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Nutsedge Control In Field-Grown Feverfew In Southwest Mississippi

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ABSTRACT

Field studies were used in 1999/2000 and 2000/2001 to investigate 'Black Plastic', 'Weed Barrier' and 'Pine Bark Nugget' (treatments) for purple nutsedge *(Cyperus rotundus)* control in field-grown feverfew *(Tanacetum parthenium)*. The effect of mulch applications on feverfew plant growth and shoot mineral compositions, soil properties and economics of production were also investigated. The synthetic mulches (black plastic and weed barrier) had greater control of nutsedge than organic mulch (pine bark nuggets) and unprotected control. Mulch applications influenced branches per plant and shoot dry weight only in 1999/2000 study season. Number of branches was greatest for black plastic but was not significantly different from weed barrier. Shoot dry weight was also greatest for black plastic, but lowest for weed barrier. Plant survival for both study periods was perfect (100%) for all treatments during the first three evaluation periods. The variations during the fourth evaluation period were also not significant. During the 1999/2000 study season shoot potassium was greatest for weed barrier and lowest for pine bark nuggets which had the greatest shoot nitrogen and magnesium compositions. Soil extractable nutrients were greatest for mulch treatments compared to the control, except for potassium. Profitability from treatments varied with study period. Six mil black plastic will control purple nutsedge, increase shoot dry weight and increase profitability more than weed barrier, pine bark nuggets and unprotected control, especially if the desire is to use the mulch materials for more than one growing season. Feverfew transplanted into field plots in October as fall crop in southwest Mississippi will overcome the mild winter in the region and grow to maturity for the following spring or early summer harvest. It is therefore a good alternative crop for farmers with desire to grow medicinal plants in southwest Mississippi.

INTRODUCTION

Feverfew (*Tanacetum parthenium*), a perennial herb belongs to the family Compositae. Its strong and lasting ordor makes it an excellent ingredient in making insect repellents. It is also rich in sesquiterpene lactones essential oils, flavonoid and costic acid. It produces histamine, while inhibiting the production of prostaglandins and serotonin (5-HT) believed to contribute to the onset of migraine headaches. It has the tendency to lower blood pressure, stomach irritation and painful or sluggish menstruation (Hoffman, 1995).

Feverfew is commercially cultivated in Japan, Africa and Europe. However, like other herbs, weed competition is a major problem in its successful production. It competes poorly against weeds and grasses. Although weed control is essential to its production, no herbicide is labeled for their control. Moreover, although weeds in crop fields have been suppressed or controlled chemically (Igbokwe, 1996; Porter, 1993; Teasdale and Frank, 1982)) the adverse effects of extensive use of chemicals on human health and the environment cannot be overemphasized. Pesticides can contaminate ground and surface waters (Ritter, 1990; Sachs, 1993), create a hazard to agricultural workers, and leave residues in vegetables (National Research Council, 1987; Zibberman et al., 1991). Most perennial herb gardens benefit from a layer of mulch by assisting with the

uniform distribution of soil temperature and moisture. It also discourages weed growth by blocking light to prevent seed germination (Felty, 1981). Residue mulches improve crop yield through their beneficial effects on soil and water conservation (Lal, 1976), improved soil structure and aeration (Adeoye, 1982), and favorable regulation of soil temperature (Maurya and Lal, 1980). Mulches may control weeds and eliminate the need for cultivation by smothering weed growth and cutting off light from the soil surface. They may be a source of organic matter and nutrients for the soil. Although organic mulches decompose to add plant nutrients to the soil, the high carbon content of many of these materials may contribute to nitrogen deficiency, especially if the mulch is later plowed under (Janick, 1979). High yields of fresh-market basil can be obtained from plants grown in double-rows with an in-row plant spacing of 15 to 23 cm, on raised beds with black, polyethylene mulch and drip irrigation (Davis, 1993).

This study determined the effects of mulch applications on weed control, plant growth, soil characteristics, and profitability.

MATERIALS AND METHODS

Two synthetic mulches (black plastic and weed barrier) and one organic mulch (pine bark nuggets) were evaluated for purple nutsedge (*Cyperus rotundus L.)* control in field-grown feverfew (*Tanecetum parthenium).* The effect of mulch application on plant survival, growth and mineral composition, soil extractable macronutrients, and economics of production were also evaluated. The study was conducted on a Memphis silt loam soil, in a completely randomized design (CRD) with three replications of each mulch application (treatment).

On October 26, 1999 field plot was disked for the first time. The second disking plus bed preparation were done one week later. Soil samples collected at 0-20 cm soil depth before disking and at the end of each growing season were analyzed for extractable nutrients (P, K, Ca, Mg), soil acidity and percent organic matter. Cations were analyzed by atomic absorption spectrometry; soil acidity by barium chloride-triethanolamine method; and organic matter by wet and dry combustion techniques. Fertilization at bed preparation with half nitrogen (42.0 Kg/ha N), and full doses of phosphorus (112 Kg/ha P_2O_5) and potassium (112 Kg/ha K_2O) were based on soil test results. Additional nitrogen fertilization was through the slits, one month later. Mulching for weed control was either with 6-mil black plastic, weed barrier or pine bark nuggets. The unprotected beds served as control. Pine bark nugget thickness ranged from 5.0 to 7.5 cm. A total of 63 feverfew seedlings, were transplanted into each of the three rows within each bed at 0.3 m within- and between-row one day after bed preparation, for a total of 189 seedlings per bed. Transplanting on mulched beds was through slits, 15.0 cm in diameter, whereas unmulched beds were conventionally transplanted. Irrigation with hose was done at transplanting and during the second nitrogen application period, and overhead sprinklers were used as needed each growing season

Weed counts were made on December 7, 1999, February 17, May 26, and June 22, 2000. Purple nutsedge which pierced through each mulch and transplanting slits were counted, pulled and discarded, whereas, feverfew plants standing at each weed count were recorded as plant survival. Those in unmulched control plots were also counted, pulled and discarded with other weeds not under investigation. The averages for weed count and plant survival were reported for each treatment and the control.

A total of five randomly selected plants from each of the three rows within each bed under each treatment and control were used for data collection on plant growth (canopy height, canopy width, stem diameter, branches per plant and shoot dry weight) and quality (mineral

compositions). Canopy height was measured from soil surface to the highest point of the canopy at natural stand. Canopy widths were average values for measures taken in North-South and East-West directions. Stem diameter was determined with a caliper at soil level; branches per plant as offshoots from the main stem; and shoot dry weight as the value after oven-drying plant shoot samples at $70^{\circ}C$ for 24 hours. Some of the dry samples ground in a Wiley Mills® to pass through 20 mesh sieve were used to determine plant shoot mineral compositions. All data were analyzed by analysis of variance and means separated by Fisher's least significant difference (LSD) test (Steel and Torrie, 1980). All input requirements for mulched and unmulched plots were determined. Summary of estimated costs and returns were used to compare the relative profitability due to treatments. Input costs included purchased mulch materials and applications, purchased fertilizers, planting and plot maintenance. Sales from shoots at $23.75 per kilogram of dry weight represented the returns for each treatment and control. Profitability was gross income less input costs.

On October 12, 2000 fields were again prepared for the second study season. The unprotected beds were tilled and built up as for the first study season. Existing nutsedge and other weeds on the protected beds were hand-pulled, making sure that the synthetic mulches were not mechanically damaged. Desired thickness for pine bark nugget was restored with additional mulch application. Seedlings were transplanted into all beds, one day after bed preparation. Plant survival and weed counts were taken on Nov. 27, 2000, Feb. 14, May 25, and June 2, 2001. Data collection on plant growth, mineral compositions, profitability was as for the first study period. Soil samples collected at 0-20 cm soil depth were used for the determination of soil extractable nutrients, acidity and organic matter. All analyses were as for the first study season.

RESULTS AND DISCUSSION

Preplant soil extractable nutrients were high for phosphorus, potassium and calcium, and was very high for magnesium. Soil acidity was pH 7.3 whereas, soil organic matter was 1.0% (Table 1). Post harvest extractable phosphorus, calcium and soil acidity were highest for black plastic; potassium was highest for the control; and both magnesium and soil organic matter were highest for the pine bark nugget. After two years of study, the average extractable nutrients were slightly increased for treatments except for potassium. Both soil acidity and organic mater were slightly increased. In general, soil extractable nutrient values suggest that feverfew may not be a heavy feeder, and could have the potential for enhancing soil fertility if roots are allowed to decompose after each growing season, and soil movement restricted with synthetic or organic mulches.

In the first study season, plant survival was perfect (100%) for the treatments and the control during the first three evaluation periods (Table 2). Plant survival was also perfect for black plastic and the control at the fourth evaluation period but was not significantly different from weed barrier and pine bark nuggets. In the second study season, plant survival was as for the first study season during the first three evaluation periods. Plant survival was perfect for weed barrier and control, at fourth evaluation period but was not significantly different from black plastic and pine bark nuggets. High levels of feverfew plant survival due to each mulch treatment and control indicate that with high soil macronutrient levels, 7.3 to 7.7 soil reaction range, and 1.0 to 1.5% soil organic matter level, feverfew could be grown as fall crop in southwest Mississippi if other growth factors are not limiting. This suggests that feverfew could be a good addition to fall crops grown by farmers in Mississippi and other southern States with mild winter, however, seedlings must be

transplanted into field plots by the third week in October, or earlier to allow for proper plant establishment before the first killing frost late in November, and greater plant survival.

Black plastic provided perfect control of purple nutsedge during both study seasons, whereas weed barrier and black plastic provided similar control during the second study season (Table 3). The untreated plots (control) had the greatest weed populations but were generally not significantly different from plots covered with pine bark nuggets. The ability of 6-mil black plastic to provide better control of purple nutsedge during both evaluation periods compared to other treatments and control could suggest the importance of mulch thickness and lack of perforations in the prevention of nutsedge seed germination and smothering of seedlings. The extent of the control will depend among other factors such as the type, thickness and duration of mulch materials.

