), developed by Melvin, Gramling & Gardner (1985). It was found that younger adults had significantly higher mean scores ($M=124.76$, $SD=13.14$) than older adults ($M=117.30$, $SD=12.26$) $t=2.63$, $df(78)$, $p<.01$). Females had significantly more positive attitudes with a $t=0.56$, $df(78)$; $p<.01$. Group one mean score of education levels "less than high school", "high school diploma" and "associated degree/some college" combined was ($M=123.03$, $SD=13.04$), Group two of education levels including "bachelor degree" and "advanced degrees" mean score was ($M=115.43$, $SD=12.15$) $t=(2.334)$ $p<.01$ results were significantly different. Positive acceptance of these individuals may help reduce recidivisms and the stress associated with reintegration. (Esperian, 2010).

THE INFLUENCE OF SINGLE, DUAL, AND DIVORCE FAMILY STRUCTURE ON INTIMATE RELATIONSHIPS

Jaleesa Rene' Seals*, Nhan Truong, PhD., Tougaloo College, Tougaloo, MS 39174

In the United States, there are millions of failed marriages each year. There has been ample research on why this is happening. One characteristic that contributes to failed marriages is family structure. However, the relationship between family structure and intimate relationships have not been explored. The present survey study examined the effects of family structure on intimate

relationships. It was hypothesized that children raised in a dual family structure would have better intimate relationships than children raised in single and divorce family structures, and there would be a notable difference between divorce and single family structures. This research was conducted using the ECR-R (Experiences in Close Relationships Revised) and a brief questionnaire. The research was done with 80 African American participants at Tougaloo College in Tougaloo, MS. The survey was conducted in a classroom setting. Two separate ANOVAs were performed, and indicated that there were no significant differences between the three family structure levels on anxiety attachment and avoidance attachment ($p > .10$). However, further analysis using a Two-Way ANOVA showed that there was a trend of gender by married family structure interaction on anxiety attachment ($F(2, 80) = 2.59, p = .08$). This study has implications for identifying which demographics to look for in a partner that contribute to positive intimate relationships.

THE RELATIONSHIP OF SELF-ESTEEM AND SELF-EFFICACY TO SCHOLASTIC ACHIEVEMENT AMONG AFRICAN-AMERICAN COLLEGE STUDENTS

Indeya Womack* and Gary Chong, Ph.D., Tougaloo College, Tougaloo, MS

Previous studies in the literature suggest that higher levels of self-esteem and self-efficacy are associated with academic success. Many African-American students face

obstacles in developing these characteristics as members of a racial/ethnic minority. High self-esteem and self-efficacy are related to self-confidence and a drive to excel and demonstrate high scholastic achievement. This study investigated the relationship of self-esteem and self-efficacy to scholastic achievement in African-American college students. Forty African-American male and forty African-American female students were administered two questionnaires: the Rosenberg Scale of Self-Esteem and the General Self-Efficacy Scale. The students were also asked to include their Grade Point Average (GPA) in the questionnaires. It was hypothesized that students with higher levels of self-esteem and a stronger sense of self-efficacy were more likely to have greater scholastic achievement as indicated by their GPA. The independent, predictor variables of the study were self-esteem and self-efficacy and the dependent variable was scholastic achievement. Results from a multiple regression analysis of the participants' scores failed to support the hypothesis by indicating that there was no significant relationship between the predictor variables of self-esteem and self-efficacy to scholastic achievement ($F=0.65, p=0.52$). The adjusted R-squared indicated that the model of predictors accounted for only 0.90% of the variance for participants' GPA values. It was concluded that among African-American students, high levels of self-esteem and self-efficacy may not necessarily predict their academic achievement.

MAS AWARD WINNERS 2012

Dr. Alamgir Hossain Recognized for the best Division Chair, 2011

Dr. Alex Acholonu Recognized for his Outstanding Contribution to Science

Dr. Robert Bateman Recognized for his Service to the Academy

Annual Report (2011-2012)

Division of Chemistry and Chemical Engineering

Annual Meeting of Mississippi Academy of Science, 2012

Prepared by Dr. Md. Alamgir Hossain

Chair, Chemistry and Chemical Engineering Division 2011-12

1. Summary

The Division of Chemistry and Chemical Engineering arranged six plenary sessions for thirty five invited speakers, two oral sessions for students and two general poster sessions. This division also arranged an NSF CAREER awardees' symposium covering all current CAREER awardees in chemistry in the State. This year, the Division of Chemistry and Chemical Engineering solicited over 100 abstracts as compared to 39 in the previous year.

