Journal of the Mississippi Academy of Sciences

Volume 47 April 2002 Number 2

The Journal of the Mississippi Academy of Sciences (ISSN 0076-9436) is published in January (annual meeting abstracts), April, July, and October, by the Mississippi Academy of Sciences. Members of the Academy receive the journal as part of their regular (non-student) membership. Inqueries regarding subscriptions, availability of back issues, and address changes should be addressed to The Mississippi Academy of Sciences, Post Office Box 55709, Jackson, MS 39296; 601-977-0627; msacad@bellsouth.net.

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Editorial

We have a new division! The Division for Ecology and Evolutionary Biology was established at our recent annual meeting. The division was created to fill a perceived need for those that felt Agriculture and Plant Science largely served applied plant science and Zoology and Entomology was restricted to animals. The new division will span both botany and zoology (and the other kingdoms), focus on ecology, and include evolution and systematics. Those of you that conduct research in these areas should consider submitting papers in this division for next year. We shall meet at the convention center in Hattiesburg for our 2003 annual meeting.

Look over the broad range of topics covered in this issue. In addition to a print version of the keynote lecture at our recent annual meeting, we also have papers focusing on fish ecology, the catfish industry, local archaeology, and local medicine. Some of the papers include student authors; others are from professional scientists. Many of you have just returned from the annual meeting of our Academy and have a research project that would be appropriate for publication in this journal. Whether you are involved in a local project, a project of limited scope, or a student project, consider whether publishing would be better than relegating the research to a file drawer. Those of you in science education are reminded that this journal publishes "how to" articles on laboratory exercises and other aspects of your educational experience and research. The journal also accepts articles on the history and philosophy of science.—Ken Curry

New Division! ECOLOGY AND EVOLUTIONARY BIOLOGY

The Mississippi Academy of Sciences is pleased to announce the formation of a new division, effective immediately, in Ecology and Evolutionary Biology. The Division of Ecology and Evolutionary Biology encourages submission of papers in these areas to the Journal of the Mississippi Academy of Sciences, and for presentation at next year's annual meeting of MAS in Hattiesburg. Papers appropriate to this division may come from researchers conducting studies in ecology and evolution in terrestrial, wetlands, or aquatic environments, involving organisms of any kind, or be strictly theoretical in content. Dr. Clifford Ochs of the University of Mississippi (byochs@olemiss.edu) and Dr. David Beckett of the University of Southern Mississippi (david.beckett@usm.edu) are the chair and vice-chair of the division for the coming year.—Cliff Ochs

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Vaccine Controversies: Past and Present

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I am honored that you have invited me to give the Dodgen lecture for 2002 here in Biloxi. I would like to talk to you about a subject close to my heart—autism spectrum disorder and the possible link to vaccines. Presently my colleague and I are treating over 1500 children with this problem. In the past five years we have seen an incredible number of children recover from this devastating illness and take their places beside their schoolmates and siblings. This subject, as you might expect, is a very controversial one, but I think you will agree with me before the end of this lecture that this is an epidemic in medicine unlike anything that we have seen in the past.

The debate about vaccinations has been going on since the smallpox vaccine was given during the early part of the twentieth century. In 1914 in Portland, Oregon, Lora Little became a vaccine activist when her seven year old son died after the smallpox vaccination. That same year, several cases of smallpox occurred in Portland. Unvaccinated children were sent home from school for two weeks. There was a massive showdown between the parents and the health officer. The judge ruled in favor of the parents and the children returned to school.

Lora Little's arguments were very similar to what we are hearing from parents today. She stated that "vaccination is an artificial pollution of the blood with a virus that is capable of propagating itself in the system." She went on to say, "This one is an effort of nature. The other is an artifice of the doctors. Trust nature is a safer motto than trust the doctor. Nature does not contradict herself. Medical authority is a mass of contradictions." Lora Little voiced her objections: "It is a violation of the blood and when performed upon a man against his will is a personal assault of exceptionally outrageous character."

She accused "slick doctors" of lying about statistics in an effort to reap the large amounts of money involved in running the state-sponsored machine. "Smallpox has declined concomitantly with vaccination," declared Little, "only because of improvements in municipal and personal cleanliness." She actually ran a campaign that came close to defeating the mandatory vaccine law that existed at that time for smallpox. (Oregon Historical Quarterly, 1998)

A number of parents, doctors, and governmental officials are recognizing a possible link between the epidemic of developmental delays and the growing number of mandatory vaccines. We are fortunate to have stopped the polio, measles, and whooping cough epidemics but have we paid a stiff price for our success?

I am certainly not opposed to giving safe vaccines. I am concerned about the growing numbers of chronically ill children. There are more learning disabled children, and more children with autoimmune illnesses than we have ever had in the history of medicine.

The incidence of autism is rising dramatically. In the fifties, it was 1/10000;1/2000 in the seventies; 1/500 in 1996;1/250 in 2000; 1/147 in 2001 according to the noted epidemiologist, Dr. Eric Fombonne. Is this rise in incidence because we have better diagnostic techniques? Are we better doctors now? I believe that if a child could not speak, had no eye contact, mutilated himself, and did not sleep but a couple of hours per night he certainly would have been given some kind of a diagnosis.

Nationwide statistics in US school children for the school years 97-98 vs. 98-99 in children ages 6 to 21 show a 2.6% increase in all disabilities, 2.3% increase in specific learning disabilities, 1% increase in speech impairments, 1.9% increase in severe emotional disturbance, and a 26% increase in autism. Autism is now the number one disability entering California's developmental services system. Historically, autism accounted for 3% of the intakes into the system. Autism now accounts for 37% of the new intakes. From April 3 to July 8, 2001, 664 new children with autism were added to the system. This is the largest number of autistic children added to the system in the 32 year history of the group. At this rate, California will add 2700 new children with autism to its system in 2001 alone. This is more than all of the new cases entering the system in all of 1994, 1995, and 1996 combined.

There have been a number of causes postulated for autism. I believe that it is generally thought that there is a genetic predisposition for these children. Dr. Andrew Wakefield, pediatric gastroenterologist in England has shown live measles particles in the small

bowel of many of the autistic children that he treats. Dr. Mary Megson, developmental pediatrician, has a hypothesis that the pertussis vaccine takes vitamin A out of its binding site in cells causing problems in cellular communication. The latest and strongest explanation is that the autistic spectrum of disorders may be caused by mercury poisoning from a number of sources including the mother's amalgam fillings, RhoGam given at 28 weeks gestation to Rh Negative mothers, diet, and the ethyl mercury in the vaccines. Finally there are others who feel that the immune systems of the children are at risk because of the toxins and human fetal tissue in the vaccines.

We are treating over 1500 children in the autistic spectrum in our office. We have learned a lot from these children but we have very few answers for these parents. Are vaccines really involved? We think so but we cannot prove cause and effect yet. We are pushing these young, underdeveloped immune systems beyond their capabilities in our zeal to keep them from being ill. Among other problems, there are not enough safety studies for the vaccines presently on the market.

We realized that the epidemic of autism has escalated in the past ten years. A possible link may be the Hepatitis B vaccine which was introduced in 1991 and was given shortly after birth. This vaccine contained 12.5 mcg of mercury. The EPA "safe limit" is 0.1 mcg/kg/day or approximately 0.4 mcg/day for the average newborn. 12.5 mcg is 25 times the EPA safe limit. Ethyl mercury is a neurotoxic form of mercury. A study in the Journal of Pediatrics, May, 2000, demonstrated mercury in the blood of newborns before the shot and a higher level after the shot. In some preterm infants the level of mercury was ten times that of term infants. Intrauterine sources may include seafood diet, maternal amalgam fillings, RhoGam-given at 28 weeks gestation, and influenza vaccine.

Besides the Hepatitis B vaccine the Hib and DTP and DTaP vaccines contained ethyl mercury in the form of thimerosal, used as a preservative. In the typical vaccine schedule, at two months an infant received 62.5 mcg, at four months, 50 mcg, and at six months, 62.5 mcg. These were given to infants with minimal bile production (needed for metal removal from the body) and a permeable blood-brain barrier. The total by 5 years of age exceeded 237 mcg.

We are giving too many vaccines in a short space of time. We do not have a clear idea of the effects of some of the components of the vaccines like thimerosal, aluminum, formaldehyde, and human fetal tissue. In addition to this, we are giving combination vaccines which have been questioned for safety.

From 1890 to 1950 mercury poisoning showed up as Pink Disease. The children had apathy, lost play, sound and light sensitivity, insomnia, seizures, poor muscle tone, repetitive behaviors, pink hands and cheeks. It had a delayed onset and affected 1/500 children. It was traced back to the use of calomel teething powders containing mercury.

If one looks at mercury kinetics, he will find that in blood and hair mercury is cleared in four to six months. In CNS organs it clears more slowly-several years. The brain mercury is removed very slowly. The half-life is estimated to be 20 years.

There is a wonderful article written by a group of parent professionals, Autism: A Unique Type of Mercury Poisoning. It is available on the Autism Research Institute website (www.autism.com/ari). All of the characteristics of mercury poisoning can be found in the autistic children. These include but are not limited to self-injurious behavior, social withdrawal, lack of eye contact, lack of facial expression, hypersensitivity to noise and touch, loss of speech, and repetitive behaviors.

Dr. Bill Walsh of the Pfeiffer Treatment Center has found that 91% of 503 autistic children have a deficiency of metallothionein. This alters the copper/zinc ratio. The normal child has a 1:1 ratio of copper to zinc. The autistic child has a 1.7:1 ratio. Dr. Boyd Haley, University of Kentucky, has found that the combination of aluminum and thimerosal in the vaccines inhibits at least 40 enzymes in laboratory animals. After the thimerosal has been removed from the vaccines, I believe that we can give them safely.

There are a number of controversies involving vaccines. Japan made the safer DTaP available to Japanese children in 1981. The CDC did not recommend this form of the vaccine for use in the United States until 1996. The National Vaccine Information Center (NVIC) under the direction of Barbara Loe Fisher was the driving force behind this recommendation. There were 300 lawsuits filed by the mid- 1980s against the DTP manufacturers In 1991 Barbara Loe Fisher wrote A Shot in the Dark, discussing the safer version of the vaccine, the DTaP. Whole cell vaccine is widely used in the third world countries today.

After the lawsuits of the 1980s, the vaccine manufacturers asked Congress to limit liability. In 1986 the Vaccine Injury Compensation Act established no fault compensation for the vaccine injured.

The Hepatitis B vaccine has not been without problems. Bonnie Dunbar, PhD, Professor of Cell Biology, Baylor College of Medicine and vaccine researcher had an interesting experience with the Hepatitis B vaccine in her laboratory. She followed OSHA regulations and gave the Hepatitis B vaccine to three laboratory workers. The first, her brother has been bedridden ever since with a demyelinating disease that the doctors cannot characterize. The second is a medical student. After the third dose of the vaccine, she became blind in one eye. The third person is all right.

Dr. Dunbar found that the drug insert mentions that the Hepatitis B vaccine was only monitored for five days for safety. The literature shows plasma immune reactions happening weeks after the shot-neurological, rheumatoid, vascular, and skin. There is a criminal investigation in France regarding the introduction of the vaccine prior to knowledge of reactions. Dr. Dunbar has discussed the fact that the clinical trail data is not available to researchers. The information of adverse reactions reported is not available and the antigens are not available to scientists for research.

The MMR vaccine has sparked much controversy here and abroad. Dr. Andrew Wakefield believes that there is a MMR vaccine/autism link. He has reported persistent measles particles in the GI tract of autistic children. A Japanese group has similar findings. In the presence of mercury, there is a shift from a predominance of the Th1 lymphocytes that fight viruses, yeast, parasites, and cancer cells to a predominance of Th2 lymphocytes and an autoimmune shift.