In 1999-2000 study season, mulch treatments did not influence feverfew growth components except for the number of branches and shoot dry weight (Table 4). Both components were highest for the black plastic mulch and lowest for the pine bark mulch. In 2000-2001 mulch treatment did not influence the growth components (Table 4). During the first study season, the number of branches per plant was greatest for black plastic, but were not different from weed barrier. Shoot dry weight was greatest for black plastic, and lowest for weed barrier (Table 4). Treatments did not influence growth components significantly during the second study period. Although variations in growth components were not generally significant, black plastic which had the greatest number of branches per plant and shoot dry weight in the first season seems to favor shoot growth more than other treatments and the control. However, the difference is dependent on the growing season.

Shoot mineral compositions were not significantly different except for potassium, which was greatest for weed barrier, and lowest

for pine bark nuggets during the first study period (Table 5). During the second study period, shoot mineral compositions were not different except for nitrogen, which was greatest for pine bark nuggets, and lowest for black plastic. The general nonsignificant variations in feverfew shoot mineral compositions suggest that mulching may not significantly influence soil nutrient uptake in locations with high soil extractable nutrients, proper soil acidity and high soil organic matter level in southwest Mississippi. Profitability was greatest for pine bark nuggets, and lowest for weed barrier during the first study season (Table 6). During the second study period, profitability was greatest for black plastic and lowest for the control. Profitability seems to depend more on the cost of mulch material purchase and plant growth than labor cost for mulched plots, but not for unprotected control. Using synthetic mulches for more than one growing season will reduce cost of production that leads to increase in profitability. The 6-mil black plastic which can be used for more than two growing seasons is more economical than weed barrier or pine bark nuggets for the control of purple nutsedge in feverfew plots.

CONCLUSIONS

Mulching can control purple nutsedge in field-grown feverfew; however the extent of control will vary with type of mulch and duration of application. Feverfew seedlings transplanted into field plots during the second or third week in October as fall crop will overcome the mild winter in southwest Mississippi, grow to maturity for the following spring or early summer harvest. It could be a good alternative crop for farmers with the desire to grow medicinal plants as fall crops in the region. Using 6-mil black plastic or similar mulch materials that could remain effective for two or more consecutive years will reduce the cost of production to enhance profitability.

Table 1. Field plot soil properties

Treatment	Soil Extractable Nutrients Level (Kg·ha^{-1})				Soil Acidity (pH)	Soil Organic Matter (%)
	P	K	Ca	Mg		
Preplant Soil Fertility Level (1999)[1]						
	108.4	230.0	4290.2	852.7	7.1	1.1
	H	H	H	H+		
Postharvest Fertility Level (2001)[2]						
Black Plastic	169.1	221.7	5062.8	843.0	7.7	1.2
Weed Barrier	134.8	193.8	4506.5	899.8	7.6	1.3
Pine Bark Nugget	115.7	188.4	4117.5	905.7	7.4	1.5
Control	110.6	280.0	4314.2	855.7	7.3	1.0
LSD (P=0.05)	7.9	9.6	115.0	31.5	0.1	0.2

[1]**Values represent the soil property before this study, where H$^+$= very high; H = high nutrient level.**
[2]**Values represent the soil properties after two years of study.**

Table 2. Mulching effect on plant survival.

Treatment	Survival Evaluation Period			
	First	Second	Third	Fourth
1999-2000[1]				
Black Plastic	100.0	100.0	100.0	100.0
Weed Barrier	100.0	100.0	100.0	96.8
Pine Bark Nugget	100.0	100.0	100.0	95.2
Control	100.0	100.0	100.0	100.0
LSD (P=0.05)	NS	NS	NS	NS
2000-2001[2]				
Black Plastic	100.0	100.0	100.0	98.4
Weed Barrier	100.0	100.0	100.0	100.0
Pine Bark Nugget	100.0	100.0	100.0	96.8
Control	100.0	100.0	100.0	100.0
LSD (P=0.05)	NS	NS	NS	NS

[1]**Plant survival counts for 1999-2000.**
[2]**Plant survival counts for 2000-2001.**

Table 3. Mulching effect on purple nutsedge control

Treatment	First	Second	Third	Fourth	Total Count
1999-2000[1]					
Black Plastic	0.0	0.0	0.0	0.0	0.0
Weed Barrier	0.0	0.0	2.7	8.3	11.0
Pine Bark Nugget	34.0	30.0	17.0	20.0	101.7
Control	39.0	35.2	23.0	20.7	118.3
LSD (P=0.05)	12.7	11.5	2.9	6.0	6.5
LSD (P=0.01)	19.3	17.5	4.8	9.1	9.8
2000-2001[2]					
Black Plastic	0.0	0.0	0.0	0.0	0.0
Weed Barrier	0.0	0.0	0.0	0.0	0.0
Pine Bark Nugget	3.7	3.4	4.3	1.0	12.3
Control	19.7	4.0	5.7	3.0	32.3
LSD (P=0.05)	1.2	1.0	1.8	1.0	1.8
LSD (P=0.01)	1.8	1.5	2.7	1.5	2.8

[1]First, Second, Third and Fourth.
[2]First, Second, Third and Fourth.

Table 4. Mulching effect on feverfew growth components
Plant Growth Components

Treatment (Mulching)	Canopy Height	Canopy Width	Stem Diameter	No. of Branches Per Plant	Shoot Dry Weight (kg/plant)
	<-------------------cm---------------------->				
1999-2000[1]					
Black Plastic	63.5	35.3	1.2	25.6	0.019
Weed Barrier	54.8	30.6	1.0	22.0	0.014
Pine Bark Mulch	60.6	27.0	1.0	10.8	0.017
Control	60.6	27.5	1.0	11.0	0.016
LSD (P=0.05)	NS	NS	NS	3.9	0.004
LSD (P=0.01)	NS	NS	NS	5.5	NS
2000-2001[2]					
Black Plastic	96.1	61.6	0.80	14.7	0.016
Weed Barrier	97.7	55.0	0.82	14.0	0.013
Pine Bark Mulch	89.2	50.5	0.86	12.1	0.011
Control	80.8	51.9	0.80	13.4	0.014

LSD (P=0.05)	NS	NS	NS	NS		NS
LSD (P=0.01)	NS	NS	NS	NS		NS

[1]**Data collected at the end of the first year of study.**
[2]**Data collected at the end of the second year of study.**

Table 5. Mulching effect on feverfew shoot mineral composition

Shoot Mineral Composition

Treatment (Mulching)	N	P	K	Ca	Mg	S
	<---%-->					
1999-2000[1]						
Black Plastic	1.6	0.28	3.1	0.48	0.15	0.10
Weed Barrier	1.8	0.34	3.9	0.58	0.21	0.12
Pine Bark Mulch	1.7	0.22	2.2	0.45	0.18	0.11
Control	1.6	0.30	3.1	0.50	0.17	0.10
Average	1.7	0.29	3.1	0.50	0.18	0.11
LSD (P=0.05)	NS	NS	1.2	NS	NS	NS

Shoot Mineral Composition

Treatment (Mulching)	N	P	K	Ca	Mg	S
	<---%-->					
2000-2001[2]						
Black Plastic	2.6	0.43	7.0	0.42	0.89	0.19
Weed Barrier	3.2	0.47	9.0	0.52	1.05	0.20
Pine Bark Mulch	5.5	0.42	8.5	0.53	1.55	0.24
Control	5.0	0.49	8.5	0.52	1.55	0.24
Average	4.1	0.45	8.3	0.50	1.26	0.22
LSD (P=0.05)	0.8	NS	NS	NS	0.41	NS
LSD (P=0.01)	1.1	NS	NS	NS	NS	NS

[1]**Data collected after the first year of study.**
[2]**Data collected after the second year.**

Table 6. Summary of estimated costs and returns per hectare.

Treatment (Mulching)	Production[1] costs ($)	Marketable[2] dry shoot ($)	Total[3] sale ($)	Total[4] profit ($)
1999-2000				
Black plastic	24,772.3	2,111.1	50,138.9	25,366.6
Weed Barrier	27,140.2	1,556.0	36,955.0	9,814.8
Pine bark nuggets	19,490.0	1,889.0	44,863.7	25,373.8
Control	24,362.5	1,778.0	42,227.5	17,865.0
2000-2001				
Black plastic	6,102.0	1,777.8	42,222.3	36,120.8
Weed Barrier	6,102.0	1,444.4	34,304.5	28,202.5
Pine bark nuggets	11,156.6	1,222.2	29,027.3	17,870.7
Control	24,362.5	1,555.6	6,945.5	12,583.0

[1]Total costs include materials, supplies and labor.
[2]Marketable leaf and flower dry weights based on 11,111 plants per hectare.
[3]Total sales at $23.75 per kilogram, based on average unit price from herb catalogs.
[4]Total sales minus production costs.

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An Experimental Exercise Used to Determine if Mississippi's Science Framework Is Adequately Preparing High School Graduates to Make Informed Decisions about Groundwater

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Abstract

According to the National Science Education Standards, eighth graders should possess appropriate knowledge about groundwater and its role in sustaining life on Earth. There were two groups of students studied, Mississippi eighth graders and earth science students at Mississippi State University. Both groups were tested to identify what types of ideas they possess about groundwater. This information can be invaluable information for high school and postsecondary science teachers in addressing students' prior conceptions. In addition, the data could provide science educators insight on where curriculum revisions in the science framework are needed. Both groups were given one multiple choice question and one drawing exercise. The multiple choice question and drawing were both scored by a rubric for evidence of understanding the formation, movement, and storage of groundwater. It is to be noted that from five Mississippi public schools, 92 percent of the eighth graders have naïve conceptions concerning groundwater. Seventy-two percent of the undergraduate college students have naïve conceptions concerning groundwater. These results show that there are some gaps within the secondary science curricula.

Introduction and Background

The aims of the present study are to show the importance of earth science in secondary schools. There is a need to make earth science more available and more relevant to the Mississippi Science Framework in 2006. So that students will be exposed to a wider variety of rigorous and relevant science activities within the science curriculum, a proposal was made during the Science Framework Revision Workshop of the Mississippi Department of Education (MDE) in October 2005. Mississippi State University is taking the lead in promoting these changes to secondary science education with the Department of Geosciences as the resource for secondary teachers as the proposed change occurs. Currently, the science framework has some gaps so that many students are not ready

for Biology I as freshmen. The geosciences could be the bridge for such a gap, because the geosciences bring together biology, chemistry, and physics and make those subjects more relevant to the students. In addition to integrating the natural sciences, they bring political, social, economics, and mathematics concepts to the minds of the students. Students' interest can be sparked and directed more to the sciences by bringing things together in such a way.