2. Planning and preparation for a successful symposium in chemistry

After accepting the chair position of the division, Dr. Hossain had set a target to increase the abstracts and participants at least by 100%. He realized that the right planning is the key to make a successful symposium. He started communications with people in other institutes, and physically visited several Universities and Colleges. In September 2011, he started the solicitation for abstracts by sending flyers, email communications, and personal phone calls. He also made plans of the overall structure of the symposium. Dr. Hossain requested all the departmental chairs/heads of higher institutes to post a flyer he prepared (*Figure 1*) on the departmental notice board, as well as to distribute it electronically to other faculty. According to his design, he started inviting the selected speakers suitable for plenary sessions.



Figure 1. Flyer used for the distribution to higher institutes in MS.

3. Overall structure of the divisional activities

The Division of Chemistry and Chemical Engineering hosted plenary sessions, a symposium workshop and contributed oral/poster sessions. Each plenary session was consisted of five to seven invited speakers (professors/scientists) from the regional higher institutes/laboratories.

Plenary sessions

- Inorganic and Bioinorganic Chemistry (5 invited speakers, Feb. 23, 2012)
- Organic and Biochemistry (7 invited speakers, Feb. 23, 2012)
- Supramolecular Chemistry and Nanomaterials (4 invited speakers Feb. 23, 2012)
- Computational and Quantum Chemistry (6 invited speakers Feb. 24, 2012)
- Chemical Engineering and Analytical Chemistry and (6 invited speakers, Feb. 24, 2012)

Plenary sessions were presented by invited speakers (professors/scientists) from the higher institutes in Mississippi as well as from the US Army Corp of Engineers.

Symposium workshop

- CAREER Awardees' Symposium (6 invited speakers, Feb. 23, 2012)

The special symposium, NSF CAREER awardees' symposium was organized for the first time, highlighting two important components of the NSF proposal: *Intellectual Merit and Broader Impacts*. This workshop was particularly designed for young faculty and graduate students. This symposium was presented by all current NSF awardees in chemistry, who described their individual mechanisms for the integration of research into education.

Student oral sessions

- Student oral presentations – I (8 Students, Feb. 24, 2012)
- Student oral presentations – II (8 Students, Feb. 24, 2012)

Poster sessions

Poster sessions I (30 posters, Feb. 23, 2012)

Poster session 11 (22 posters, Feb. 24, 2012)

Sessions Chairs

Based on the prior communication, a session chair was selected to conduct each oral session.

4. Attendance



Figure 2. Dr. Jiben Roy (MUW) presents his work in the Plenary Session II.

Each session held on the first day was attended by an impressive number of faculty and students (**Figure 2**). There were also several guests who attended the sessions. The oral presentations were attended with an average number of 35 attendees, with the highest of 55 attendees in one session on the first day. However, because of the concurrent sessions, two morning plenary sessions on the second day were attended by relatively small numbers of people. It was observed that the student oral sessions, even they were concurrent, were well attended with an average of 20 attendees in each session. Each oral presentation was followed by questions and lively discussion with attendees and the presenter. Each oral session was held on time and all the scheduled speakers arrived on time. The symposium room was spacious with an adequate seating arrangement and well equipped.

5. Posters presentation

There were 52 posters in this division. Because of the large number of posters, the chemistry poster sessions were spitted into two sessions. All posters were displayed on boards and the presentation went smoothly, with a large number of visitors. The easels were nicely arranged with appropriate poster numbers, and all are filled with scheduled posters (**Figure 3**). Both poster sessions were attended by a large number of students, faculty and scientists.



Figure 3. An undergraduate student and two faculty during the chemistry Poster Session I.

6. Students' oral/poster presentation

All the students' oral and poster presentations were sponsored by JSU chemistry and biochemistry department. In order to recognize the students' research productivity, and to encourage future participation, students' oral and poster presentation were judged by at least three independent judges. Based on the judging scores, the division selected three best students for oral presentations at graduate level, three best students for poster presentations at graduate level, three best students for poster presentations at undergraduate level, and one special award for high school student (**Figure 4**). The winners of the completions will receive 'Certificates' from the Mississippi Academy of Science, and small token money from the Mississippi Academy of Science. This money was sent to the academy by the JSU chemistry and Biochemistry.