The new Pneumococcal vaccine, Prevnar, has good efficacy for meningitis and bacteremia but only a four to twenty-three percent efficacy for otitis media. The vaccine only covers seven of ninety serotypes.

Varivax (chicken pox) is grown in human tissue. There is a question of lifetime immunity after the shot. Merck has begun a study to determine how long this vaccine can be expected to last but it will not be ready until 2010. If this vaccine only lasts ten to fifteen years, we may have a serious problem if chicken pox becomes an adult disease.

There is some question that some of the vaccines may trigger insulin dependent diabetes. There have been studies in 1967,1977, 1990, and 1999 in several countries. The studies demonstrated a twenty to fifty percent rise in insulin dependent diabetes approximately three and one-half years after the vaccines. The vaccines studied were DTP, Hib, MMR, Anthrax, BCG, and Hepatitis B.

There are a number of allergy triggers in the vaccines including baker's yeast in the Hepatitis B, Neomycin, Streptomycin, Polymyxin B in the IPV, gelatin, Neomycin, and egg in the MMR, gelatin, Neomycin, and glutamate in the Varivax, and eggs and Neomycin in the Influenza vaccine. A little known fact is that six percent of the commercial vaccines are contaminated with Mycoplasma.(Dr. Garth Nicolson, October, 2001)

Many people do not realize that there are several vaccines that have been grown in human fetal tissue. These include the MMR. Rabies, Hepatitis A, and Varivax. The cell lines are from aborted fetuses secured in the sixties and the seventies.

Neal Halsey, M.D., past president of the American Academy of Pediatrics, has stressed that it is not about vaccinating vs. not vaccinating. It is about giving safe vaccines.

I would like to give you some information about the legal aspects. The National Childhood Vaccine Injury Act of 1986 provided for the establishment of the National Vaccine Injury Compensation Program. It was initially to help parents of vaccine injured children with the costs of caring for them. In 1995, Dr. Shalala, HHS Secretary, tightened the requirements for compensation and excluded 75% of the applicants. This happened in the face of a two billion dollar surplus in the fund. The program is adversarial at best after changes. There presently is a bill at the federal level to reinstate coverage for the autistic children under the compensation program.

Presently all states allow medical exemptions for vaccines. All states except Mississippi and West Virginia allow religious exemptions. Only sixteen states allow philosophical exemptions-Arizona, California, Colorado, Idaho, Indiana, Louisiana, Maine, New Mexico, Michigan, Minnesota, Nebraska, North Dakota, Ohio, Oklahoma, Rhode Island, and Wisconsin.

Congressman Dan Burton has been an advocate for the parents for the past couple of years. He has held several congressional hearings in the Government Reform Committee on vaccine safety. He has a personal interest in this. His grandson became autistic following several vaccines that were given on the same day when he was about fifteen months of age. He feels that the public trust has been violated. After studying the situation, he found that the financial disclosure statements of some of the advisory panel

members are incomplete. He also noted that the chairmen and many of the members of both advisory committees own stock in vaccine manufacturing firms, and have research funded with funds from the same. Several members of the advisory committees hold patents for the vaccines. This is a conflict of interest in any book.

The following are landmarks in vaccine history from 1905 to present:

1905 Smallpox mandated
1906 Pertussis developed
1921–1928 Diphtheria developed
1954 First polio vaccine (shot)
1961 Oral Polio approved
1962 Grants to states for mass vaccination
1963 Measles vaccine licensed
1981 Japan licensed DTaP
1982 Hepatitis B available
1986 Vaccine Injury Compensation Act
1987 Hib licensed
1991 Hepatitis B licensed-first genetically engineered vaccine
1995 Varivax licensed
1996 DTaP recommended for all US children
1998 French suspends Hepatitis B vaccine for teens when SKB was sued for possible link with MS in a young girl
1999 Hepatitis A recommended for children in endemic areas
1999 ACIP recommends Neisseria vaccine for college students (meningitis vaccine)
1999 Congressional hearings on vaccine safety
1999 FDA admits infants exposed to unsafe limits of mercury in the vaccines. Government asked the manufacturers to voluntarily remove or significantly reduce the thimerosal by the following spring in all vaccines routinely administered to infants.
1999 Rotavirus vaccine pulled off the market because of ill infants and 1 death
2000 Pneumococcal vaccine recommended for infants
2000 Congressional hearings on MMR, Mercury in Vaccines
2000 IPV replaces OPV
2001 Additional hearings on vaccine safety
2001 Institute of Medicine (IOM) meets regarding possibility of MMWAutism link and Thimerosal/Autism link
2001 US contracts for millions of doses of smallpox vaccine in the light of terrorist activity.

The information that appeared in the newspapers across the country following the IOM meetings in no way reflected the conclusions. Examples are the following: Panel Finds No Link Between Childhood Vaccines, Autism (New York Times), No Links Found Between Childhood Vaccines, Autism (Los Angeles Times), US Expert Group Rejects Link Between MMR and Autism (Lancet) The Actual report regarding the MMR/Autism link was as follows: "Although the committee has concluded that the evidence favors rejection of the causal relationship at the population level between the MMR vaccine and ASD, the committee recommends that this issue receive continued attention . . ." ". . . Its conclusion does not exclude the possibility that MMR vaccine could contribute to ASD in a small number of children . . ."

On July 16, 2001 the IOM met to study the possible link between autism spectrum disorder and thimerosal in the vaccines. The committee concluded that there is not enough evidence to prove or disprove the hypothesis that mercury containing vaccines have caused children to develop learning disabilities, ADHD, and autism. The IOM found enough evidence that mercury can damage the human brain to say that the theory is "biologically plausible" and to recommend that mercury preservatives be removed from all vaccines and over-the-counter products.

Barbara Loe Fisher, NVIC president feels that we need a comprehensive analysis of the potential toxicity of all other vaccine additives, starting with aluminum. NVIC joined SAFEMINDS in calling for the removal of all mercury containing childhood vaccines from the market in the US and for doctors to warn pregnant women that the flu vaccine contains mercury. (October 1, 2001 press release)

I would like to offer some practical suggestions for giving vaccines. Use thimerosal free vaccines. Do not vaccinate ill children. Space vaccines where possible and do not try to give nine or ten organisms in one day. Give vitamin C before and after the vaccines. Use DTaP consistently. Monitor children for adverse effects of vaccines and report these immediately. Do not give live viral vaccines to immunodeficient children. Do not give vaccines if the child is allergic to one of the components (yeast-Hepatitis B, eggs-MMR, neomycin-MMR or Varicella. Give a form of natural vitamin A like cod liver oil as a daily supplement keeping the vitamin A level

safe for age. Separate the MMR into the three components starting with measles component at 15 months of age. Follow with Rubella at 27 months and Mumps at 39 months. Consider giving the Hepatitis vaccine to a child older than four if not in daycare. Hold Varicella if not mandated by law until the child is four to five years of age if the child is not shown to be immune to chickenpox. Consider checking vaccine titers before giving boosters at four to five years of age. Check titers at twelve years of age. Keep children on nutrient rich diets and limit environmental exposure as much as possible.

I have included a schedule for the safe administration of vaccines in chapter 15 of my new book, What Your Doctor May Not Tell You About Children's Vaccinations (Warner Books, 2001).

In conclusion, let me say that we cannot eliminate all infections. We need safety studies on all vaccines. We need freedom of choice for immunization for our children because ONE VACCINE DOES NOT FIT ALL.

Location of Thermal Refuge for Striped Bass in the Pascagoula River

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We conducted a two-year study (1997–1999) to locate cool water thermal refuge for striped bass *Morone saxatilis* in the Pascagoula River, its principal tributary streams and associated off-channel environments. Sampling with gill nets (33.2 hours soak time), hoop nets (26,160 hours soak time), electrofishing (39.9 hours pedal time), trotlines (121 lines with 10 hooks each @ 4.6 ± 1.3 hours/line) and angling (99.2 hours) resulted in the capture of only 12 striped bass. Of these, seven were large adult fish that we equipped with radio transmitters and released for telemetry. To increase sample size for the telemetry study, eight adult striped bass from the Gulf Coast Research Laboratory (Ocean Springs, Mississippi) and 15 adult striped bass from the Mammoth Springs National Fish Hatchery (Mammoth Springs, Arkansas) were equipped with radio and/or sonic transmitters and released into the system. Data for one of these Mammoth Springs National Fish Hatchery striped bass were lost, thereby resulting in a total sample size of 30 fish. Ninety-five days in 1998 and 99 days in 1999 were spent tracking striped bass by boat. Six days were spent conducting aerial radio telemetry surveys in 1998. Only the Cedar Creek effluent into the Pascagoula River (N 30° 41' 58" W 88° 37' 56") was confirmed as thermal refuge for striped bass. Although no striped bass tagged in 1998 were recorded in this thermal refuge, two of five wild fish and six of 23 hatchery fish utilized the Cedar Creek thermal refuge during 1999. In order to limit fishing mortality of large adult striped bass in this system, we recommend that the Cedar Creek thermal refuge be closed to all fishing during May-September, and that use of live bait on set lines be restricted in the river during striped bass spawning migrations (February–May).

Striped bass *Morone saxatilis* are anadromous, spawning in freshwater and then remaining in cool water thermal refuges along the stream continuum, or returning to brackish, estuarine or marine environments (Dudley et al. 1977; McLaren et al. 1981; Wooley and Crateau 1983; Moss 1985; Van Den Avyle and Maynard 1994). Intrusion of saltwater wedges into traditional spawning areas, or rapid flushing into high salinity waters, can induce high mortalities to striped bass eggs and larvae (Morgan et al. 1981; Van Den Avyle and Maynard 1994). Winger and Lasier (1994) suggested that salinities > 9.0 ppt critically impacted striped bass eggs and larvae. Subsequently, striped bass must have spawning sites sufficiently upstream in river ecosystems to ensure that eggs and larvae are buffered from salt water. In coastal streams along the northern Gulf of Mexico, striped bass spawn between February and May when water temperatures are in the 19–24°C range (Seltzer et al. 1980).

After spawning, striped bass that remain in freshwater seek cool water refuges (Cheek et al. 1985; Lamprecht and Shelton 1986). Coutant (1985) addressed this behavior and stated that in these refuges, striped bass are "squeezed" between their thermal and dissolved oxygen preferences or requirements. Moss (1985) documented lower condition for fish captured from summer thermal refuges in the Alabama River than for fish captured from the river during the spring. Coutant (1985)

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reported that crowding due to temperature preferences alone, or coupled with avoidance of low oxygen, can lead to stress-induced pathology and overfishing, both of which can contribute to population declines.

Striped bass were common to abundant in all major river systems along the Mississippi Gulf Coast until the early 1950's, but subsequently have experienced serious declines (Nicholson et al. 1986). Nicholson et al. (1986) suggested that the main reason for the declines is loss of suitable habitat, even in the Pascagoula River, which is the largest, physically-unmodified river in the lower 48 states of the continental United States (Dynesius and Nilsson 1994).

Our objective was to locate thermal refuges for striped bass in the Pascagoula River, its principal tributary streams and associated off-channel locations (Figure 1) using radio and sonic telemetry of wild-caught as well as hatchery-derived striped bass during summer and early autumn low stream flow conditions.