This study examines Mississippi eighth graders' understanding of groundwater and compares their understanding to that of earth science students at Mississippi State University. This will provide support for a science framework with more rigor and relevance in the geosciences at the secondary level in Mississippi. MDE is interested in the *Rigor/Relevance Framework* (International

Center for Leadership in Education, n.d.), a framework tool examines curriculum, instruction, and assessment. It uses a familiar knowledge taxonomy (Bloom's Taxonomy), while encouraging a move to application of knowledge. The *Rigor/Relevance Framework* (International Center for Leadership in Education, n.d.) helps make explicit the relevance of learning to the real world, broadening the historically narrow focus on acquisition of knowledge (Miles, 2005). Thus, during the 2006 Mississippi Science Framework Revision, the committee is challenged with this integration into all sciences, and the geosciences could be the component that brings all disciplines together for science, math, and technology so that the National Science Education Standards are addressed in a proper manner.

Several states, such as Georgia, New York, and Pennsylvania, have already realized the importance of geosciences as a vector for integration. In 2004, the Commonwealth of Pennsylvania passed into law the environment and earth science (ESE) standards as core content knowledge for all public school students. As a result, the Pennsylvania Department of Education, the Department of Environmental Protection, the Center for Environmental Education, and the State System of Higher Education formed a partnership to survey all teacher preparation institutions in the state (Mastrilli, 2005).

There are several research reports that support such movements as that of the Pennsylvania law. According to Orion and Kail (2005), students have considerable difficulties in understanding the basic concepts underlying the scientific inquiry, and that "The Rock Cycle" and "The Water Cycle" have the potential to help in developing such understanding. In their study, Orion and Kail (2005) found an unexpected gender difference. Girls outperformed boys in scientific thinking on both the pretest and the posttest involving the rock cycle and the water cycle. The unique character of geosciences methodology, with structured-inquiry and meta-cognitive activities, served as an appropriate framework for students to develop basic scientific thinking. Recent science education reform efforts have encouraged the development of hands-on laboratory and field activities to improve the high school science curriculum (Trop, Krockover, and Ridgway, 2000). In addition, many science education reform recommendations call for active learning styles that contain critical thinking and problem solving rather than passive learning (Rimal and Stieglitz, 2000). Trop, Krockover, and Ridgway (2000) presented research that students are more likely to understand hydrological concepts through real world experiences in their study of 528 high school students.

With all these facts in mind, we wanted some comparison data that would start to show the gaps between eighth grade and undergraduate earth science students. Showing the gaps in the curriculum will make a compelling case to the MDE for geosciences integration into the new science framework. We identified one such gap as that of the understanding of groundwater by both eighth graders and undergraduate earth science students. According to the *National Science Education Standards* (1996), eighth graders should possess appropriate knowledge about groundwater. If they master the standards, students are more likely to carry that knowledge with them through secondary school without reinforcement.

Method

This paper reports on one aspect of a larger research study conducted to examine understanding of groundwater principles and processes held by children and adults. The study

is limited in scope (i.e., just including Mississippi students). The insights gained, however, will aid in developing and refining the Mississippi Science Framework so that it meets the needs of students. There are larger scale studies being conducted at Purdue University for the purpose of gaining a more complete and accurate picture of teaching and learning about groundwater in the U.S. and abroad (Dickerson, Callahan, Sickle, and Hay, 2005).

First, before any students were studied, we sought approval from the Institutional Review Board for the Protection of Human Subjects in Research (IRB) at Mississippi State University. The IRB addressed such issues as confidentiality of all students' information and voluntary participation. Students were assured that all information would remain confident and that there was no possibility of risk or discomfort during this research project. Assurance was given to students who refused participation and those who chose to discontinue participation at any point during the study that there would be no penalty or loss of benefits because of their choice. After students gave their informed consent, they were included in the study. As well, parental approval was necessary in order for eighth graders to participate with a licensed school teacher as the researcher.

We used Dickerson and Dawkins' (2004) methodology set forth in the article, "Eighth Grade Students' Understanding of Groundwater" in the *Journal of Geoscience Education*. The methods for both the eighth graders and the undergraduate college students were the same. A total of 115 eighth grade students from five different Mississippi public school districts participated. The participants reflected the demographic composition of the schools in areas of race, socioeconomic status,

and gender. While there was a broad skill base among students, most students had a D average or better. In the eighth grade classes, the focus was explicitly on groundwater in only one fifty-minute class period during a nine-week course. At the beginning of the period, the students were given instructions about the survey. The survey consisted of two questions: (a) one multiple choice item and (b) one open response drawing prompt. A multiple choice item and rubric developed by Dickerson & Dawkins (2004) was used to evaluate the students in a pre-test and post-test design (see Table 1). The drawing prompt was included to check for evidence of understanding of groundwater formation, movement, and storage. At the end of the fifty-minute period of instruction and modeling of groundwater flow, the students engaged in discussion about the survey and had many reflections about groundwater movement.

The MSU earth science students reflected the same demographic composition of the public schools. However, there were some differences in age and gender. There were more females than males with ages ranging from 17 to 31. The race distribution was similar to the race distribution in the public schools. A total of 124 MSU earth science students participated in the study. In the undergraduate lab on hydrology, the earth science students were given the same survey and fifty-minute lecture/modeling session as the eighth graders were given. Toward the end of the session, the earth science students were engaged in discussion and reflections about the survey. However, the college students had fewer reflections than the eighth graders. Their survey was also graded by the rubric shown in Table 1.

Table 1. Multiple Choice Item and Rubric.

Item	If a person drilled a well to get groundwater, from where would this water come? (Choose all that apply.) A. river B. sand layer C. underground pool D. water tower E. soil F. spigot or faucet G. solid/fractured rock H. underground stream I. lake J. city water supply	
Score	**Definition of Level**	**Classification of Level**
2	Approaching a scientifically appropriate understanding of groundwater	Answer only includes one or more of the following: B, G, and/or E
1	Understands that groundwater occurs beneath the surface of the earth, but does not understand how groundwater functions	Answer may but does not have to include any of the following: B, G, E AND Must include one or both of the following: C, H
0	Does not understand that groundwater resides beneath the surface of the earth or in what medium	Any combination not listed above

Results

Of the 115 eighth graders who completed the multiple choice item, 33 students received a score of 1 and 5 students received a score of 2, thus leaving 77 students (67% of the eighth grade population tested) with no understanding that groundwater resides beneath the surface of the earth or in what medium. Over all 92% of the eighth graders from Mississippi schools have a naïve conception about groundwater. Of the 124 MSU earth science students who completed the multiple choice item, 56 students received a score of 1 and 15 students received a score of 2, thus leaving 53 students (43% of the MSU earth science population tested) with no understanding that groundwater resides beneath the surface of the earth or in what medium. Insight into these data reveals that one-half of the earth science students enrolled at MSU have some understanding that groundwater occurs beneath the surface of the earth, but they still do not understand how groundwater functions. Over all 72% have naïve conceptions about groundwater. A possible reason for this misunderstanding could be that students were not required to study earth science after eighth grade, and it is apparent that the 115 tested eighth grade students did not have a scientifically appropriate understanding of groundwater.

Both groups of students frequently used the phrases "underground stream" and "underground pool" in labeling their drawings. Additionally, words and phrases such as "pores," "water table," "aquifer," and "flows" appeared in many of the drawings that contained "underground pools" or "underground streams." In most cases, the vernacular terms such as "underground streams" were disconnected from the typically scientific terms such as "pores" and "pressure." In almost all drawings, pores do not connect in any way to the underground pool. The isolation of groundwater concepts commonly occurred in the student drawings.

Additional in-depth research is needed to determine the nature of the conceptions these drawings represent.

From the multiple choice survey question, the most frequent answers included river (A), underground pool (C), underground stream (H), and lake (I). All students who completed the survey included one or more of these answers. These answers reflect the results of the study of Dickerson and Dawkins (2004) who studied eighth graders with no comparison group.

Conclusions

Both groups of students hold naïve conceptions concerning groundwater, although the nature of those conceptions is not easily recognized because of the way that groundwater concepts are typically explained. Even at the introductory level, students may have some difficulty with the interdisciplinary nature of hydrogeology as they struggle to understand the interconnection among topics in geology, physics, chemistry, and mathematics. One reason for the difficulty of understanding the interdisciplinary nature may be the lack of reinforcement of integrated science in the high school science framework. The teaching of earth science and integrative science stops in the eighth grade for a majority of Mississippi students. It stops because it is not in the science framework and teachers lack training in how to integrate the sciences.

One way to address students' inappropriate conceptions involves more rigor and relevance in the science education framework. In many cases, more comprehensive instruction in science education would require teachers themselves to get more training. Thus, there would be a need for workshops that address these topics. National Science Foundation grants would be a start in implementing these new integrated methods of teaching science. Another option would be for teachers to assist students in better visualization of groundwater concepts along with other topics in the geosciences. However, oversimplified models could prompt students to develop disconnected, isolated notions of groundwater concepts that yield incomplete and inaccurate concepts (Dickerson and Dawkins, 2004).

According to Dickerson and Dawkins (2004), among the first steps in addressing students' misconceptions of groundwater is the recognition by science educators and the scientific community that this is a problem area. Mississippi's science educators are sending high school graduates out into the real world without common science knowledge about critical issues such as groundwater management. Changing the science framework to bridge these necessary gaps in science education could lie within the geosciences to make Mississippi's high school graduates more informed citizens. Thus, scientists who are in positions to educate teachers and citizens in the community can contribute enormously by examining their own roles and practices. Perhaps most importantly, science teachers can and should increase their own accurate understanding of the content and exercise great care in choosing appropriate strategies and materials as they prepare to teach. Educational programs in hydrogeology are often criticized as being too theoretical. Responding to this call for education and training, Auburn University worked with high schools and undergraduate programs to make them more of a hands-on experience and relevant to students' lives (Lee, 1998). Reform is needed in our Mississippi science framework, teacher education, and undergraduate programs for Mississippi students to be prepared for the real world.