Figure 4. The chair, vice chair and Professor William Henry (MSU) are counting the judges' scores for students' oral and poster competition.

Winners from poster and oral competitions

A. Undergraduate student poster presentation:

1. **1st place** (\$ 70): Aida Demissie, Department of chemistry and biochemistry, *Jackson State University, USA*.
2. **2nd Place** (\$50): Jasmine Taylor (Dr. Bidisha Sengupta), Department of Natural Science, *Tougaloo College*
3. **3rd place** (\$ 40): Priya Patel (Dr. Wolfgang Kramer), *Department of Chemistry and Biochemistry Millsaps College, USA*

B. Graduate student poster presentation:

1. **1st place** (\$ 70): Elizabeth Mobley (C/O Dr. David Magers), *Mississippi College, USA*
2. **2nd Place** (\$ 50): Musabbir A. Saeed (C/O Dr. Alamgir Hossain), *Department of Chemistry and Biochemistry Jackson State University, Jackson, MS*
3. **3rd place** (\$ 40): Martha Johnson (C/O Dr. Zikri Arslan), *Jackson State University, USA*

C. Graduate student oral presentation:

1. **1st place** (\$ 70): Shana Stoddard (C/O Dr. Randy Wadkins), *Department of Chemistry and Biochemistry, The University of Mississippi*
2. **2nd Place** (\$ 50): Sadia A. Khan (C/O Dr. Paresh C. Ray), *Department of Chemistry and Biochemistry Jackson State University, Jackson, MS*
3. **3rd place** (\$ 40): Emily Matthews (C/O Dr. Paige Buchanan), *University of Southern Mississippi, USA*

D. High School Student:

1. **Certificate of Appreciation** (\$ 40): Nanhan Karim, *Jackson Preparatory School, Jackson, USA*

7. Announcement of students' awards and closing:

Dr. Hongtau Yu, Chair, Department of Chemistry and Biochemistry, Jackson State University, announced the winners of student presentation, and the divisional meeting closed at 3.30 pm (**Figure 5**).



Figure 5. The winners of students' oral/poster competition are shown with Dr. Hongtau Yu and Dr. Alamgir Hossain.

8. Divisional chair awarded Outstanding Scientific Division Chair:

Dr. Alamgir Hossain, the divisional chair in 2011-12, has been awarded Outstanding Scientific Division Chair by Mississippi Academy of Science during the annual symposium held on February 23-24, 2012 (**Figure 6**).



Figure 6. Dr. Alamgir Hossain expresses his thanks to MAS board members, abstract contributors of chemistry, and JSU chemistry department after receiving the award of Outstanding Scientific Division Chair before the Dodgen Lecture on February 23, 2012.

9. Election for 2012-2013:

Divisional business meeting was held on February 23, 2012 at 2.00 pm. Before the accepting the nomination, the divisional responsibilities were explained by the divisional chair. Based on the nomination and voting the followings officers were selected and accepted the positions:

Chair: Dr. Wolfgang Kramer, Associate professor, Department of Chemistry and Biochemistry, Millsaps College, was elected as the Chair of the division.

Email: kramewh@millsaps.edu

Tel: (601) 974-1444

Vice Chair: Dr. Zikri Arslan, Associate professor, Department of Chemistry and Biochemistry, Jackson State University, was elected as the Vice- Chair of the division.

Email: zikri.arslan@jsums.edu

Tel: (601) 979-2072

ZOOLOGY AND ENTOMOLOGY DIVISION REPORT FOR FEBUARY, 2012 ANNUAL MEETING

The Zoology and Entomology Division met in the morning and afternoon of February 23, 2012, during the 76th annual meeting of the Mississippi Academy of Sciences, held at the Lake Terrace Convention Center in Hattiesburg, Mississippi. There were 11 oral presentations out of 13 scheduled as the presenters of 2 papers were unavoidably absent. There were 6 poster presentations. The students that presented papers were both graduate and undergraduate students. About 30 individuals attended the presentations. The papers presented were interesting stimulating and informative and generated several questions and pertinent comments. They dealt with public health, environmental concerns or water quality and entomological problems. The Division was, for the first time, joined by a team from Nigeria – **The Jobelyn Team**. The team was made up of a herbalist, Mr. Moses O Okubena, the founder of Jobelyn, Dr. David Abia-Okon and Mr. Michael Okubena. They came at my invitation to share with us important health information about Jobelyn, a food supplement made from sorghum or guinea corn which they said is an elixir of life; it can prolong life! Their coming added flavor to the Division's presentations. We were grateful that they could come. An interesting and informative special presentation titled "Hematological, anti-inflammatory and antiodant properties of a sorghum-based commercial herbal presentation, Jobelyn" was made by Dr. Abia-Okon on behalf of the team (see picture). It generated a lot of discussions and comments.