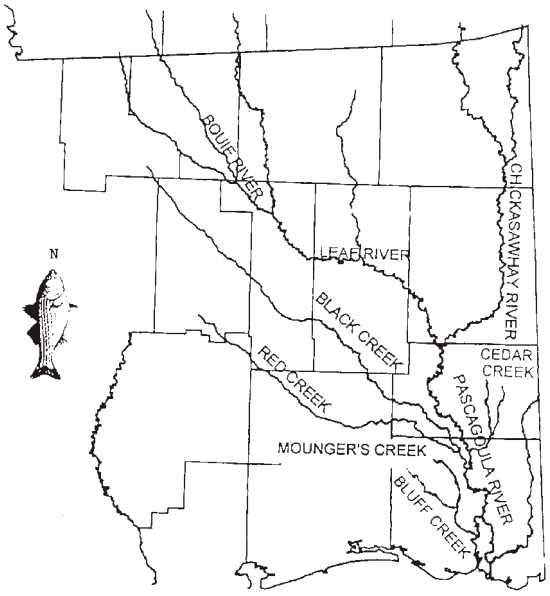

Figure 1. Pascagoula River Study Area

METHODS

Striped bass were collected from the Pascagoula River during 1998 and 1999 using hoop nets (1.5 m diameter with 7.62-cm bar mesh), experimental gill nets (3.0 m x 12.2 m, 6.35-cm and 10.16-cm bar mesh), electrofishing, and hook and line fishing (passive set lines; active angling). Hoop nets were set along streambanks, parallel with the current, with codends oriented upstream. During 1998 nets were checked every four hours during daylight, and then left overnight and checked again the following day. Due to low catch rates of striped bass in 1998, the check frequency for hoop nets in 1999 was decreased to every third day. Experimental gill nets (used only during 1998) were set parallel with the direction of the river's current and checked every 1 to 2 hours in order to minimize stress to captured fish. Fish captured by hoop nets and gill nets were processed immediately at their respective capture location and released. Trotlines were composed of a nylon main line (254 kg tensile strength) with 10 nylon dropper lines (54 kg tensile strength) equipped with 4/0 hooks baited with minnows or freshwater shrimp collected from the river. This gear and bait were the same as typically used by local fishers. Electrofishing was conducted during July and December 1998, and throughout 1999 with a boat-mounted Smith-Root unit configured to deliver three to five amperes of pulsed DC current, and 500 to 1000 volts. Electrofishing was conducted during daylight hours and at night. Fish captured by electrofishing were held temporarily in a tank onboard the vessel until they could be processed and released. Water in the tank was aerated with a sprayer system, and continually circulated and replaced with water from the river.

Captured striped bass (Table 1) were placed in a tank containing a concentration of MS-222 at a concentration of 150 mg/L. After the fish were sedated, they were weighed (kg) and total length (mm) was measured. Radio and/or sonic transmitters then were implanted completely in the abdominal cavity (no trailing antenna) of the fish. Surgical procedures were those described by Hart and Summerfelt (1975). Additionally, incisions and sutures were sealed by external application of "super glue" (cyanoacrylate**)** (Nemetz and MacMillan 1988; Petering and Johnson 1991). After surgery, fish were held until they regained equilibrium and were actively swimming, then released back into their respective capture location.

In 1998 and 1999 radio transmitters (30 MHz) were obtained from Custom Telemetry, Watkinsville, Georgia. Radio transmitters used in 1998 had a battery life of two years and a wet weight of 18 g. Radio transmitters used in 1999 had a battery life of one year and a wet weight of 8 g. Sonic transmitters

(72–76 kHz) purchased from Sonotronics, Tucson, Arizona were added to the telemetry study in 1999. Sonic transmitters had a battery life of one year and a wet weight of 8 g.

Table 1. Striped bass movements in the Pascagoula River ecosystem, Mississippi (1998–1999). The tracking period denotes number of days between release and last relocation. Fish noted by asterisk (*) were relocated in the Cedar Creek effluent.

Fish	Source	Release Date	Release Site	Relo-cations[c]	Tracking Period	Last Location
1	Wild	19 Feb 98	W Pascagoula R.	2	181	Chickasawhay R. (Dead)
2	Hatchery	24 Apr 98[a]	Red Creek	1	13	Confl. Red & Black Creeks
3	Hatchery	24 Apr 98[b]	Red Creek	3	169	W Pascagoula R (Dead)
4	Hatchery	24 Apr 98[b]	Black Creek	1	19	Bluff Creek
5	Hatchery	24 Apr 98[b]	Black Creek	None	-	Release Site
6	Hatchery	27 Apr 98[b]	Bluff Creek	None	-	Release Site
7	Hatchery	27 Apr 98[b]	Chickasawhay R.	1	75	Chickasawhay R.
8	Hatchery	27 Apr 98[b]	Chickasawhay R.	1	46	E Pascagoula R. (Dead)
9	Hatchery	27 Apr 98[b]	Leaf River	1	75	Leaf River (Dead)
10	Hatchery	27 Apr 98[b]	Leaf River	None	-	Release Site
11	Wild	29 Apr 98	Pascagoula R.	None	-	Release Site
12*	Wild	15 Feb 99	Pascagoula R.	9 (8)	211	Cedar Creek Effluent
13	Wild	19 Feb 99	Pascagoula R.	2	145	Bouie River
14*	Wild	03 Mar 99	Pascagoula R.	2 (2)	61	Cedar Creek Effluent
15	Wild	04 Mar 99	Pascagoula R.	None	-	Release Site
16	Hatchery	08 Mar 99[a]	Bluff Creek	1	53	Conf. Bluff and Little Bluff Creeks
17	Hatchery	08 Mar 99[a]	Bluff Creek	None	-	Release Site
18	Hatchery	08 Mar 99[a]	Bluff Creek	2	92	Bluff Creek
19	Hatchery	08 Mar 99[a]	Bluff Creek	1	71	Bluff Creek
20	Hatchery	08 Mar 99[a]	Bluff Creek	None	-	Release Site
21*	Hatchery	08 Mar 99[a]	Pascagoula R.	6 (5)	143	Escatawpa River
22*	Hatchery	08 Mar 99[a]	Pascagoula R.	4 (1)	117	Pascagoula River (Dead)
23*	Hatchery	08 Mar 99[a]	Pascagoula R.	4(2)	72	Cedar Creek Effluent
24*	Hatchery	08 Mar 99[a]	Pascagoula R.	6(3)	76	Cedar Creek Effluent
25*	Hatchery	08 Mar 99[a]	Pascagoula R.	3(2)	67	Cedar Creek Effluent
26	Hatchery	08 Mar 99[a]	Pascagoula R.	>10	213	Conf. Black Creek and Pascagoula R. (Dead)
27*	Hatchery	08 Mar 99[a]	Pascagoula R.	2(2)	67	Cedar Creek Effluent
28	Hatchery	08 Mar 99[a]	Pascagoula R.	4	123	Pascagoula R. below Interstate-10 (Dead)
29	Hatchery	08 Mar 99[a]	Pascagoula R.	3	43	Pascagoula River
30	Wild	12 Mar 99	Pascagoula R.	None	-	Release Site

[a]Fish donated by the Mammoth Springs National Fish Hatchery, Arkansas
[b]Fish donated by the Gulf Coast Research Laboratory, Mississippi
[c]Numbers in parentheses are relocations in Cedar Creek effluent

The Gulf Coast Research Laboratory (GCRL), Ocean Springs, Mississippi donated eight broodstock striped bass to the project in 1998. These fish were implanted with radio transmitters on 21 and 22 April 1998 and released into the Pascagoula River system on 24 and 27 April 1998. The fish weighed an average of 3.3 kg and were fed pelleted feed prior to their release. Fifteen additional striped bass were donated to the program in 1998 by the Mammoth Springs National Fish Hatchery, Arkansas. However, only one of these 15 fish survived after the trip from Arkansas to Mississippi. This fish was implanted with a radio transmitter on 22 April 1998 and released into the Pascagoula River system on 27 April 1998.

The Mammoth Springs National Fish Hatchery donated another 15 broodstock striped bass in 1999. These fish were implanted with radio and/or sonic transmitters on 26 February1999 at the GCRL and released into the Pascagoula River system on 8 March 1999. Six of these striped bass were implanted with radio transmitters, three were implanted with sonic transmitters, and six received both radio and sonic transmitters. The average weight of these striped bass was 2.0 kg at the time of transmitter implantation. They were fed twice prior to release with live prey obtained from the Pascagoula River.

Ninety-five days were spent tracking transmitter-equipped striped bass by boat during 1998 (April through November) and 99 days were spent tracking during 1999 (March through October). Searches included the main channels of the Pascagoula River and its principal tributaries and off channel backwaters. Data for one of the 1999 Mammoth Springs National Fish Hatchery striped bass were lost, thereby resulting in a total sample size of 30 fish for the study.

In 1998 six days were dedicated to aerial radio telemetry surveys that covered Red and Black creeks and the Pascagoula, Chickasawhay, Escatawpa and Leaf rivers. Black Creek was surveyed twice by aerial radio telemetry, and the Pascagoula River was surveyed on each flight date in route to the above-mentioned tributary streams. Aerial surveys used a loop antenna mounted to the right wing strut of the aircraft.

We recognized that telemetry might not be sufficient for locating potential cool water thermal refuges for striped bass in this system. Therefore, we conducted environmental surveys April through September of both years along the entire main channel of the Pascagoula River, as well as in off-channel locations (i.e., oxbow lakes, bayous, and tributary streams) throughout the lower Pascagoula River system (Figure 1). The environmental surveys initially encompassed the Pascagoula River north of Interstate 10 (both east and west forks of the river), upstream to the river's confluence with the Chickasawhay and Leaf rivers. The survey area was expanded during the second year of the project to include the Chickasawhay River up to its confluence with Buckatunna Creek, the Leaf River up to Hattiesburg, Mississippi, and the lowermost reaches of the Bouie River at Hattiesburg (to the Glendale Bridge). Additionally, Black, Red, Cedar, and Bluff creeks were included in the survey area. Black, Red, and Cedar creeks were surveyed as far upstream as was possible using small boats and canoes. Bluff Creek was surveyed up to its confluence with Mounger's Creek.

Environmental variables measured during habitat surveys were water temperature (°C), dissolved oxygen (mg/L), and salinity (ppt). These variables were measured with a YSI Model 85 meter. Additionally, these environmental variables were measured at each site where transmitter-tagged striped bass were located.

Thermal refuge was defined as locations in two manners: (1) potential—locations meeting physiological temperature preferences of striped bass as stated in the literature; (2) actualized—locations meeting physiological temperature preferences of striped bass as stated in the literature, and that yielded multiple relocation records of transmitter-tagged striped bass. By using these definitions, we avoided inclusion of locations of transmitter-tagged striped bass that may have been used by the fish for other purposes (e.g., foraging, transitory movements).

RESULTS

Gillnets (33.2 hours soak time), hoopnets (26,160 hours soak time), electrofishing (39.9 hours pedal time), trotlines (121 lines with 10 hooks each @ 4.6 + 1.3 hour/line; baited with live bait) and angling (99.2 hours) resulted in the capture of 12 striped bass (one with gillnet; four with hoopnet; four with electrofishing; two with trotlines). One striped bass was donated to the project by an angler. Three additional striped bass were observed during electrofishing but evaded capture. Of the 12 striped bass captured from the wild, seven were adult fish having total lengths greater than 500 mm. These seven fish

were equipped with radio and/or sonic transmitters and released for telemetry (Table 1). Three of these seven fish had tags when captured indicating that they had been stocked by the Gulf Coast Research Laboratory.