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A Discussion of Binomial Interval Estimators on the Boundary

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ABSTRACT

Often in biomedical research, a binary outcome variable has minimal expected value, for example, mortality for aspirin users. For moderate sample sizes, it is not uncommon to observe zero successes in these instances. Confidence interval estimation, in this case, may be more informative than hypothesis testing. There is an appeal to using one-sided confidence intervals for this special case; however, this practice is arguably inappropriate unless the decision is made a priori. The commonly used Wald intervals, as presented in most elementary textbooks, are known to perform poorly, particularly when the proportions are near zero or one. Further, for zero observed successes, the Wald interval estimate is $[0,0]$. A method of confidence interval construction based on the score statistic has been shown to outperform the Wald intervals. This paper will review binomial parameter confidence interval estimates for uncommon events.

Introduction

In pharmaceutical research there are numerous binary events for which the expected proportion is low. For example, the presence of a life threatening adverse effect during post-marketing testing when none have been observed during pre-marketing clinical trials. In the realm of scientific study, a binary outcome with $x = 0$ observed successes is an often ignored issue, and sometimes incorrectly interpreted as indicating $\pi = 0$. Elementary texts typically use a normal approximation, inverted from a Wald statistic, to estimate π under the condition $\min\{n\pi, n(1-\pi)\} \geq 5$. There is no guarantee this condition is met since π is unknown. Brown, et al. (2001) discussed problems even when the criterion is met. Further, if $p = x/n$ is used to estimate π,

$np = 0$ for the zero success case regardless of sample size. There have been several papers written on the subject of interval estimation for the binomial in this special case, each offering possible solutions (Wilson, 1927; Louis, 1981; Hanley and Lippman-Hand, 1983; Newcombe, 1998; Agresti and Coull, 1998).

This issue is exacerbated by small sample sizes. As sample sizes increase, and thus more information is obtained from the population, observing zero successes is less likely to happen by chance. Note that $P(X = 0) = (1-\pi)^n$, a decreasing function of sample size for fixed π, with $\pi = 0$ being a notable exception. It is thus important to treat an experiment where $n = 500$ differently than from, say, $n = 10$.

The polar opposite of this case, $x = n$

observed successes, is also of great importance. Yet, a binomial distribution can be defined by either the number of successes as well as by the number of failures. Interpretations made from confidence intervals estimated from $x = 0$ successes and $x = 0$ failures are equivalent, thus a discussion of the case where $x = n$ successes has been omitted. In the following, we present some of the issues with interval estimators, in general, with a specific focus in case zero successes are observed.

Methods

The most common interval estimate of the binomial parameter, found in most textbooks, is computed by inverting the Wald statistic given by

$$z = \frac{p - \pi}{\sqrt{\dfrac{p(1-p)}{n}}}$$

where $p = x/n$ is the maximum likelihood estimate (mle) of π. The resulting interval estimate is

$$p \pm Z_{\alpha/2} \sqrt{p(1-p)/n}.$$

This interval has been shown to perform adequately outside of extreme cases; the $x = 0$ case being one of the two most extreme. Note that the Wald interval is only valid when $p \in (0,1)$, as the interval estimate is reduced to either of the singular values $\{0,1\}$ on the endpoints. Further, the variance estimate, using the invariance property of the mle p, is 0 when $p \in \{0,1\}$. Again, we discuss the case when $p = 0$ with similar indications when $p = 1$.

For the zero case, the Wald interval fails on a couple of additional counts. It is symmetric about $p = 0$ and produces an interval that includes negative values, yet $\pi \in [0,1]$. Further, the variance estimate implies $P(success) = 0$.

Unfortunately, however, most elementary textbooks present the Wald intervals; Brown, et al. (2001) mention only one text that offers an alternative.

Using an exact approach, Louis (1981) developed a confidence interval for the zero case. The probability of observing zero successes (or n failures) is $P(X = 0) = (1 - \pi)^n$. A one-sided $(1 - \alpha)100\%$ confidence interval, as advocated by Louis, is constructed using the solution to $\alpha = (1 - \pi)^n$, given by $\left[0, 1 - \alpha^{1/n}\right]$. For large sample sizes using

$$\lim_{n \to \infty} n(1 - \alpha^{1/n}) = -\ln(\alpha),$$

the interval estimate is $\left[0, -\ln(\alpha)/n\right]$. When $\alpha = 0.05$, the interval is approximately $\left[0, 3/n\right]$, or the "rule of three." A similar method using a two-sided 95% confidence interval approach is $\left[0, 3.69/n\right]$, where $\alpha/2 = 0.025$ is used in lieu of α in the above formula. Hanley and Lippman-Hand (1983) mention several other extensions to the "rule of three." Perhaps a more conservative approach would warrant using a "rule of four" with $4/n$ representing an upper boundary.

Near the boundary, one-sided confidence intervals are less conservative than two-sided intervals. The coverage probabilities in this region are highly erratic (Brown, et al., 2001). Therefore, the more conservative two-sided approach should be used to account for this unreliability. Further, the construction of one-sided confidence intervals should be determined before data are collected and not ad hoc. The common practice of using one-sided intervals when $x = 0$ and two-sided intervals when $x > 0$ is inconsistent. Analogous to deciding a priori whether to perform a one-sided or two-sided hypothesis test, the data should not dictate the method of interval construction.

An alternative to the Wald interval construction is based on inverting the score statistic,

$$z = \frac{p - \pi}{\sqrt{\dfrac{\pi(1-\pi)}{n}}}.$$

This interval, first discussed by Wilson (1927), is constructed in a similar manner to the Wald while using the exact variance, $\pi(1-\pi)/n$, instead of the invariant estimate, $p(1-p)/n$. As noted by Olivier and May (2006), the inversion of the score statistic can be written as a weighted estimator

$$(1-w)p+(w)\frac{1}{2}\pm Z_{\alpha/2}\sqrt{(1-w)\frac{p(1-p)}{n+Z_{\alpha/2}^2}+(w)\frac{1}{4(n+Z_{\alpha/2}^2)}}$$

where the weight is

$$w = \frac{Z_{\alpha/2}^2}{n+Z_{\alpha/2}^2}.$$

Note that the maximum binomial variance of $1/4$ occurs at $\pi = 1/2$. As sample size approaches infinity, w tends to zero and the Wilson intervals converge to the Wald intervals. Whereas for small samples, the Wilson estimate depends more on the most conservative estimate of π, $p = 1/2$.

For the case of $x = 0$ successes, the Wilson interval simplifies to $[0, w]$.

For those who argue for the use of one-sided intervals, the Wilson interval is interestingly constructed as two-sided, yet it is inherently one-sided in that zero is always the lower limit. Thus the need for truncating the interval is ameliorated and there is no need to apply ad hoc methods as a special case when $x = 0$. If one-sided confidence intervals are decided upon a priori, one would use Z_{α} in the definition of w.

Regarding the coverage probabilities for the Wilson intervals, Chebyshev's inequality guarantees a minimum coverage of $\left(1 - 1/Z_{\alpha/2}^2\right)$ for the Wilson intervals since the population variance, not the sample variance, is used in the calculation. For 95% intervals, the minimum coverage for the Wilson intervals is about 75% without making any distributional assumptions. In fact the global minimum coverage for the binomial parameter occurs at $\pi \approx 0.176/n$ for a minimum coverage probability of at least 82.4% for the Wilson intervals (Olivier and May, 2006). There is, however, no such guarantee for the Wald intervals or its derivatives where the variance is estimated from the sample.

Wilson (1927) commented that if using $estimate \pm 2 \times s.e.$ (which implies the lack of a distributional assumption) is a valid alternative to a 95% confidence interval, then Wilson's point estimate simplifies to

$$(1-w)p+(w)\frac{1}{2} = \frac{x+2}{n+4}.$$

Agresti and Coull (1998) inserted Wilson's point estimate into the Wald interval calling the resulting interval the "add two successes and two failures adjusted Wald interval." We refer to this interval as the Wilson/Agresti/Coull interval (WAC). Wilson (1927) also discusses using $p^* = (x+1)/(n+2)$ as a point estimate. The WAC interval estimate can be written as

$$\frac{x+2}{n+4}\pm Z_{\alpha/2}\sqrt{\frac{(x+2)(n-x+2)}{(n+4)^3}}$$

which is truncated to a one-sided interval as

$$\left[0, \frac{2}{n+4}+Z_{\alpha/2}\sqrt{\frac{2(n+2)}{(n+4)^3}}\right]$$

for the zero success case. It is worth noting that the Wilson intervals are a proper subset of the WAC intervals (Agresti and Caffo, 2000).

The Wilson intervals are based on inverting the binomial test statistic and are thus theoretically justified. The WAC intervals are overly conservative, especially on the boundary. In addition, the minimum coverage probability

can be guaranteed with the Wilson intervals but not with the Wald intervals. One line of reasoning for using the Wald or adjusted Wald intervals seems to center on a didactic argument that they are easier to teach. We note that with the case of $x = 0$, the Wilson intervals are simply $[0, w]$ and a 2σ interval comparable to WAC is $4/(n + 4)$, an alternative to the "rule of four."

Examples

In a recent meeting with a colleague, there was a discussion regarding two samples in which he observed zero negative effects. The sample sizes for the two studies were $n = 10$ and $n = 359$, respectively. Since larger sample sizes provide more information about the population, the more likely $\pi = 0$ when $x = 0$ as n increases. Intuitively, then, observing zero successes is a more significant finding for $n = 359$ than for $n = 10$.

As mentioned previously, a hypothesis test might not be appropriate in studies where small proportions are expected; alternatively, a confidence interval estimate of π would be more informative. For the zero observed successes case, the upper limit of each interval is often interpreted as an approximate representation of the maximum value of π for a specific sample size. Inferences can be made by comparing the upper limit with the largest acceptable value of π, or *maximum allowable risk*. Wilson (1927) offered the interpretation that if the true parameter is outside the interval $[0, w]$, the probability of observing 0 successes is α.