During the business meeting, a motion was made for Dr, Julius Ikenga to be the Chair of the Division for the next year while Dr. Alex D.W. Acholonu serves as the Vice Chair. The motion carried. So Dr, Julius Ikenga of Mississippi Valley State University has becomes the Chair of the Division while Dr. Alex D.W Acholonu is the Vice- Chair. The membership of the Division increased with several new people signing up as members.

I am glad to have served as the Chair of the Division for two consecutive years and to be a lucky recipient of the Mississippi Academy of Sciences 2012 Outstanding contribution to Science Award. This is an honor for me and the division. The attached photographs give a sought of idea about what transpired in the lively meeting. – **Alex D.W. Acholonu**



Picture shows some individuals that attended the session. Dr. Julius Ikenga, (3rd from left) Mr. Okubena behind Dr. Ikanga, Dr. Sandra Barnes of ASU chemistry Department (5th from left), Dr. Alex Acholonu (7th from left) and his brother, Dr. Wilfred Acholonu Jr. next to him, Dr. David Abia-Okon is behind Dr. Acholonu to his left.



Picture shows Dr. David Abia-Okon who presented the Jobelyn paper



Picture shows Dr. David Abia- Okon (left) making a congratulatory presentation to Dr. Alex Acholonu (right) for the award given him by MAS and appreciation for the opportunity given the Jobeyln team to participate in the MAS annual meeting of this year.



Picture shows Dr. Alex Acholonu (Right) receiving the Outstanding Contribution Award from Dr. Kenneth Butler, Chair, of Awards and Resolutions Committee and Director of MAS.

MEMBER RECOGNITION

MAS Executive Director Receives National and International Recognition!



It is for a great honor to share with our MAS family the recent accolades received by Dr. Benghuzzi. Currently, Dr. Benghuzzi is a Professor at the University of MS Medical Center, as well as is the Academy's Executive Director. Dr. Benghuzzi is known nationally and internationally as a pioneer in Ceramic Drug Delivery Systems. He has over 250 pubmed indexed articles and over 600 abstracts detailing the release characteristics of various biologicals from the carriers as well manipulating various physical components of the delivery devices that ultimately control the release profile of the drugs. He has trained more than 30 PhD Mississippians who are actively involved in academic careers. He has mentored students at all levels (from high school, undergrad, grad, post doc and faculty). He has served as a mentor for residents and faculty on more than 10 funded grants.

He has been in research leadership roles in many organizations such President of the Academy of Surgical Research, Vice President of the Rocky Mountain Bioengineering Society, President of MAS, and organized and chaired several national society programs. He has also served on numerous NIH special emphasis panels including R-25, K01, KO8, T-35, and the P-60 center grants. In addition, he has received numerous awards from various organizations during his career. A few of his awards included: (1) The Presidential Award from the RMBS, (2) Presidential Award from SEM International, (3) the Endocrine's Society Outstanding Investigator Award, (4) MAS Contribution to Science Award, (5) The MAS Dudley Peeler Award, and (6) HEADWAE Award. He was invited to speak at state, national and international levels including recent invitations in France, Italy, and Canada.

Recently, Dr. Benghuzzi was inducted into the College of Fellows of the American Institute for Medical and Biological Engineering (AIMBE). AIMBE is a non-profit organization, headquartered in Washington, D.C., and

represents 50,000 individuals. The College of Fellows – consists of only 1,000 members who are recognized as the outstanding scientists and bioengineers in academia, industry and government. These leaders in the field have distinguished themselves through their contributions in research, industrial practice and/or education.

In addition to this award the International Union of Societies for Biomaterials Science and Engineering (which consists of the American Society for Biomaterials, European Biomaterials Society, Japanese Biomaterials Society, and Asian Biomaterials Society), have affirmed his status as an International Fellow of Biomaterials Science and Engineering (FBSE). He was recognized at a special ceremony during the 9th World Biomaterials Congress Meeting on June 1st, in Chengdu, China. He has the privilege to carry the letters FBSE with his name for life which indicates world-wide respect for his comprehension of professional issues and accomplishments as a scientist in the field of biomaterials science and engineering.