Cedar Creek and its effluent into the Pascagoula River (N 30° 41' 58" W 88° 37' 56"), was identified and confirmed as a thermal refuge utilized by striped bass. Water temperature in Cedar Creek and its effluent never exceeded 24.6°C. Two wild and six hatchery striped bass equipped with transmitters were located in the Cedar Creek effluent. An additional five striped bass were observed while electrofishing in the Cedar Creek effluent. Aside from the Cedar Creek effluent, coolwater refuges were not located in the main channel (including east and west forks) of the Pascagoula River from the I-10 Bridge upstream to the confluence of the Chickasawhay and Leaf Rivers. Environmental surveys of principal tributaries and off-channel backwaters associated with the Pascagoula River ecosystem also did not have characteristics favorable as thermal refuges for striped bass (Jackson et al., 2000).

Although Bluff Creek at its confluence with Mounger's Creek (N 30° 31' 36" W 88° 40' 54") tended to have characteristics favorable as thermal refuge for striped bass, these conditions were not as consistent as those of the Cedar Creek effluent. We recorded only one striped bass (total length ca. 75 cm) while electrofishing in Bluff Creek, and none of our transmitter-equipped fish were ever re-located in the Bluff Creek-Mounger's Creek confluence. Favorable thermal refuge characteristics were never recorded downstream from the junction of Bluff Creek with Little Bluff Creek (N 30° 29' 32" W 88° 41' 06").

The Cedar Creek effluent was approximately 15-m wide and 14-m long. In September 1999 it was reduced to a small 2-m deep thermal refuge where water spilled over a shallow sand bar at the creek's mouth. Water temperature in Cedar Creek ranged from 20.3°C to 24.6°C during June-September 1999 (corresponding with severe regional drought conditions). Dissolved oxygen concentration ranged from 4.1 mg/L to 7.1 mg/L.

The Bluff Creek refuge was a somewhat larger area with a width of approximately 20 m and a length that varied seasonally up to 200 m. During September 1997 we found water temperatures that ranged from 26°C at the surface to 23°C at a depth of 3 m. Corresponding dissolved oxygen concentrations were 5.2 mg/L at the surface and 6.0 mg/L at a depth of 3 m. Similar conditions were found again in May 1998 (surface readings 24.1°C and 6.3 mg/L). On 17 July 1998 water temperature at the Bluff Creek refuge was 27.0°C at the surface and 25.9°C at a depth of 3 m. On 22 July 1998, we were able to electroshock a large adult striped bass in this location. Favorable thermal conditions also were recorded in the Bluff Creek refuge from May through September 1999. However, continuation of regional drought conditions during 1999 resulted in saltwater encroachment. This led to warmer, more saline water with reduced dissolved oxygen concentrations at greater depths. For example, on 22 September 1999, even though water temperature was 24.7°C at the surface, it was 27.2°C at a depth of 2 m. Corresponding dissolved oxygen concentrations were 4.1 mg/L at the surface but only 0.2 mg/L at a depth of 2 m. Salinity was 0.1 ppt at the surface but 9.8 ppt at a depth of 2 m. It is unlikely that striped bass would long remain in an area where favorable temperature and oxygen conditions were associated only with water near the surface.

DISCUSSION

Our study suggests that the number of adult striped bass in the Pascagoula River is very small. From our sampling, upstream migration of striped bass apparently began in the second week of February during both 1998 and 1999. Spawning of striped bass is induced by a rapid rise in water temperature (Setzler et al. 1980). In the Pascagoula River, a rapid rise in temperature occurred around the first week of April during both years of our study (Figure 2). Most of the fish we captured were female, a situation that may be problematic because spawning stocks of striped bass typically are dominated by males (Worth 1903; Merriman 1941; Trent and Hassler 1968).

Tracking striped bass using radio signals from transmitters implanted completely within the abdominal cavity of the fish often required the radio receiver to be within 10 meters of a transmitter-equipped fish. To have greater signal range, sonic transmitters were added to the program in 1999. This substantially enhanced our ability to relocate fish in the system, including also fish with internal radio transmitters. When sonic transmitter-tagged fish were located, radio transmitter-tagged striped bass frequently were associated with them.

Broodstock fish implanted with radio transmitters in 1998 had just 12 to 15 days after being released

into the Pascagoula River before water temperature in the river exceeded 26ºC. None of these fish were ever relocated in thermal refuge areas. Some were never relocated at all following their release, and there were several cases of confirmed post-release mortalities.

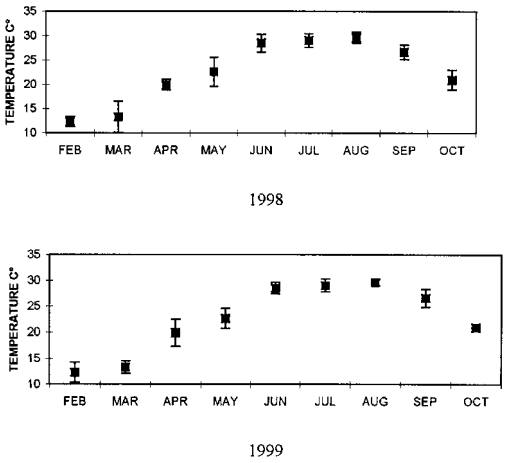

Figure 2. Mean monthly water temperatures in the main channel of the Pascagoula River during 1998–1999.

In contrast to 1998, radio and sonic transmitter-equipped broodstock hatchery fish released into the Pascagoula River in 1999 had 67 days in the river before water temperature in the river exceeded 26°C. This gave the 1999 broodstock hatchery fish an opportunity to explore the riverine environment prior to the onset of adverse thermal conditions, and subsequently an opportunity to find thermal refuge. These 1999 broodstock hatchery fish found the thermal refuge of the Cedar Creek effluent and, in contrast to tagged wild caught striped bass utilizing the refuge, the tagged broodstock fish remained in the refuge for a period of 11 days after water temperatures decreased below 25°C.

Cedar Creek and its effluent into the Pascagoula River provided thermal refuge for striped bass in this riverine ecosystem. However, it was a very small refuge and subsequently may induce crowding of striped bass in a very localized area. It also was readily accessible to anglers. Such crowding of striped bass has been shown to lead to overfishing, and can contribute to population declines (Coutant 1985).

This may be the case for the Cedar Creek effluent thermal refuge. The Cedar Creek effluent was the last relocation for five of the eight transmitter-equipped striped bass that we recorded in this thermal refuge. Striped bass using the thermal refuge at Cedar Creek possibly were targeted by local anglers. The Pascagoula River channel near the Cedar Creek effluent is heavily fished with trotlines. Additionally, one illegal hoopnet was located in Cedar Creek, approximately 500 meters upstream from the creek's confluence with the Pascagoula River.

One angler we interviewed reported that in 1985 Hurricane Elena changed the location of the Cedar Creek confluence with the Pascagoula River. He indicated that the original confluence was about one kilometer downstream from the present confluence location, and that this shift in the creek channel may have isolated important coolwater springs. This coincides with historical accounts that the last significant catches of the larger striped bass from the area were more than 10 years ago, and suggests that basin-wide natural disturbances (e.g., hurricanes) may be responsible for declining populations of striped bass in the Pascagoula River ecosystem.

Bluff Creek also served as a thermal refuge for striped bass during our study. It was also a small refuge but notably larger than the Cedar Creek effluent refuge. In addition to our observation of a large striped bass while electrofishing in Buff Creek during July 1998, angler reports during our creel surveys indicated numerous catches of smaller striped bass in the creek.

Interviews with fishers encountered throughout the Pascagoula River system revealed that they typically did not target striped bass, but will harvest them given the opportunity. This was especially so for larger fish. The river was exploited for catfishes, primarily with trotlines and limblines, and for flathead catfish *Pylodictis olivaris*, a highly predatory catfish (Jackson 1999), the trotlines and limblines were baited with live bait. Larger striped bass in the river seem to be vulnerable to this gear when it is baited with live bait, and especially so from February through May when these fish are engaged in upstream movements to spawn and/or to locate thermal refuge.

In consideration of the limited availability of thermal refuge for striped bass in the Pascagoula River ecosystem, and the system's apparently small number of large, potentially spawning adult fish, we propose that Bluff Creek and Cedar Creek thermal refuges be protected from fishing during the period May through September. This would help protect striped bass using these areas. Additionally, and because live baits have been associated with high

hooking mortalities for striped bass (Harrell 1987; Hysmith et al. 1992), we also recommend that use of live bait on trotlines and other set lines be regulated during the period February through May in order to minimize bycatch harvesting and hooking mortality of striped bass, and particularly with respect to adult fish that may be moving in the system for spawning purposes.

ACKNOWLEDGMENTS

Appreciation is extended to the U.S. Fish and Wildlife Service and the Gulf States Marine Fisheries Commission for co-sponsoring this project. Larry Nicholson of the Gulf Coast Research Laboratory donated broodstock striped bass, assisted with surgical implantation of transmitters and helped with stocking of fish. Thanks goes also to the Mammoth Springs National Fish Hatchery for donations of broodstock striped bass used in our telemetry studies. Ryan Heise of the University of Southern Mississippi relayed positions of sonic tagged striped bass in conjunction with his studies of Gulf sturgeon *Acipenser oxyrinchus desotoi* on the system. Michael Everett and Trey Pitalo of the Mississippi Department of Wildlife Fisheries and Parks provided facilities for equipment storage on the Lower Pascagoula River Wildlife Management Area and assisted in the field. Don Cloutman, Craig Chisam, Kelly McCoy, Michael Miller, and Robert Hand of Mississippi State University helped with striped bass collections. This paper is approved for publication as journal article WF178 of the Forest and Wildlife Research Center, Mississippi State University.

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Use of Pulsed-light to Treat Raw Channel Catfish Fillets

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Fish shelf-life is determined mainly by microbiological spoilage. Shelf-life of raw, refrigerated channel catfish (*Ictalurus punctatus*) fillets ranges from 4–14 days. A new processing technology uses very brief intense pulses of broad-spectrum white light to reduce microbial loads of products. Catfish fillets were subjected to 0.25 and 0.50 J/cm^2 and 2–4 flashes, for a total of 0.5, 1, and 2.0 J/cm^2. Psychrotrophic plate counts were reduced ($p \leq 0.05$) by 1.5 log CFU/g after treatment. Increased Hunter 'L' and 'b' values were observed after 4 and 2 days, respectively, on treated fillets. Thiobarbituric acid oxidation values (TBARs) increased for all treated fish after 2 days storage. Gapping was not affected by treatment and storage time. Decreased water holding capacity and moisture were observed for all catfish fillets during storage time.

Annual (live weight) catfish sales have grown from 87 million kg to more than 270 million kg in 2000. The U.S. per capita consumption has more than doubled to 0.51 kg in 2000 (USDA, 2001) in the past 10 years. Most of the catfish produced is in the form of fillets (Silva and Dean, 2001). Fresh shelf-life is limited by initial microbial load, temperature, handling, and other factors. Due to increased distribution channels and further distances to markets, it is necessary to search for methods and procedures to increase product's shelf-life. Conventional methods of extending shelf-life of channel catfish such as ice and refrigeration may not be sufficient to reach further markets from the center of the source, the Mississippi Delta. Investigations on the use of modified atmospheres (Ashie et al., 1996; Silva and White, 1994), sanitizers and antimicrobials (Handumrongkul and Silva, 1994; Efiuvwevwere and Ajiboye, 1996), and super chilling(Ashie et al., 1996) have shown the possibility of extending shelf-life by 2X to 5X. However, some of these technologies pose safety concerns, use unapproved additives, or may not be economically feasible. Non-thermal processes (Barbosa-Canovas et al., 1998) are being explored to treat products for increased shelf-life, increased keeping quality, and safety. Amongst these is pulsed light. The Pure Bright® process (Barbosa-Canovas et al., 1998) utilizes flashes of intense broad-spectrum pulse light to sterilize or decrease microbial load in pharmaceuticals, medical devices, packaging, and water. This process utilizes flashes of very short duration (<1 ms) of light contained in the visible, UV, and IR spectrum.