For the current example, the researcher expected a priori to find at least some negative effect, so a one-sided confidence interval would not be appropriate. The upper 95% confidence limit for each sample is presented in Table 1 for

the WAC, Wilson and Hanley intervals. Note that when $n = 10$, both the WAC and Hanley intervals are more conservative than the Wilson interval. Yet for $n = 359$, all three estimates are similar. As sample size increases, all three upper endpoints converge to the same value, namely 0. Figure 1 makes note of their convergence behavior.
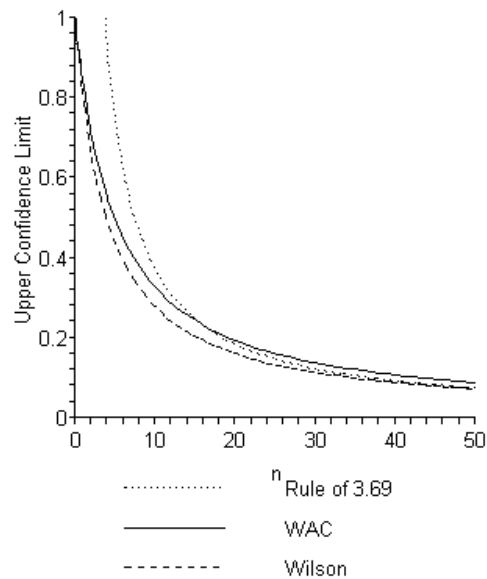

Figure 1. The upper limit of two-sided 95% **binomial confidence intervals for zero observed successes**.

In practice, the concern is how large does a sample size need to be to claim a treatment is a complete success (or failure). From a design perspective, if the maximum allowable risk is known, an appropriate sample size can be computed from each interval. Letting π_a be the maximum allowable risk, the sample size is $n = Z^2(1 - \pi_a)/\pi_a$ for the Wilson interval and $n = 3.69/\pi_a$ for the Hanley interval. The WAC interval does not solve readily for n. However, the sample size is

roughly $n = (4.8 - 4\pi_a)/\pi_a$ using the large sample approximation

$$\frac{2}{n+4} + Z_{\alpha/2}\sqrt{\frac{2(n+2)}{(n+4)^3}} \approx \frac{4.8}{n+4} \ .$$

Table 2 summarizes sample size calculations for the cases when the maximum allowable risk is $1/100$ and $1/1000$. The WAC sample size calculation is much more conservative than the other intervals (see Figure 2 for a more comprehensive perspective).

Discussion

Most elementary statistics texts present binomial parameter confidence intervals defined on the open interval $(0,1)$, although $\pi \in [0,1]$. Procedures for estimates near the boundary are too often ignored. We have presented three alternatives to the Wald intervals. One-sided intervals are inappropriate a priori and should thus be avoided. The WAC interval is more conservative than the Wilson interval (often unnecessarily). The Hanley and Wilson intervals perform similarly; however, the Wilson estimate is the only inherently one-sided interval and thus the need for truncating the lower limit ad hoc is ameliorated. Interestingly, Agresti and Coull (1998) advocate the use of the Wilson intervals as a didactic tool, as well as Santner (1998). When estimating the binomial parameter on the boundary, we also recommend using the Wilson interval.

Table 1. Comparison of the 95% interval upper limits when observing $x = 0$ success among $n = 10$ and $n = 359$ trials.
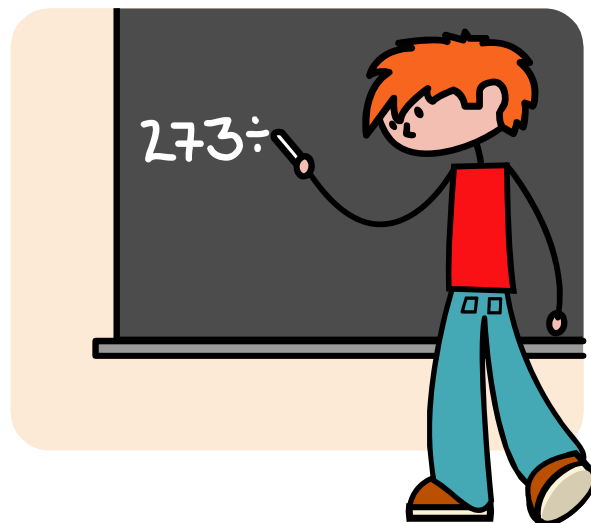
	Formula	$n = 10$	$n = 359$
Wald	$[0,0]$	0	0
WAC	$\dfrac{2}{n+4} + Z_{\alpha/2}\sqrt{\dfrac{2(n+2)}{(n+4)^3}}$	0.326	0.013
Wilson	w	0.277	0.011
Hanley	$3.69/n$	0.369	0.010

Table 2. Comparison of sample size estimates for maximum allowable risk.

	Formula	$\pi_a = 0.01$	$\pi_a = 0.001$
Wald	none		
WAC	$(4.8 - 4\pi_a)/\pi_a$	476	4796
Wilson	$Z^2(1-\pi_a)/\pi_a$	381	3836
Hanley	$3.69/\pi_a$	369	3690

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AGRICULTURE AND PLANT SCIENCE

FRIDAY AFTERNOON, FEBRUARY 23
New Posters, Friday, 3:00p.

CHARACTERIZATION OF OXIDATION PRODUCTS FROM CATFISH OIL AND BIODIESEL

Supanee Danviriyakul[1], Ashli E. Brown[2]*, William E. Holmes[3], Elizabeth C. Rogers[3], and Juan L. Silva[2], [1]Chandrakasem Rajabhat University. Bangkok, Thailand; [2]Mississippi State University, and [3]Mississippi State Chemical Laboratory, Mississippi State, MS 39762.

The stability of biodiesel depends on the quality of the feedstock, transesterification process, environmental conditions, and other factors. Oxidation of biodiesel can lead to lower engine performance and shorter life. Oil breakdown can occur through hydrolysis of triglycerides and through oxidation of fatty acid methyl esters (FAMEs), resulting in low molecular weight FAs and/or polymerized molecules of very high MW. Polymerization can result in increased viscosity of the biodiesel and failure to meet ASTM standards. Catfish oil was trasesterified with excess methanol and sodium hydroxide and refined. The resulting product was heated to 80 and 110°C, with and without air. The oxidation products were analyzed using GC/MS and LC/MS. These highly selective analytical techniques allow identification and monitoring of these products. Samples stored without available oxygen did not produce significant ROOH or conjugated dienes, and the acid number remained low. When the samples were stored open to air, ROOH and conjugated dienes both increased. The acid number and viscosity increased more in samples exposed to air than for samples not exposed to air

UTILIZING ZEBRAFISH AS A MODEL FOR FISH DISEASES.

L. Petrie-Hanson, P. Khosravi, C.M. Hohn and L. Hanson. Mississippi State University, Mississippi State, MS 39762.

Aquaculture, or the production and rearing of aquatic animal species, is rapidly growing throughout the world to replace dwindling natural resources. Channel catfish production is the largest aquaculture enterprise in the United States. The leading cause of loss in channel catfish (*Ictalurus punctatus*) production is disease, with very high losses occurring at the fry stocking to fingerling stage. The leading cause of fry/fingerling loss is Enteric Septicemia of Catfish (ESC), with 57.8% of fry/fingerling producers reporting losses. Providing broad protection against multiple pathogens at an early developmental stage is especially critical in extensive aquaculture because very young fish are placed in extremely vulnerable situations. Research investigating disease progression in channel catfish fry is difficult because channel catfish take 3 years to mature, and spawn once a year, so the availability of fry for developmental immunology studies is limited. Additionally, the genome of this species has not been sequenced, and micro array reagents are limited. These factors negatively impact developmental immunology and infectious disease research of this commercially important fish. Alternatively, zebrafish reproduce by three months of age, spawn weekly, are hardy and easy to maintain. The zebrafish genome has recently been sequenced; so characterizing the interaction of zebrafish and pathogens can be more readily investigated at the molecular level. We are investigating disease progression of several fish pathogens utilizing the zebrafish model.

CELLULAR, MOLECULAR AND DEVELOPMENTAL BIOLOGY

THURSDAY AFTERNOON, FEBRUARY 22
Moved Lecture, 2:00p. Moved to Health Sciences, Poster, Friday, 9:30a.
DELETION AND EPITOPE-TAGGING OF CELL CYCLE GENES USING UNCLONED PCR FUSION PRODUCTS AND HOMOLOGOUS RECOMBINATION IN *ASPERGILLUS NIDULANS*
Moved Lecture, 3:30p. Moved to Lecture, Friday, 10:15a.
EXPRESSION ANALYSIS OF THE MOLD-SPECIFIC M46 GENE IN FIVE STRAINS OF THE PATHOGENIC FUNGUS *HISTOPLASMA CAPSULATUM*
Moved Lecture, 3:45p. Moved to Lecture, Friday, 10:30a.
THE CO-EXPRESSION OF AMPKA, AMPKB, AND AMPK" FROM *TRYPANOSOMA BRUCEI*

FRIDAY MORNING, FEBRUARY 23
New Lecture, 10:45a.
A NOVEL APPROACH FOR IDENTIFYING POLYMORPHIC SIMPLE SEQUENCE REPEAT MARKERS IN GOSSYPIUM USING GENE-ENRICHED DNA SEQUENCES

Linda Ballard[1]*, Abigail Newsome[2], and Brian E. Scheffler[1], [1]USDA-ARS-MSA Genomics Laboratory, Stoneville, MS 38776, [2]Mississippi Valley State University, Itta Bena, MS 38941

Over the last decade, the use of simple sequence repeats (SSRs) has greatly advanced the development of molecular markers. However, many of these SSRs are not proximal to genes even though many are derived from genomic DNA and can be linked to genes of interest. In addition, they can be related to potentially less desirable repetitive DNA regions from which to develop markers. Efforts to use expressed sequence tag sequences (ESTs) derived from coding DNA have provided a number of SSRs, but they are typically not polymorphic due to strong selection pressure to preserve the coding region. Polymorphism between parental lines or within a population are desirable characteristics of SSRs. The USDA MSA Genomics Laboratory generated 27,186 sequences from a pilot methylation filtration project involving four species of *Gossypium*. A novel technique was developed to screen this data for non-coding regions which contain SSRs associated with genes. Primers were designed for the selected SSRs. A *Gossypium* panel was genotyped using these primers and polymorphic SSRs were determined and categorized. within *G. hirsutum* and between five other *Gossypium* species of the Cotton Microsatellite Database panel.

New Lecture, 11:00a.
ROS INDUCED GERM LINE GENOMIC INSTABILITY (GI) IN THE HUMAN TESTIS

Megid, W[2,3], Bacher, J[3], Bedran, W[1]., Prolla, T.[4], Menendez, C.[1] Lucena, E[5]. and Kent-First, M.G[1,2] [1]Mississippi State University, [2]University of Wisconsin, Madison, WI; [3]Promega Madison, WI; [4]University of Wisconsin, Madison, WI, [5]CECOLFES, Bogota, Columbia.