Even with all of this national and international recognition, he is not too busy to serve our MS Academy of Science. In fact, he may not have been born and raised in Mississippi but his HEART and SOUL are deeply rooted in this state.

SEVENTY SEVENTH ANNUAL MEETING

THAD COCHRANE CONVENTION CENTER

HATTIESBURG, MS

February 21-22, 2013

More Information will be available in the October issue

**SUBMIT ABSTRACTS BY
NOV. 1, 2012**

Make sure to Renew Your Membership

Can also be done on-line at : <http://msacad.org/>

MISSISSIPPI ACADEMY OF SCIENCES ABSTRACT FORM/MEMBERSHIP FORM

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Abstract title: _____

Name of Presenting Author(s): _____

If you are a student please fill-out the next line

Name of Mentor and e-mail of Mentor _____

(Presenter must be current (i.e., 2013 membership dues must be paid), student member, regular member or life member of the MAS)

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Check the division in which you are presenting

- ___ Agriculture and Plant Science ___ Health Sciences ___ Physics and Engineering
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___ Chemistry and Chem. Engineering ___ Math., Computer Sci and Statistics ___ Science Education
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Complete either the Membership/Pre-Registration form if you plan to attend and present at the meeting if you do not plan to attend the meeting please complete the membership form

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PLEASE INDICATE DIVISION YOU WISH TO BE AFFILIATED _____

Before January 15, 2013.....Regular Member/Pre-Registraion \$80 Student Member/ Pre-registration \$40

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CHECKLIST

Please complete the following:

- ___ Enclose title of abstract (even if abstract has been submitted electronically)
___ Complete membership/registration form (this form)
___ Enclose the following payments (Make checks payable to Mississippi Academy of Sciences)
___ \$25 per abstract
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___ You must supply a check # _____ or P.O. # _____ (or indicate Pay Pal confirmation) _____

MISSISSIPPI ACADEMY OF SCIENCES—ABSTRACT INSTRUCTIONS
PLEASE READ ALL INSTRUCTIONS BEFORE YOU SUBMIT YOUR ABSTRACT ON-LINE

- Your paper may be presented orally or as a poster. Oral presentations are generally 15 minutes. The speaker should limit the presentation to 10-12 minutes to allow time for discussion; longer presentations should be limited accordingly. Instructions for [poster presentations](#) are linked here.
- Enclose a personal check, money order, institutional check, or purchase order for \$25 publication charge for each abstract to be published, payable to the Mississippi Academy of Sciences. The publication charge will be refunded if the abstract is not accepted.
- The presenting author must be a member of the Academy at the time the paper/poster is presented. Payment for membership of one author must be sent for the abstract to be accepted.
- Attendance and participation at all sessions requires payment of registration.
- Note that three separate fees are associated with submitting and presenting a paper at the annual meeting of the Mississippi Academy of Sciences.
 1. An abstract fee is assessed to defray the cost of publishing abstracts and
 2. a membership fee is assessed to defray the costs of running the Academy.
 3. Preregistration payment (\$25 regular; \$10 student) may accompany the abstract, or you may elect to pay this fee before February 1, or pay full registration fees at the meeting.
- Abstracts may **only** be submitted on line via a link through the MAS website. The appropriate abstract fees can be paid via Paypal or sent via mail to Barbara Holmes at the Academy address.
- **Late abstracts will be accepted with a \$10 late fee during November increased to \$25 after that. Late abstracts will be accepted only if there is room in the appropriate division. They will be published in the April issue of the MAS JOURNAL.**
- Submit your appropriate fees **NO LATER THAN NOVEMBER 1, 2012.**

Ms. Barbara Holmes
Mississippi Academy of Sciences
Post Office Box 55907
Jackson, MS 39296-5907

GUIDELINES FOR POSTER PRESENTATIONS

- The Academy provides poster backboards. Each backboard is 34" high by 5' wide. Mount the poster on the board assigned to you by your Division Chairperson. Please do not draw, write, or use adhesive material on the boards. You must provide your own thumb tacks.
- Lettering for your poster title should be at least 1" high and follow the format for your abstract. Lettering for your poster text should be at least 3/8" high.
- Posters should be on display during the entire day during which their divisional poster session is scheduled. They must be removed at the end of that day.
- Authors must be present with their poster to discuss their work at the time indicated in the program.