The system delivers a spectrum of light much more intense than sunlight or UV alone on the earth's surface. Since it is short in duration, the product suffers little, if any, temperature increases, thus maintaining its "freshness."

The system offers other advantages such as being able to act on the surface of prepackaged products and avoiding post-process contamination. The process has proven to be effective against spore and non-spore formers and achieving many log reductions in "transparent" materials (Barbosa-Canovas et al., 1998; Stier, 2000). The objectives of this study were to evaluate initial and periodic quality and

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microbiological counts of pulsed-energy light-treated catfish fillets stored at 2°C.

MATERIALS AND METHODS

***Preparation of catfish fillets*—**Catfish fillets (fresh) were secured from a catfish processing plant (Macon, MS) during the summer of 1999. The fillets were placed on ice, transported, and packaged individually in sterile 532 mL Whirl-Pak sterile sampling bags (Fisher Scientific, Pittsburgh, PA). The fillets were placed in ice chests with ice and sent overnight to Pure Pulse (San Diego, CA) for treatment. Upon receipt the next day, fillets were exposed to 0.25 and 0.5 J/cm^2 per flash using 2 and 4 flashes at each energy level. The product was then placed in ice chests and shipped on ice overnight to MSU. Upon receipt (2nd day of life of product), fillets were analyzed. Fillets were held at 2°C and analyzed after 2, 4, 6, 9, and 13 days of processing.

***Psychrotropic plate counts*—**A 25 g sample of aseptically cut catfish fillet was blended with 225 mL of 0.1 % wt/vol. sterilized Bacto®-peptone solution (DIFCO, Detroit, MI) during 1 min on Stomacher bags (model 400 closure bags 6041/CLR, Seward Limited, London, U.K.). A Stomacher 400 (Tekmar®, Cincinnati, OH) was used for the preparation of the samples.

Serial dilutions were made by placing 1 mL of the homogenate into dilution tubes with 0.1% peptone solution. Appropriate dilutions were plated (duplicates) onto Petrifilm™ Aerobic Count (APC) plates (The 3M Corp., Minneapolis, MN) in duplicate. The plates were incubated at 20°C for 72–96 h, and all colonies were enumerated (APHA.1992). These were done throughout the life of the fish fillets.

***Color measurement*—**A Hunter Labscan 6000/45° spectrocolorimeter (Hunter Associates Laboratory, Fairfax, VA) was used to evaluate the color. Three measures were made on the anterior, middle, and posterior part of the skin side of a catfish fillet for the color reading. The fillet was placed on a 13 mm port and the data gathered with a Universal Software Version 3.1. Hunter color was expressed as 'L' (lightness) where 100 represent lightness and 0 darkness, 'a' (redness +, greenness -), and 'b' (yellowness +, blueness -). Hue was calculated as $\tan^{-1}$ (b/a).

***Determination of thiobarbituric acid reactive substances (TBARs)*—**TBARs were determined using a distillation method as described by Tarladgis and Watts (1960). Ten grams of each sample of fillet were placed in a 800 mL Kjeldahl flask containing 97.5 mL distilled water and 2.5 mL 4 N HCl. One or two drops of antifoam (Fisher Scientific) and two to three glass beads were added. The flasks were then connected to a Kjeldahl distillation apparatus and 50 mL of distillate were collected. Five milliliters of distillate was transferred to a test tube containing 4 mL TBA reagent. The solutions were mixed and the test tube was stoppered before being placed in a boiling water bath for 30 min. After cooling, a Coleman 101 Spectrophotometer (Coleman Instruments, Maywood, IL) was used to measure the absorbance of the mixture at a wavelength of 538 nm, after collection with a reagent blank. The absorbance was multiplied by a constant of 7.8 to express TBARs as mg malonaldehyde per 1000 g of fillet (Guillen-Sans and Guzman-Chozas, 1998).

***Gapping*—**Fish fillets are often produced in which the muscle flakes, called myotomes, separate, creating the effect called "gapping." Gapping appears to be the result of the breakdown of connective tissue protein, stroma and related components which hold the fish muscle together. The gapping score of the fillets was recorded according to the method of Love et al. (1972). using a 5-point scoring system: 0 (no gaping or longitudinal splitting) to 5 (dropping to pieces).

***Water holding capacity*—**Ground meat from fillet samples (10 g) was placed in 50 mL screw-capped Fisherbrand® polypropylene centrifuge bottles (Fisher Scientific), tightly sealed, and weighed. Samples were heated for 30 min in a 70°C water bath. The cooked samples were allowed to cool at ambient temperature and reweighed to measure any evaporative loss. Bottles were then centrifuged at 1300 g (CU-500 centrifuge, International Equipment Co., Needham Heights, MA) for 15 min. The supernatant was withdrawn using a pasteur pipette and weighed. Moisture content of the raw sample and the supernatant was determined by drying 2 to 3 g of sample in a 121°C oven (Fisher Isotemp® Oven 300 Series Model 318F. Fischer Scientific Co. Houston, TX) for two hours, and weight and moisture content were calculated after drying (Trout, 1988). The WHC was calculated by the following formula:

WHC = % Shrinkage = (Wt before centrifugation - Wt after centrifugation/Wt before centrifugation) × 100

***Moisture content*—**Two grams of fish were

shredded by hand, placed on a pre-weighed, pre-dried aluminum dish and placed on an oven at 100°C (Fisher Scientific Isotemp® oven, Model 318F) and let dry for 16 h. The percent moisture was calculated using the following equation:

$$\% \text{ moisture} = (IW - FW)/IW \times 100$$

Where IW = Initial weight (g) and FW = Final weight (g).

Experimental analysis and statistical design—Data were arranged in a 5 (treatments) x 6 (storage time dates) factorial with 3 replications arranged in a completely randomized design. Analysis of data was performed using PROC GLM (SAS, 1996). Whenever significant ($p \leq 0.05$) mean differences were separated using Fisher's Protected LSD (Steel et al., 1996).

RESULTS AND DISCUSSION

Treated samples had a longer lag phase, being 1.5–2.0 log CFU/g less than untreated samples by the ninth day (Fig 1). Huang and Toledo (1982) reported 2.6 log reduction in PPC of Spanish mackerel skin by subjecting to UV light (120–180 mW/cm^2) at 253.7 nm. However, their maximum reduction in croaker and mullet were of 1.06 and 1.13 log CFU/cm^2. Dunn et al. (1988) reported a 3 log CFU/g reduction in PPC and coliforms on fish subjected to high-pressure wash prior to pulsed-light. MacGregor et al. (1998) reported that pulsed light emissions could significantly reduce populations of *Escherichia coli* O157:H7 and *Listeria monocytogenes* on exposed surfaces with exposure times that are 4–6 orders of magnitude lower than those required using continuous UV light sources. The PPC were similar for all samples by the thirteenth day of storage. Since pulsed-light is a surface treatment, the process is difficult in fish fillets due to their irregular surface and the ability of bacteria to adhere and "hide" on the muscular structure (Kim et al., 2000).

Hunter 'L'(brightness) values increased after 2–4 days of treatment, decreased by the sixth day, and remained steady thereafter for all treatments (Fig. 2). Fish treated for a total of 2.0 J/cm^2 had higher ($P \leq 0.05$) 'L' values than untreated samples (Fig. 2). Hunter 'a' values fluctuated, but were similar ($P \leq 0.05$) to initial values, regardless of treatment (Fig. 3). Hunter 'b' (yellowness) values increased slightly ($P \leq 0.05$) initially but remained steady thereafter, regardless of treatment (Fig. 4). These color data show that only whiteness was affected positively by the high dose treatment, and that changes in hue (pigmentation changes, oxidation) were not affected by treatment or storage (Fig. 5). Initial moisture, water-holding capacity (WHC), and gapping scores were not affected by treatments (Data not shown). This shows that pulsed-light flashes of up to 0.50 J/cm^2 and up to four flashes over ($\leq$2.0 J/cm^2) did not change the characteristics of "freshness" of catfish fillets. However, moisture decreased with storage and WHC increased until 6 days and decreased thereafter (Table 1). Moisture migration may be remediated with better packaging while reduced WHC is the result of protein denaturation and enzymatic breakdown (Ashie et al., 1996).

Table 1. Moisture, water holding capacity, and gapping score of catfish fillets stored at 2°C.

Storage time (days)	Moisture (%)	Gapping score	Water holding capacity (%)
0	81.6 a	0.0 a	10.8 d
2	76.6 bc	0.0 a	14.3 c
4	77.5 b	0.0 a	18.3 b
6	73.6 c	2.3 b	22.7 a
9	79.4b a	2.3 b	20.5 ab
13	77.0b c	2.5 b	19.2 b
LSD(0.05)	3.5	0.25	3.3

abc–Means within a column not followed by same letter differ ($P \leq 0.05$)

Oxidative rancidity (TBARs) increased after two days for all treated fish as compared to the untreated samples ($p \leq 0.05$), but were not different thereafter (Fig. 6). The TBARs levels did not reach anywhere near levels of rancidity for seafood (Sinnhuber and Yu, 1958).

Further research is needed to ascertain if higher doses or number of flashes is effective in enhancing shelf-life of catfish fillets. Nonetheless, this process proved effective in maintaining "freshness" of catfish fillets. Furthermore, since this can be used in prepackaged product, this process may be effective in killing pathogens in individually packaged fillets, especially those that are precooked.

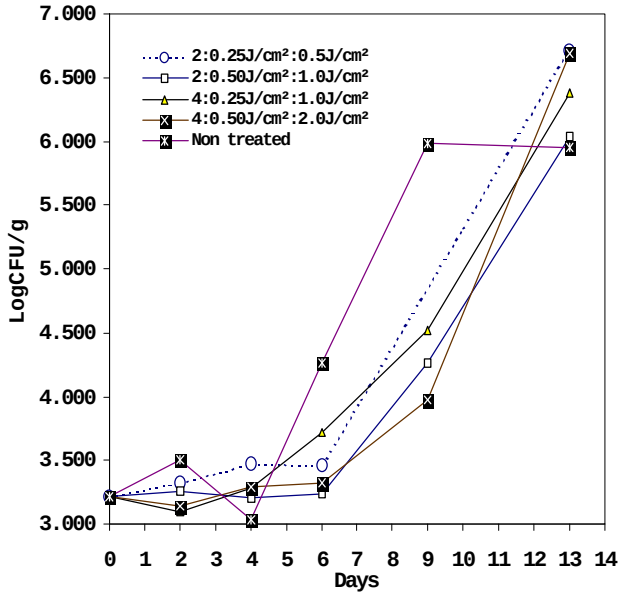

Figure 1. Effects of Pulsed-light on TBARs (oxidation) of catfish fillets stored at 2°C.

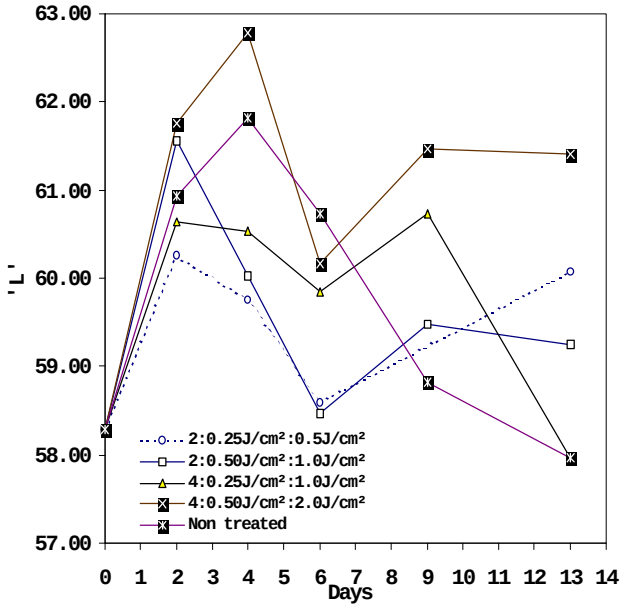

Figure 2. Effects of Pulsed-light on Hunter 'L' (brightness) value of catfish fillets stored at 2°C.