The male germline is susceptible to damage that result from pro-mutagenic changes having the potential to generate mutations, including defects in mismatch repair (MMR), recombination errors, and DNA or chromatin fragmentation, specifically DNA strand breaks. Pro-mutagenic changes may be induced, for example, in the abortive apoptosis pathway, by deficiencies in natural processes such as recombination and chromatin packaging that involve the induction of DNA strand breaks, and by oxidative stress. Single and double DNA strand breaks are particularly frequent in DNA isolated from the ejaculates of sub-fertile men, as is aneuploidy and other indicators of genomic instability (GI). Men with this type of testis profile are at risk of developing testicular tumors.

There exists a need in the art for improved methods of evaluating germline specific genomic instability and to define the mechanism that leads to DNA strand breaks and/or chromosome instability. Detection of microsatellite and chromosomal instability will allow assessment of risk for testicular cancer, detection of acute exposure to ROS or mutagens, and monitoring of exposure over time. In our studies we have identified specific microsatellite repeats that are sensitive to ROS exposure in human and mouse cells. We have determined that these microsatellites are highly unstable in the germ line (sperm) of infertile men. We have shown that a significant subset of these infertile men followed over time develop germ cell tumors (testicular cancer). Results demonstrate that this genomic instability is a part of a ROS induced mutator phenotype in the testis that leads to tumorogenesis. ROS induced DNA strand breaks lead to progressive alterations in the testis including MSI and CIS. Though the normal DNA repair mechanisms are unaffected, ROS induced damage overrides the cells ability to repair DNA strand breaks leading to progressive alterations in the testis including MSI and CIS and tumor formation. The completion of this project provides a valuable clinical research tool to identify men at risk of testicular cancer and to track tumor progression.

FRIDAY AFTERNOON, FEBRUARY 23
Canceled Poster, 3:00p
EFFECT OF HETEROTROPHY ON OXIDATIVE STRESS IN THE HERMATYPIC CORAL *CAULASTREA ECHINULATA*
Canceled Poster, 3:00p
CULTURE MAKES A DIFFERENCE IN DEVELOPMENT AND MOLECULAR BIOLOGY OF PORCINE PREIMPLANTATION EMBRYOS IN VITRO
Moved Poster, 3:00p. Moved to Health Sciences,

Poster, Friday, 10:30a.
EFFECTS OF VALPROATE AND ALCOHOL ON
CADHERIN EXPRESSION

HEALTH SCIENCES

THURSDAY MORNING, FEBRUARY 22
Moved Lecture, 9:00a. Moved to Poster, Friday, 10:30a
COMPARISON OF GENE EXPRESSION IN
MALIGNANT GASTRIC AND ENDOMETRIAL
TUMORS
Moved Poster, 9:30a. Moved to Lecture, Thursday, 11:00a
CHARACTERIZATION OF PEDIATRIC
PNEUMOCOCCAL OTITIS MEDIA ISOLATES
New Poster, 9:30a. Moved from Cellular, Molecular and Developmental Biology Lecture, Thursday, 2:00p.
DELETION AND EPITOPE-TAGGING OF CELL
CYCLE GENES USING UNCLONED PCR
FUSION PRODUCTS AND HOMOLOGOUS
RECOMBINATION IN *ASPERGILLUS NIDULANS*
Canceled Lecture, 11:00a
GENERATIONAL AGE DIFFERENCES IMPACT
THE COLLEGE CLASSROOM

THURSDAY AFTERNOON, FEBRUARY 22
Moved Lecture, 3:00p. Moved to Friday, 10:30a poster session
BLOOD PRESSURE IS NOT SALT SENSITIVE
IN OBESE DOGS
Canceled Lecture, 3:30p
THE EFFECT OF ELLAGIC ACID
ADMINISTERED INTRAPERITONEALLY AND
ORALLY IN *TRYPANOSOMA LEWISI* INFECTED
RATS
FRIDAY MORNING, FEBRUARY 23
New Poster, 10:30a. Moved from Cellular, Molecular, and Developmental Biology, Poster, Friday, 3:00p.
EFFECTS OF VALPROATE AND ALCOHOL ON
CADHERIN EXPRESSION

New Posters, 10:30a
CHOLESTEROL PRODUCTION INHIBITOR (STATIN) INCREASED BONE HEALING IN SURGICALLY CREATED FEMORAL DEFECT IN AN ANIMAL MODEL

Felix Adah[1], Hamed Benghuzzi[1], Michelle Tucci[1], George Russell[1], and Barry England[2]. [1]University of Mississippi Medical Center, Jackson, MS and [2]University of Michigan Medical School, Ann Arbor, MI

This study investigated the effects of dual delivery of statin and vancomycin on the healing process of a femoral defect injury using tricalcium phosphate lysine (TCPL) delivery system in an animal model. The experimental design consisted of 14 rats divided into the following three groups: Group I animals (n=5) served as the intact control without treatment. Group II animals (n=5) were subjected to a surgically induced defect (2 mm, midshaft of the right femur) and implanted (IM) with TCPL capsules loaded with vancomycin (20mg) (TCPL-AB). Group III animals (n=4) were operated on in a similar fashion as Group II, and subsequently implanted with TCPL capsules loaded vancomycin (20 mg) plus statin (5 mg). The animals were euthanized at 30 days post-implantation using overdose of isoflourane. The right femurs were then harvested in addition to the vital organs, the reproductive organs, and sample of the adjacent skeletal muscles. The hard and soft tissues were evaluated histopathologically by following laboratory standard techniques. The results of this study indicated that statin plus vancomycin treated animals healed in a greater magnitude than the sham group (independent evaluators ($p < 0.001$)). Histomorphometric analysis demonstrated that exposure to sustained delivery of statin resulted in increased in cortical width and periosteal area compared to the sham group ($p < 0.05$). In conclusion, data obtained from this study demonstrated that sustained delivery of statin resulted in a remarkable increase in osteogenic activity.

BETA-2-MICROGLOBULIN COMPARED WITH SIX OTHER ANTIGENS FOR THE DETECTION OF HUMAN REPRODUCTIVE CANCERS

Mary J. Guo*, Michelle Branson, Sabrina Bryant, Margaret Jackson, James T. Johnson, and Margot Hall, University of Southern Mississippi, Hattiesburg, MS 39406

Human reproductive cancers are a major problem in the United States. In 2006, there were ~475,810 new cases (breast 212,920, ovarian 20,180, testicular 8, 250, prostate 234,460) and ~84,000 deaths (breast 40,970, ovarian 15,310,

testicular 370, prostate 27,350) from reproductive cancers in the US. Tumor antigens are used for therapeutic monitoring and have been used in combination with other methods for the diagnosis of cancer. In this continuing study, our new goal was to compare the diagnostic potential of beta-2-microglobulin ($2M) with that of six other tumor antigens for breast, ovarian, testicular and prostate cancers. Sera from 554 patients (87 breast cancer, 6 ovarian cancer, 20 testicular cancer, 17 prostate cancer, 229 other cancers, and 195 non-cancer) were assayed for the presence of tumor antigens and the results correlated with diagnoses established pathologically. Immunoassay test kits from Diagnostic Automation ($2M, Ferritin), Hybritech (CEA), Centocor/Fugirebio Diagnostics (CA125, CA15-3, CA27.29), and Abbott (AFP) were used to test for the concentration of these antigens. Using the manufacturers= decision values the following diagnostic sensitivities were obtained: (Breast CA) $2M 77.3%, Ferritin 40.0%, CA 15-3 63.4%, CA27.29 39.3%, CEA 22.4%, CA125 12.1%, AFP 21.8%, (Ovarian CA) $2M: 50.0%, Ferritin 25.0%, CA 15-3 0.0%, CA27.29 0.0%, CEA 0.0%, CA125 16.7%, AFP 0.0%, (Testicular CA) $2M: 50.0%, Ferritin 31.3%, CA 15-3 30.0%, CA27.29 15.8%, CEA 20.0%, CA125 0.0%, AFP 23.5%. (Prostate CA) $2M: 57.1%, Ferritin 17.7%, CA 15-3 11.8%, CA27.29 17.7%, CEA 11.8%, CA125 5.9%, AFP 20.0%. We hypothesized that $2M would prove superior to the other markers and this hypothesis was accepted for all of the cancers.

BETA-2-MICROGLOBULIN COMPARED WITH SIX OTHER TUMOR ANTIGENS FOR THE SERODIAGNOSIS OF PANCREATIC, GASTRIC, AND COLORECTAL CANCER

Michelle Branson*, Mary Guo, Sabrina Bryant, Margaret Jackson, James T. Johnson, and Margot Hall, University of Southern Mississippi, Hattiesburg, MS 39406.

With 33,730 (pancreatic), 22,280 (gastric), and 106,680 (colorectal) new cases and 32,300 (pancreatic), 11,430 (gastric), and 55,170 (colorectal) deaths estimated during 2006, pancreatic, gastric, and colorectal cancers are important pathologies in the USA. Tumor antigens have been used in combination with other methods for diagnosis. The objective of this study was the comparison of beta-2-microglobulin ($2M) with six other tumor antigens for diagnostic efficacy in pancreatic, gastric, and colorectal cancer. We hypothesized that $2M would be the best tumor marker for these cancers. Sera from 554 patients (16 pancreatic cancer, 12 gastric cancer, 101 colorectal cancer, 230 other cancers, and 195 non-cancer) were assayed for the presence of tumor antigens and the results correlated with diagnoses established pathologically. Immunoassay test kits from Diagnostic Automation ($2M, CA242), Hybritech (CEA, CA195), Centocor/Fugirebio Diagnostics (CA19-9, CA72-4), and CIS Biointernational (CA50) were used to test for the concentration of these antigens. Using the manufacturers' decision values the following diagnostic sensitivities were obtained: Pancreatic CA: $2M 58.3%, CEA 37.5%, CA19-9 66.7%, CA195 100.0%, CA50 66.7%, CA242 66.7% ,CA72-4 31.3% ; Gastric CA: $2M 80.0%, CEA 50.0% , CA19-9 63.6%, CA195 58.3%, CA50 70.0%, CA242 70.0% , CA72-4 27.3%; Colorectal CA: $2M 28.4%, CEA 26.7% , CA19-9 18.8%, CA195 36.6%, CA50 18.2%, CA242 16.7%, CA72-4 17.0%. Diagnostic specificities were >75%. From these data we conclude that $2M was the best marker for gastric cancer supporting our hypothesis but that CA195 was superior for pancreatic cancer and colorectal cancer rejecting our hypothesis.