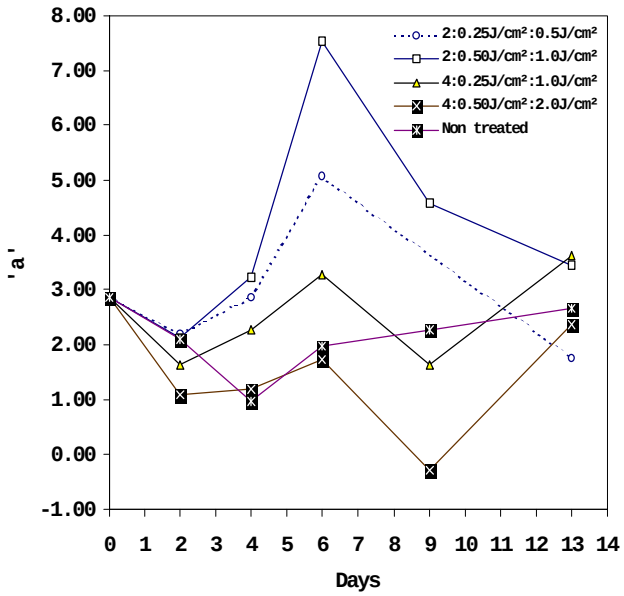

Figure 3. Effects of Pulsed-light on Hunter 'a' value (redness) of catfish fillets stored at 2°C.

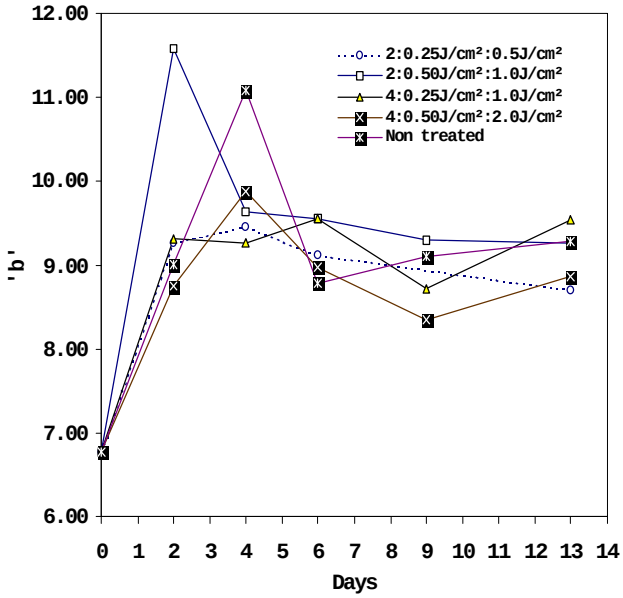

Figure 4. Effects of Pulsed-light on Hunter 'b' value (yellowness) of catfish fillets stored at 2°C.

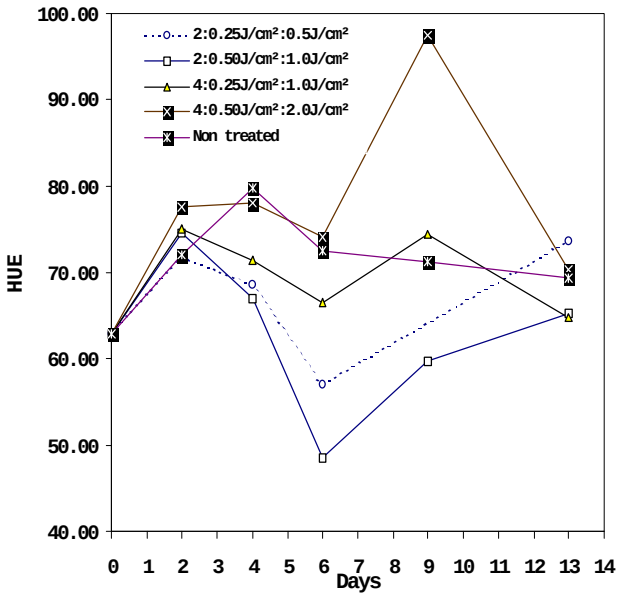

Figure 5. Effects of Pulsed-light on Hue value of catfish fillets stored at 2°C.

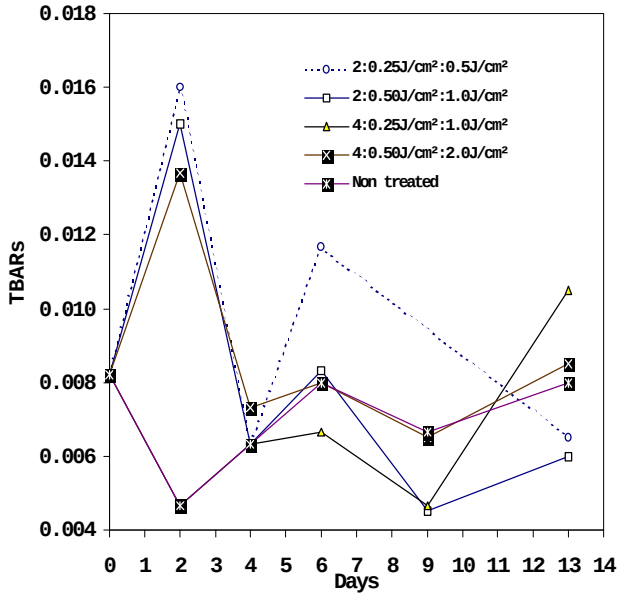

Figure 6. Effects of Pulsed-light on TBARs (oxidation) of catfish fillets stored at 2°C.

CONCLUSIONS

This study indicated that pulsed light was effective in reducing microbial flora on catfish fillets and did not affect gapping score, initial moisture, and WHC in fillets. Slight changes of TBARs, Hunter 'L,' 'a,' and 'b' values were observed for treated fillets during the initial 2–3 days.

Therefore, pulsed light may have potential as a catfish fillet sanitizer. However, pulsed light may not be enough for eliminating bacteria attached or hidden on the fish surface. For further research, pulsed light may be used in combination with other alternative processing technologies, including various powerful oxidizing agents such as ozone, hydrogen peroxide, and peroxiacetic acid.

ACKNOWLEDGMENTS

Approved for publication as Journal Article No. J–10005 of the Mississippi Agricultural and Forestry Experiment Station, Mississippi State University. Research funded in part by the Mississippi Agricultural and Forestry Experiment Station Project and by USDA-ARS project No. 320329-081100. The authors acknolowledge the assistance of Maxwell Technologies (San Diego, CA).

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A Prehistoric Unionid Assemblage from the Big Black River Drainage in Hinds County, Mississippi

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Archaeological remains can provide baseline biogeographical data for plant and animal species. Freshwater mussel shells from the Pocahontas site, a ca. 500-year old Native American mound and village in Hinds County, Mississippi, were analyzed. A minimum of 20 taxa were represented in over 1,800 mussel valves obtained from a large pit feature. Frequency data for these taxa are presented. The known historical ranges of three species—*Cyprogenia aberti*, *Plethobasus cyphyus*, and *Quadrula quadrula*—can be extended into the Big Black River drainage based upon their presence at the site.

Shell deposits left by prehistoric humans have been found throughout the world, on every continent except Antarctica. Most known shell-bearing sites date to the Holocene epoch, probably because melting glacial sheets caused sea levels to rise at the end of the Pleistocene, destroying many coastal and estuarine sites before around 10,000 years ago (Claassen, 1998:1, 2). Throughout the Holocene, prehistoric Native Americans intensively harvested freshwater mussels from the river systems of the southeastern United States. Evidence of this activity exists in abundance at archaeological sites in the region, where archaeologists frequently recover thousands of mussel valves from excavations (Peacock, 2002).

In late 1974 and early 1975, archaeologists with the Mississippi State Highway Department (now the Mississippi Department of Transportation) conducted excavations at the Pocahontas site (state site number 22HI500) in Hinds County, Mississippi (Figure 1). The site is a prehistoric village with a large, flat-topped mound characteristic of the Mississippian period (A.D. 1000–1540). Among other things, the excavations produced large amounts of freshwater mussel shell, analyzed for the first time in this report.

MATERIALS AND METHODS

***Natural setting*—**The site is located near the end of a broad, low ridge separating Limekiln Creek, which lies about 240 meters to the east, and a small tributary of Limekiln located about 270 meters to the west/northwest. Limekiln Creek flows into Bogue Chitto Creek, itself a tributary of the Big Black River. The site lies within the thick loess physiographic zone as displayed in Moran et al. (1997).

***Archaeological work*—**Excavations were done prior to the four-laning of U.S. Highway 49 and attendant construction of a parking facility at the mound (Rucker, 1976:4). Most of the mussel shell recovered was found in "Area B," an area of cultural deposits near the eastern edge of the mound. Rucker (1976:25–27) describes "a large basin shaped pit" approximately 12 meters long and 4 meters wide. Its original depth is unknown, as the pit had been truncated during construction of Old Highway 49. Rucker interpreted this feature as a borrow pit for mound fill, and described the contents and excavation procedures as follows:

> Because preservation of bone and shell remains appeared to be excellent, arrangements were made to waterscreen virtually all of the pit fill in an attempt to secure nearly 100 percent recovery of both large and small remains…The large quantity of mussel valves present in several lenses made excavation with shovels most difficult, and resort was had [sic] to four-pronged gardening forks. The fork tines more easily penetrated the shall [sic] layers and resulted in less damage to mussel valves, bone fragments, and pottery sherds. Pit fill was initially broken loose using garden forks, and all visible sherds and large bone pieces

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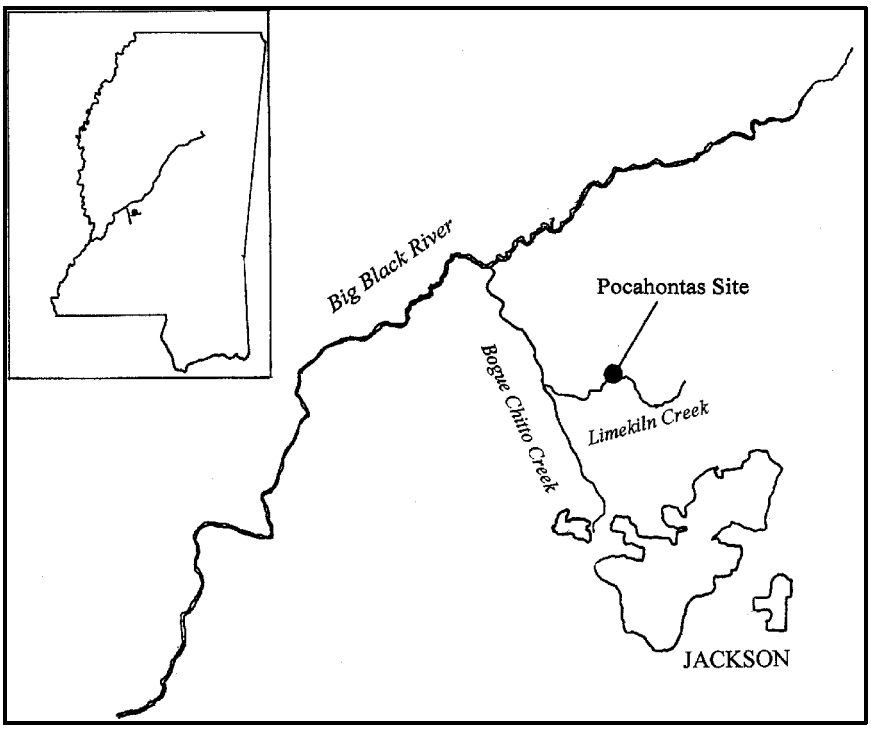
> picked out and placed in level bags for hand washing and laboratory sorting. Fill dirt containing all shell and other small cultural remains was then shoveled into large cotton bags and removed to a water source for waterscreening through one-sixteenth inch aluminum mesh screen (Rucker, 1976:28, 29).

Based on stylistic analysis of the recovered ceramics, Rucker (1976:35) believed the pit to date between A.D. 1400 and 1600, although overall occupation of the site probably encompassed a greater span (Rucker, 1976:90). Mussel shell occurred in discrete lenses within the pit and was tentatively interpreted by Rucker as representing seasonal deposits. We are assuming that the mussel remains excavated at Pocahontas originated in nearby Limekiln creek, as most prehistoric mussel assemblages in the Southeast seem to have been gathered from the nearest waterway capable of sustaining a mussel population (Peacock, 2002). It is possible, however, that mussels from elsewhere in the drainage are represented.



RESULTS

Considerations of bias—According to archaeologists currently working at the Mississippi Department of Transportation, much of the shell recovered from the site was discarded without being analyzed. Unfortunately, no tabulation of shell by valve count or weight is given in Rucker's report. It is thus difficult to say how representative of the overall site assemblage the shell sample reported herein actually is. Two shell beads were the only modified shell found in the excavations, so it is unlikely that much shell was being introduced for reasons other than subsistence (it should be noted, however, that crushed mussel shell was a common pottery tempering agent at the site). The range of taxa identified does not suggest cultural bias in the selection of species.

Following Peacock (2000), the left valves of three species (*Fusconaia flava*, *Pleurobema rubrum*, and *Amblema plicata*) were analyzed for size using the pallial line—lateral tooth (PL-L) measurement suggested by Warren (1975). Peacock (2000) has demonstrated that interior measurements such as PL-L are strongly correlated with more typical size measurements such as length. A lateral interior measurement (e.g., between the anterior and posterior adductor scars) would perhaps provide a better proxy for shell length, commonly used by biologists studying living mussel populations. Unfortunately, many valves from Pocohontas are broken along the posterior and/or ventral margins, making measurement of shell length difficult or impossible. The measurements were taken only on the left valve in order to prevent one bivalve from being counted twice and thus skewing the data. Left valves were used because they were more abundant for the three species chosen for measurement. As measured by PL-L, the valves are small overall (*F. flava*—average 16.72 mm, range 10.15–23.80 mm; *P. rubrum*—average 15.82 mm, range 8.8–25.33 mm; *A. plicata*—average 19.67 mm, range 13.34–25.53 mm), a common characteristic of archaeological shell in the eastern United States (Peacock, 2000, 2002). These data indicate that collection was not biased against small mussels. Large mussels either were not present at that time or were avoided by the prehistoric shell fishers. A recent literature review and analysis of shell from three archaeological sites on the Tombigbee River suggests that prehistoric human bias in the selection of species was the exception, rather than the rule, in the Southeast (Peacock 2000).

As can be seen in Table 1, 454 valves (about 24 percent of the total assemblage) were unidentifiable even to genus. These were mostly small and/or fragmentary valves with eroded shell features. Such a high percentage of unidentifiable valves is not uncommon in archaeological assemblages from the Southeast (Peacock, 2000; Peacock and Chapman, 2001). Overall, the shell from Pocahontas is in moderately good condition in terms of preservation. The major source of bias that likely is structuring the assemblage is the limited contexts from which the shell was retrieved. As demonstrated by Peacock (2000), the accuracy of taxonomic frequency data improves when multiple contexts at an archaeological site are sampled.

Table 1. Freshwater mussel taxa identified from the Pocahontas site (22HI500), Hinds Co., Mississippi

Taxon	# of valves	Percent of total identified valves
Pleurobema rubrum	385	27.07
Fusconaia flava	301	21.17
Obovaria subrotunda	162	11.39
Cyprogenia aberti	149	10.48
Quadrula pustulosa	83	5.84
Amblema plicata	82	5.77
Quadrula cylindrica cylindrica	70	4.92
Fusconaia ebena	50	3.52
Elliptio dilatata	31	2.18
Obliquaria reflexa	29	2.04
Plethobasus cyphyus	28	1.97
Truncilla truncata	11	0.77
Lampsilis sp.	10	0.70
Quadrula nodulata	9	0.63
Quadrula sp.	8	0.56
Quadrula quadrula	6	0.42
Ellipsaria lineolata	3	0.21
Elliptio crassidens	2	0.14
Truncilla donaciformis	1	0.07
Glebula rotundata	1	0.07
Megalonaias nervosa	1	0.07
unidentifiable	454	
Total:	1876	100.00

DISCUSSION

Discussion of taxa—The mussel taxa identified at Pocahontas are presented in Table 1. The unidentifiable valves were not used in calculating the percentages. These data provide an interesting comparison to modern mussel surveys in the Big Black River drainage.

Hartfield and Rummel (1985) compared the results of their 1980–81 mussel survey along the Big Black River to earlier data reported by Hinkley (1906) and Grantham (1969). Following Hartfield and Rummel, we are assigning specimens to *Fusconaia flava* rather than to *F. cerina* (cf. Bogan 1987). The two are indistinguishable in archaeological material, but *F. cerina* is considered to be an endemic of the Tombigbee River drainage. Also following Hartfield and Rummel, we have assigned our specimens of *Obovaria* to *O. subrotunda*, although it is possible that other species of this genus may be present in the Pocahontas collection.

Of the 31 species of unionids collected by Hartfield and Rummel, 15 are present in the prehistoric shell from Pocahontas. Some of the taxa listed by Hartfield and Rummel but not found at Pocahontas are silt-tolerant species (e.g., *Plectomerus dombeyanus*; Miller et al., 1992:10) that may have extended their ranges in historic times. Others (*Uniomerus tetralasmus*, *Pyganodon grandis*, *Anodonta imbecillis*, *Ligumia subrostrata*) were collected by Hartfield and Rummel "from oxbows or [were] found dead below oxbows draining into the river" (Hartfield and Rummel, 1985:119). Other differences between their list and ours may simply reflect differences between small- and large-stream faunas. Surprisingly absent at Pocahontas in this regard is *Tritogonia verrucosa*, found in the Big Black by Hinkley (1906), Grantham (1969), and Hartfield and Rummel (1985). Its absence at Pocahontas may simply be due to sampling error.

Four species reported by Hinkley (1906) and/or Grantham (1969) (*Pleurobema curtum*, *Obovaria unicolor*, *Lampsilis hydiana*, *L. ornata*) were not found by Hartfield and Rummel. We did not find any of these taxa in the archaeological shell assemblage. Distinguishing these species in archaeological material would be difficult, however (e.g., Peacock and

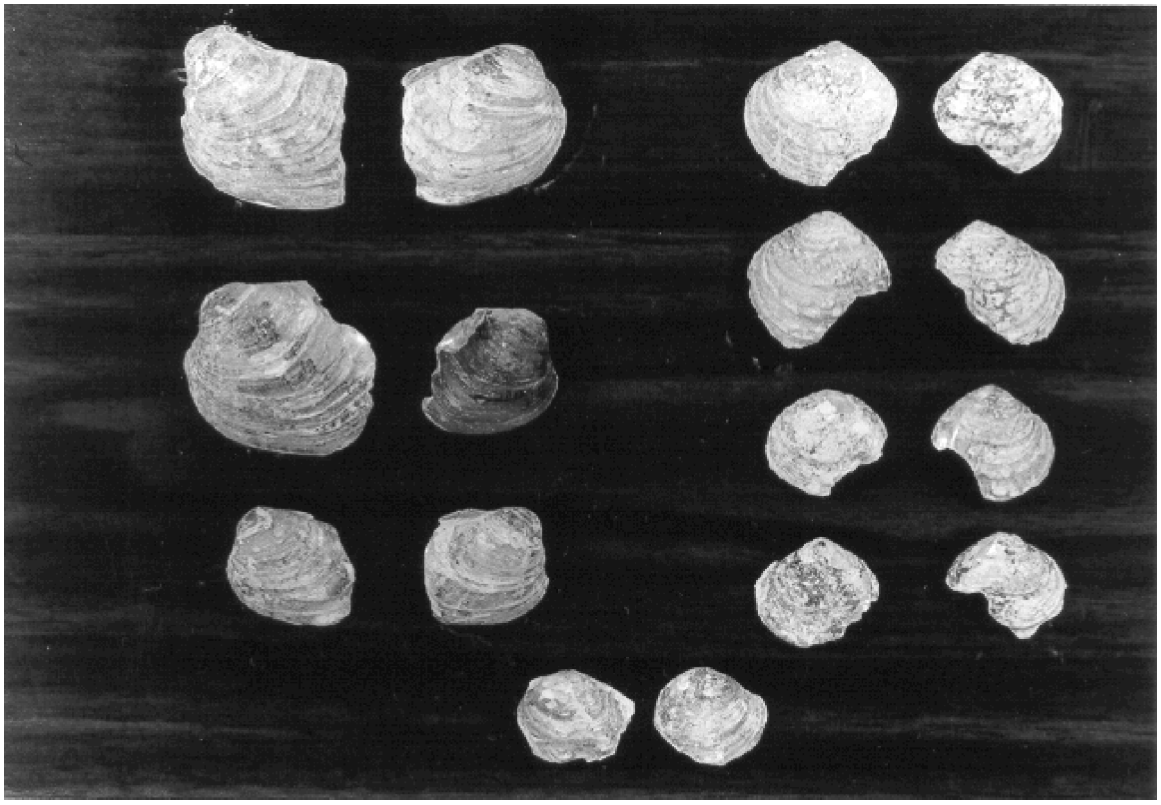


Figure 2. New mussel records for the Big Black River drainage. Left, *Plethobasus cyphus* (six valves); right, *Cyprogenia aberti* (eight valves); bottom, *Quadrula quadrula* (two valves). Photograph by Jimmy Cole.

Chapman, 2001). Hartfield and Rummel reported three species (*Quadrula nodulata*, *Q. cylindrica cylindrica*, and *Pleurobema rubrum*) "for the first time in the eastern drainage of the Mississippi River south of the Tennessee River" (1985:117, 118). Hartfield (1987) notes that all of these species have been found in prehistoric shell middens in the Delta. *Pleurobema rubrum* is the dominant mussel in our sample, making up about 27 percent of the total identified shell by valve count. *Quadrula cylindrica cylindrica* also is fairly common, at about five percent. *Quadrula nodulata* is present, although it apparently was rare in Limekiln Creek.

To our knowledge, the western fan shell, *Cyprogenia aberti*, has not been reported in the Big Black drainage before. It apparently was common in prehistoric times (assuming prehistoric human collection bias was negligible), being the fourth most abundant taxon in the assemblage at about ten and one-half percent. Peacock and Chapman (2001) recently reported a single valve of this species from a prehistoric shell midden on the Ouachita River in Ouachita Parish, Louisiana (cf. Vidrine et al., 1999). The known historical range of *C. aberti* was pushed considerably southward and eastward by its presence at two prehistoric (A.D. 300–600) sites located on O'Neil Creek, a tributary of the Yazoo River in Yazoo County, Mississippi (Bogan 1987). The Yazoo is the first major drainage north of the Big Black. The range of *C. aberti* can again be extended based on its presence at Pocahontas. The archaeological specimens are generally triangular in outline and have a well-developed sulcus adjacent to the posterior ridge. Sample valves are shown in Figure 2.