FRIDAY AFTERNOON, FEBRUARY 23
Moved Poster, 1:15p. Moved to Lecture, Thursday, 9:15a
SEASONAL VARIATION IN ANTI-CCV SERUM ACTIVITY IN CHANNEL CATFISH: IMPLICATION FOR BROODSTOCK SCREENING
Moved Poster, 1:15p. Moved to Lecture, Thursday, 11:00a
SELECTIVE HUMAN MELANIN-CONCENTRATING HORMONE RECEPTOR 1 AND MELANIN-CONCENTRATING HORMONE RECEPTOR 2 ANTAGONISTS FOR THE TREATMENT OF METABOLIC DISEASES
Moved Poster, 1:15p. Moved to Lecture,

IMMUNIZATION WITH PSPA INCORPORATED INTO A POLY(ETHYLENE OXIDE) MATRIX ELICITS PROTECTIVE IMMUNITY AGAINST *STREPTOCOCCUS PNEUMONIAE*
Moved Poster, 1:15. Moved to Lecture, Thursday 2:30p
DOES YOUR IMMUNE SYSTEM HAVE

STRIPES? INVESTIGATING THE SIMILARITIES AND DIFFERENCES BETWEEN THE IMMUNE SYSTEM OF MAN AND ZEBRAFISH
Moved Poster, 1:15. Moved to Lecture, Thursday 3:00p
BUTORPHANOL-INDUCED NEURONAL ACTIVATION WITHIN THE PARAVENTRICULAR NUCLEUS (PVN) OF THE HYPOTHALAMUS AND RESULTING ACTIVATION OF THE HYPOTHALAMIC-PITUITARYADRENAL (HPA) AXIS

MATHEMATICS, COMPUTER SCIENCE AND STATISTICS

THURSDAY AFTERNOON, FEBRUARY 22
New Poster, 6:00p

A COMPARATIVE STUDY OF NORMALIZATION METHODS USED IN STATISTICAL ANALYSIS OF CDNA MICROARRAY DATA
Dharmendra K. Singh, Deborah L. Boykin, Abigail S. Newsom, Mississippi Valley State University, Itta Bena, MS 38941
Normalization methods used in the statistical analysis of cDNA microarray data are evaluated. The cDNA microarray is considered an efficient analytical tool for analyzing thousands of genes simultaneously in a single experiment. However, systematic variation in microarray, originating from various sources, affects the measurement of gene expression levels. The purpose of normalization methods is to identify and eliminate any systematic variance in the measurements. Several normalization methods, such as total intensity normalization, intensity-dependent normalization, and global normalization are studied. Our choice for the normalization method would depend on the nature of experiments, and the type of data set being used. Different normalization methods are compared to determine the most suitable method for achieving greatest precision and eliminate spatially dependent variability. Precision will be evaluated using analysis of variance procedure and measuring the rate of erroneous decisions. A Type I error occurs when significance is falsely declared and a Type II error occurs when important differences are not detected. Decreasing variability using these normalization and statistical analysis methods will decrease Type I and Type II error rates. Minimization in Type II error signifies grater precision or higher power of study. A lower Type I error, in the microarray case, results in a lower false discovery rate of responsible genes. Spatial patterns in variability will be detected by plotting residuals from analysis of variance using the x,y coordinates from the microarray slide. Our method will be focused on a maize research project to look at gene expression related to disease resistance.

PSYCHOLOGY AND SOCIAL SCIENCES

THURSDAY MORNING, FEBRUARY 22
New Presenter
Dr. Shaila Kahn's lectures will be given by Dr. Abu Khan.

THURSDAY AFTERNOON, FEBRUARY 22
Division Business Meeting, New Time, 3:15p
Division Poster Session, **moved from Thursday, 3:20p to Thursday 6:00p in Bost Auditorium**
New Posters, 6:00p.
ELMO EATS BROCCOLI: A COMPARISON OF ACTUAL VERSUS REPORTED FOOD CHOICES
Christy Jayne* & Karen Christoff*, University of Mississippi, University, MS 38677
The prevalence of childhood obesity has continued to grow over past decades and is reaching epidemic proportions. While decreasing the prevalence of overweight children is important, prevention is essential. Understanding ways that children develop eating habits is crucial to prevention efforts. Children can be picky eaters and reluctant to try new foods. However, there are ways to impact on food choices. Birch and Fisher (1997) found that children base their food decisions on someone that is in a similar or more powerful position to them. Others have found that exposing children to food advertisements can impact later food choices (e.g., Halford et al., 2004; Borzekowski & Robinson, 2001). The present study examined children's beliefs about healthy eating as well as factors that impact children's food choices. We looked at the impact of pairing foods with familiar images on children's reported and actual food choices. Food choices were recorded over three sessions. In the first session, food choices were not paired with images. In the second two sessions the food choices were paired with either a Muppet

character or a shape. Examining frequencies of food choices showed that for children that picked the Muppet character as their favorite, pairing a food with a Muppet character increased the likelihood that those children would report that food as the favorite of a pair in a forced-choice protocol. However, the relationship was less strong when children actually got to eat the food they picked. Additional results and implications of the findings will be discussed. With special thanks to David Cohen and Jennifer Kotler of the Sesame Street Workshop

AN EXAMINATION OF THE RELATIONSHIPS AMONG GREEK STATUS, SOCIAL BEHAVIOR, ALCOHOL/SUBSTANCE USE, AND ASSOCIATED RISK BEHAVIOR

Kristen Sellers*, Carly Green*, and Karen Christoff, University of Mississippi, University, MS 38677

The current study examined the relationship between social Greek organization membership, risk behavior, and a variety of social variables known to be associated with substance use. Approximately 300 undergraduate students at the University of Mississippi were administered the Texas Social Behavior Inventory, the UCLA Loneliness Scale, CDC's Youth's Risk Behavioral Surveillance Survey, a risk behavior checklist, and a demographic questionnaire. Our sample consisted of 161 Greek students and 139 non-Greeks. A series of ANOVA's were computed to assess between group differences. Data indicate that non-Greek students report having significantly fewer friends than Greeks (F=11.7987, p=.001) and experiencing significantly greater loneliness than Greek students (F=4.972, p=.027). However, there were no differences in their self-perceived social competence. Therefore, their perceived ability to establish social relationships may not account for the differences in their actual social involvement. In addition, Greek students reported significantly more overall substance use (F=5.373, p=.021), in particular, alcohol (F=25.33, p=.000) and amphetamine (F=9.16, p=.003) use. Greeks also reported having engaged in risk behaviors associated with alcohol and substance use significantly more often than non-Greeks (F=30.191, p=.000). The data are consistent with the literature suggesting that students who are members of social Greek organizations engage in alcohol/substance use, as well as their associated risk behaviors, more often than non-Greeks. Risk behaviors may be seen as social in nature and depicting more social students as more likely to engage in more frequent risk behavior.

INTEGRATED FRUIT PRODUCTION IN BRAZIL

Paulo R. C. Lopes* and Juan L. Silva, Embrapa Semi-Arido, Petrolina, PE 56300-000, Brazil and Mississippi State University, Mississippi State, MS 39762

Integrated (fruit) production, IFP is defined by the International Organization for Biological Control as a "farming system that produces high quality food and other products by using natural resources and regulating mechanisms to replace polluting inputs and to secure sustainable farming." Emphasis is placed on a holistic systems approach involving the entire farm as the basic unit, on the central role of agro-ecosystems, on balanced nutrient cycles, on the welfare of all species in animal husbandry, on the safety of the product, and the economic feasibility. Brazil optimized this system and has been able to apply it to more than 20 fruit crops and other agricultural commodities. The system is implemented by developing and adapting technologies needed, selecting production/packing facilities, changing the conventional practices into this system's approach, training of technicians and growers/packers. IFP includes the adaptation of Integrated Pest Management practices, use of GPS technology, monitoring and records, and continuous evaluation to improve and insure that the system is working. This system has resulted in over 80% reduction in chemical usage and a significant decrease in costs of production, development of guides specific to each fruit (product), and a stamp to identify the product satisfies IFP guidelines. This system also satisfies the new traceability requirements placed by buyers and regulators around the world. Today there are over 13,000 ha of mangoes and 6,000 ha of grapes under IFP.

DIVISIONAL REPORTS

The divisional reports will be featured in the October issue of the journal. If you are divisional chair, and have not sent in your conference report you have until the August 23, 2007 to e-mail mtucci@orthopedics.umsmed.edu to be included in the special Katrina issue.

The October issue will focus on the recovery of science on the Mississippi Gulf Coast.

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President 2006-2007

Dr. Juan L. Silva

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Research group page:
http://www.msstate.edu/org/silvalab/

President's Column

I will like to thank each and every one of you for your support and dedication and for the tremendous success of our 2007 annual meeting, held at Mississippi State University this past February 23-24, 2007.

Thanks to your effort, we have had the most successful meeting ever in the history of the Academy. We had a total of 430 abstracts presented, with a total of 692 participants. The number of student participants outnumbered the number of professional registered participants by 55.5 to 44.5 %. In terms of abstracts accepted, 53% were oral and 47% posters. This is a great accomplishment for a two day meeting, with great balance and outstanding student participation. I hope to have an article in the near future in your journal, the Journal of the Mississippi Academy of Sciences, on the achievements we have made in our short history and the challenges we have to make the Academy the major venue for scientists, researchers, engineers and alike, in Mississippi. I want to thank the Division chairs for their efforts. In addition to our program, we had the Dodgen lecture given by Dr. Ramish Patel, Professor of Radiology and Director of the Diagnostics Imaging Center at UMC, a plenary lecture on Obesity and Health by Dr. Mary Schmidl, former President of the Institute of Food Technologists and renowned in her field. The divisions also had excellent programs and many had student competitions.

However, this would not have been possible without the financial and logistic support of my alma mater. Mississippi State University contributed over $ 20,000 to the meeting, in addition to our loyal suppliers (over $6,000) and others like the Magnolia section of the Institute of Food Technologists. We were able to have a positive balance in terms of meeting costs and expenses. The facilities were outstanding, most of the rooms had the support equipment and assistance needed by the presenters. Mississippi State University also contributed by providing wireless access, parking, shuttle services and many other services.

I want to thank the MSU Vice-President for Agriculture, Forestry and Veterinary Medicine, Dr. Vance Watson for his financial and moral support, the former and present Vice President for the Office of Research and Economic Development, Drs. Colin Scannes and Kirk Schulz, the former Dean of Engineering, Dr. Kirk Schulz, the interim Director of Graduate Studies, Dr. William Person, and my department head, Dr. Benjy Mikel, for their financial and logistics support. In addition, I want to thank Drs. Charles Lee and Robert Foglesong, past and present Presidents of MSU, for their support and encouragement. There were many people at MSU that were supportive and made the meetings run smoothly and flawlessly. I also want to thank Ms. Armaruth Salazar of the Greater Starkville Partnership Development for hosting a table with information and goodies for the attendants.

I also owe much of the success of this meeting to Dr. John Boyle, Board Director, Abstracts editor, webmaster and supporter of science in our state; Mr. William Holmes, Exhibits Chair, who along with his research group was instrumental in the exhibits logistic, food, and beverages; Dr. Taejo Kim, Poster Chair, the other members of the annual meeting committee, Ms Cynthia Huff and our Program chair, Dr. Anne Marie Kinnell. I also want to thank many other people, including my research group, for their dedication and hard work.

I want to thank especially Dr. Ham Benghuzzi, now our Executive Director, the person responsible for nominating me and for supporting and guiding me through this year. I also want to thank our esteemed Board members and journal editors, Drs. Michelle Tucci and Edwin Swiatlo, our longtime supporters including Dr. Rob Rockhold, and the many others that have contributed to a successful and growing academy.

Finally, thank all of you for your support and cooperation. You and your division chairs and other division volunteers make the meeting and the academy a success story in our state and our nation. It is the dedication of the many volunteers and the support of my institution and other higher education institutions in the state that have made this a successful and most meaningful meeting. There are not many meetings where we can say that the students are the majority participants, where the students are able to present in oral or poster forms their scientific findings, and where the state can come together to showcase science, engineering and technology.

I look forward to your continues participation and support of the academy and to see you next year (February 21st-22nd) at Whispering Woods Conference Center in Olive Branch, MS.

Sincerely,

Juan L. Silva
President, MAS 2006-2007
Professor, Mississippi State University

PRESIDENT 2007-2008

Dr. Joseph A. Cameron
Department of Biology, Jackson State University
Professor and Director of Graduate Program
Former Director of Minority Institutional Research Training Program
Former Director of Community Mobilization, Jackson Heart Study
Director of the Bridges to the Baccalaureate Degree Program
Coordinator of the Bridges to the Doctorate Program with Indiana University Purdue University at Indianapolis

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Sponsored by the National Institute of General Medical Sciences, National Institutes of Health

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Hinds Community College Jackson, MS   (601) 987-8174

Executive Director Column

by

Dr. Ham Benghuzzi

It is with pleasure to share with you the positive direction that the Academy is headed. First, it is imperative that we recognize Dr. Juan Silva for taking the challenge to lead the Academy and for making last year's meeting a true success in terms of funding, student participation, and the number of abstracts and presenters. We also want to thank the Mississippi State University for their contributions as well as hosting our program on their campus. We are truly indebted to their immeasurable support. We anticipate that this year's meeting will follow in the success of the previous meeting. Dr. Cameron is drumming up support for this year's meeting from his colleagues at Jackson State University in addition to beating on the doors of outside industry. Now, it is up to us to send in our contributions in terms of abstracts to support the academy. This February, we will hold the meeting for the first time in Olive Branch, MS at the Whispering Woods Conference Center. It is a beautiful location, and the conference center looks as if it was designed especially for our academy needs. The information for reservations and abstracts can be found on pages 195 and 196 of this issue.

Dr. Baker has been affiliated with the University of Mississippi Medical Center as a professor in the Department of Pharmacology since 1993. He has trained Ph.D students and has hosted several post doctoral fellows through out this tenure. He was a recipient of the **Mississippi Academy of Sciences-Outstanding Contributions to Science-award (2005).** Dr. Baker has received funding from granting agencies such as NIH, NIAAA, and various foundations over the years. Dr. Baker is well recognized in his field and has been invited to lecture at 27 national and international symposiums and institutions on topics ranging from Alcohol and Immunology to lipid metabolism. Let us all offer our support to Dr. Baker and help make the MAS 2009 meeting a success. We also are happy to announce the appointment of Dr. Ann Marie Kinnell to the MAS Board of Directors.

I now challenge you, my friends and colleagues, to put forth the efforts to become involved and help the leadership to advance **our** MAS. Our goal as educators and scientists should be to provide a conduit for the dissemination of ideas and a forum for their presentation and discussions. Each of us has a lot to offer, and it should be our duty and responsibility as well as an honor to serve as an **active** member in the Academy. Our membership continues to grow, but the rate is not fast enough. We all need to be aware of young talent in our state and encourage them to participate. I leave you with a quote from -- Albert Gyorgyi - **Discovery consists of seeing what everybody has seen and thinking what nobody has thought**.

Mississippi Academy of Sciences 2008

Whispering Woods Hotel and Conference Center

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Olive Branch, MS 38654

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CALL FOR ABSTRACTS

MISSISSIPPI ACADEMY OF SCIENCES ABSTRACT FORM/MEMBERSHIP FORM

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Abstract title:_____
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Check the division in which you are presenting

__ Agriculture and Plant Science   __ Health Sciences   __ Physics and Engineering
__ Cellular, Molecular, and Dev. Biol   __ History and Philosphy of Sciences __ Psychology and Social Sciences
__ Chemistry and Chem. Engineering   __ Math., Computer Sci and Statistics __ Science Education
__ Ecology and Evolutionary Biology   __ Marine and Atmospheric Sciences   __ Zoology and Entomology
__ Geology and Geography

Type of presentation
__ **Poster presentation**   __ **Workshop**   __ **Lecture presentation** __ **Invited Symposium**
If the presenting author for this paper will also present in another division, please list the other
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Audiovisual Equipment needs:
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CHECKLIST
Please complete the following:
__ Enclose copy of abstract (even if abstract has been submitted electronically)
__ Complete and enclose abstract/membership form (this form)
__ Enclose the following payments (Make checks payable to Mississippi Academy of Sciences)
   __ $25 per abstract
   __ $25 regular membership fee OR $5 student membership fee (2007 membership must be paid for abstract to be accepted)
__ You must supply a check #_____ or P.O. #_____ (credit cards are not accepted)

In addition, you MAY preregister at this time to take advantage of the saving
__ Enclose the following payments:
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 __ $35   student member (after 23 Jan)   __ $20 student member (Preregistration before Jan 23)
 __ $100 nonmember   (after 23 Jan)   __ $80 nonmember   (Preregistration before Jan 23)

Note: Abstracts that are resubmitted for changes will incur a $10 resubmission fee. 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.

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

- 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 ($20 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 be submitted by e-mail or entered directly through the MAS website. The URL is http://www.msacad.org/index.html (case sensitive). This abstract submission form and the appropriate fees should be sent by US mail even if the abstract has been submitted electronically.
- **Abstracts that are resubmitted for changes will incur a $10 resubmission fee.**
- **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 abstract and appropriate fees to the Abstracts' Editor, John Boyle, TO BE RECEIVED NO LATER THAN NOVEMBER 1, 2006.

Dr. John Boyle
Mississippi State University
Dept. of Biochemistry
P.O. Drawer 9650
Mississippi State, MS 39762

jab@ra.msstate.edu

FORMAT FOR ABSTRACT

➢ Your abstract should be informative, containing: (a) a sentence statement of the study's specific objectives, unless this is given in the title; (b) brief statement of methods, if pertinent; (c) summary of the results obtained; (d) statement of the conclusions. It is not satisfactory to state, "The results will be discussed."

➢ Your abstract, including a concise, descriptive title, author(s), location where work was done, text and acknowledgment, may not exceed 250 words. **Excessively long abstracts will be truncated**.

➢ The title should be all capital letters. Use significant words descriptive of subject content.

➢ Authors' names start a new line.

➢ The institution where your research was done should include city, state, and zip code. Do not include institutional subdivisions such as department.

- ➢ The abstract should be one paragraph, single spaced, starting with a 3-space indentation.
- ➢ Use standard abbreviations for common units of measure. Other words to be abbreviated, such as chemical names, should be spelled out in full for the first use, followed by the abbreviation in parenthesis. Do not abbreviate in the abstract title.
- ➢ Special symbols not on your printer or typewriter must be in black ink.
- ➢ Use italics for scientific names of organisms.
- ➢ Begin authors' names on a new line. Place an asterisk (*) after the presenter(s), if there are multiple authors.
- ➢ Use superscripts for institutional affiliations where necessary to avoid ambiguity.
- ➢ Refer to these examples as guides.

EXAMPLES OF TITLES AND AUTHORS:

[single author, no ambiguity about designated speaker or affiliation]

AN EXPERIMENTAL MODEL FOR CHEMO-THERAPY ON DORMANT TUBERCULOUS INFECTION WITH PARTICULAR REFERENCE TO RIFAMPICIN

Joe E. Jones, Mississippi State University, Mississippi State, MS 39762

   Abstract body starts here . . .

[two authors, one designated speaker, different affiliations, but no ambiguity]

AN EXPERIMENTAL MODEL FOR CHEMO-THERAPY ON DORMANT TUBERCULOUS INFECTION WITH PARTICULAR REFERENCE TO RIFAMPICIN

Joe E. Jones and Ralph A. Smith*, Mississippi State University, Mississippi State, MS 39762, and University of Mississippi Medical Center, Jackson, MS 39216

   Abstract body starts here . . .

[two authors, both designated as speakers, different affiliations, but no ambiguity]

AN EXPERIMENTAL MODEL FOR CHEMO-THERAPY ON DORMANT TUBERCULOUS INFECTION WITH PARTICULAR REFERENCE TO RIFAMPICIN

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