Other species not previously reported from the Big Black drainage are *Plethobasus cyphyus* and *Quadrula quadrula*. The presence of the *P. cyphyus* at prehistoric sites on O'Neil Creek (Bogan 1987) represented a major extension of its range as shown, for example, in Parmalee and Bogan (1998:Range Map 78). The Pocahontas site specimens represent a further southern extension for this species. The presence of the *Q. quadrula* in the Big Black drainage is not as much of a surprise, given its occurrence in the Mississippi River drainage south into Louisiana (Vidrine, 1993). Bogan (1987) also found this species from archaeological sites on O'Neil Creek. Sample

valves of both species are shown in Figure 2.

CONCLUSIONS

The archaeological shell assemblage from Pocahontas has provided valuable data on the historical ranges of freshwater mussels. The natural ranges of three species (*Cyprogenia aberti*, *Plethobasus cyphyus*, *Quadrula quadrula*) can be extended based upon their presence at the site. Although not discussed in this article, the site also produced large numbers of aquatic gastropods of the genus *Campeloma*. Apparently these gastropods were a food source for the prehistoric inhabitants of the Pocahontas site.

It would be valuable to have a larger sample of mussel valves from the site, to confirm the taxonomic frequencies and to provide identifications for poorly represented taxa such as those of the genus *Lampsilis*. Future archaeological work there should be conducted with this need in mind.

ACKNOWLEDGEMENTS

This article had its roots in a paper prepared by the junior author for an undergraduate class in Archaeological Method and Theory, taught at Mississippi State University by Dr. Janet Rafferty. We would like to thank the archaeologists with the Mississippi Department of Transportation for making the shell available for analysis and for providing information regarding the site. We would like to thank Art Bogan for bringing the O'Neil Creek archaeological shell assemblages to our attention. Bob Jones and Paul Hartfield were kind enough to check our identifications on a large sample of valves. The work was conducted at the Cobb Institute of Archaeology, Mississippi State University, where the senior author is a Senior Research Associate. We would like to thank the reviewers for their positive comments and helpful suggestions.

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A Comparative Study of Four Serological Tumor Markers for the Detection of Breast Cancer

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Breast cancer is currently the third most common cause of cancer in the world. Circulating tumor antigens are often used as a minimally invasive tool for noting breast cancer progression. The objective of this study was to compare four tumor antigens (CA 15-3, CA 27.29, alpha-fetoprotein [AFP], and carcinoembryonic antigen [CEA]) for their diagnostic efficacy in breast cancer patients. It was hypothesized that CA 15-3 would prove to be superior to CA 27.29, CEA, and AFP in assay performance. Tumor marker assays were performed according to the manufacturers' directions. Assays used in this study were CA 15-3 and CA 27.29 (Fujirebio Diagnostics/Centocor Inc.), AFP (Abbott Inc.), and CEA (Hybritech Inc.). A total of 554 patient samples were obtained from an area hospital, plus 200 healthy adult samples which were used for the determination of normal reference intervals. The patients included patients with no disease (184), with non-malignant disease (11), with breast cancer (87), and with other types of cancer (272). Diagnostic percent sensitivities for each marker were: CA 15-3 (63%), CA 27.29 (39%), CEA (22%), and AFP (22%). Diagnostic specificities for each marker were comparable, ranging from 80–88%. Analytical parameters were evaluated for the assays and compared favorably. We concluded that CA 15-3 was the best tumor antigen for use as a diagnostic aid and monitoring agent.

Keywords: cancer, breast cancer, carcinoembryonic antigen, alpha-fetoprotein, CEA, AFP, CA 15-3, CA 27.29, tumor marker.

Cancer is a leading cause of death in the United States. Contributing 22% of total deaths, it ranks second only to cardiac disease. With 182,000 new cases in the year 2000, breast cancer incidence ranks first among US females (Cancer Facts and Figures, 2000) and third in the world for cancer occurrence (Key et al., 1998). It affects one in ten women and its financial and emotional costs are huge.

Traditional methods of breast cancer diagnosis have included biopsy, radiographs, ultrasonography, computed tomography (CT), and magnetic resonance imaging. A monthly self examination is recommended for all women and it is suggested that women have a baseline mammogram when they are between the ages of 35 and 40, with a follow-up mammogram approximately every 2 years thereafter (Hossfeld and Sherman, 1990). Additionally, tests for serum tumor antigens have proven useful as an aid in the assessment of tumor burden, and therapeutic monitoring of breast cancer (Wu and Nakamura, 1997). Among the tumor markers that have been reported to have some clinical utility in establishing the diagnosis and prognosis of breast cancer are CEA, CA15-3, CA27.29, and CA549 (Wu and Nakamura, 1997; Hubbard, 1990). Elevated circulating alpha-fetoprotein has not been reported in breast cancer patients and therefore could serve as a good negative control.

CEA is a 150–300 kDa heterogeneous glycoprotein whose serum concentration is abnormally increased in patients with colorectal cancer, breast cancer, and a variety of other carcinomas (Reynoso et al., 1972; Cooper et al., 1979). Additionally, CEA levels are elevated in heavy smokers and

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nonmalignant pathologies (Clarke et al., 1982). For this reason CEA is not recommended as a screening procedure but has been used in combination with other methods for diagnosis and is often used in therapeutic monitoring.

CA 15-3 is a glycoprotein with a molecular weight of 300–450 kDa. Two monoclonal antibodies have been developed against it: DF3 which was developed against a membrane enhanced breast cancer extract and 115D8 which was developed against the membrane of human milk fat globule (Kufe et al., 1984; Hilkens et al. 1984). It has been reported in cases of breast, ovarian, pancreatic, lung, and colorectal cancer (Wu and Nakamura, 1997).

CA 27.29 is a mucin antigen detected by the monoclonal antibody B27.29 which was developed against an antigen found in the ascites of patients with metastatic breast cancer. CA 27.29 has an epitope that is shared with the DF3 antibody of CA15-3. (Burtis and Ashwood, 1996). It is currently being marketed as a specific test for breast cancer.

CA 549 is a glycoprotein with two identified species of 400 and 512 kDa. It is detected by two monoclonal antibodies developed against the T417 human breast cancer cell line, and human milk fat globule membranes (Bray et al., 1987). It has been reported in breast, prostate, ovary, and lung cancer (Beveridge et al., 1988).

Alpha-fetoprotein is a 70,000 kDa glycoprotein which was first described in murine sera (Abelev et al., 1963) and subsequently described in human patients with hepatocellular carcinomas and germ cell tumors (Chan et al., 1986). Synthesized by the yolk sac and the liver during fetal development, AFP is present in both maternal and fetal sera and is elevated in maternal sera and amniotic fluid in cases of open neural tube disease and gastroschisis, and decreased in cases of Down's syndrome (Milunsky, 1987; Knight et al., 1988). Alpha-fetoprotein has been reported to be useful in screening for hepatocellular carcinoma in high incidence areas such as Asia, and for classifying and staging germ cell tumors (Chan et al., 1986).

When comparing different assay methods one evaluates their specific performance characteristics (precision, linearity, analytical sensitivity and specificity) and their clinical performance (normal reference interval and predictive values). Precision is determined by assaying replicate samples and determining the mean, standard deviation, and coefficient of variation. Linearity is determined by assaying dilutions of an elevated serum sample and plotting the results and/or performing regression analysis. Analytical sensitivity represents the minimum detectable concentration of analyte and is determined by assaying replicate samples lacking the analyte (e.g., diluent) and calculating the mean plus two standard deviations. Values which fall below this cutoff are presumed to have no analyte. The analytical specificity represents the degree of interference in the assay from drugs and other chemicals such as bilirubin or lipids. This is not always reported but can be determined by spiking samples with varying concentrations of the suspected interfering analytes.

In clinical chemistry, the normal or healthy adult reference interval is established by calculating the mean plus or minus the standard deviation (95% confidence interval) for a population set of adults known to be in good health. Thus any patient result which is within this interval is considered to be "normal" or healthy; whereas, patient results that fall outside (above or below) the limits of this interval are considered to be abnormally elevated or decreased respectively. Since for tumor markers a low result would have no clinical significance, one establishes the cutoff between normal (presumed negative for disease) and abnormal (presumed positive for disease) results by using the mean plus two standard deviations. Predictive validity compares the ability of a new test method to accurately diagnose/predict the presence or absence of disease with that of an established method. Predictive value results include diagnostic sensitivity and specificity, diagnostic efficiency, and positive and negative predictive values. For the calculation of predictive values, one compares the test results with the "true results" as defined by an external test method considered to be the reference test method. For example one could compare the results of a tumor antigen test with those obtained by the physician with histologic analysis of biopsy material. Predictive values include: (a) diagnostic sensitivity (percent of individuals with the disease who test positive by the assay), (b) diagnostic specificity (percent of individuals without the disease who test negative by the assay), (c) diagnostic efficiency (percent of all test results that are either true positives or true negatives), (d) positive predictive value (percent of all positive test results that are true positives), and (e) negative predictive value (percent of all negative test results that are true negatives).

The purpose of this study was to compare the

analytical and clinical performances of four serologic tumor marker tests (CA15-3, CA 27.29, AFP, and CEA) for the detection of breast cancer. Test kits for CA 549 were not available and so this marker was not evaluated in this study. A working hypothesis that CA 15-3 would prove to be superior to the other three tumor markers was developed based on reports in the literature of its superiority and the fact that it has been evaluated on much larger groups of patients than CA 27.29 which shares an overlapping epitope and therefore could be expected to perform equivalently (Safi et al., 1991; Pannall and Kotasek, 1997; Wu and Nakamura, 1997).

MATERIALS AND METHODS

***Assays*—**All assays were performed according to the directions supplied by the manufacturers. The Tandem®-E CEA assay (Hybritech, Inc) is a solid phase two-site immunoenzymometric assay (ELIZA) utilizing two monoclonal IgG antibodies directed against unique sites on the CEA antigen. This assay was quantitated spectrophotometrically using the Photon Immunoassay Analyzer™ from Hybritech, Inc. The Centocor® CA 15-3® assay (Fujirebio Diagnostics, Inc./Centocor, Inc.) is a solid phase radioimmunoassay (RIA) using the 115D8 murine monoclonal antibody as the capture antibody and the I^{125} labeled DF3 murine monoclonal antibody as the tracer. This assay was quantitated using an Iso Data® gamma counter. The Truquant® BR™ assay (Fujirebio Diagnostics, Inc./Centocor, Inc) is a solid phase competitive inhibition radioimmunoassay (competitive RIA) using polystyrene tubes coated with CA 27.29 antigen and I^{125} labeled murine monoclonal B27.29 antibody. This assay was quantitated using an Iso Data® gamma counter. The IMx® AFP assay (Abbott Laboratories, Inc.) is a microparticle enzyme immunoassay (MEIA) utilizing two monoclonal antibodies directed against unique sites on the AFP antigen. This assay was quantitated using the IMx® Automated Analyzer from Abbott Laboratories, Inc. Statistical analysis was performed using SPSS software.

***Patients*—**Procedures used in this study were in accord with ethical standards established by the University of Southern Mississippi (USM). Permission for the study was granted by the USM Human Subjects Protection Review Committee (HSPRC/IRB).

All study participants were selected from patients seen in an area hospital. Five hundred fifty-four patients were randomly chosen and the assays were run blind. Blood samples were collected using appropriate aseptic technique. Following serum separation aliquots were coded and frozen at -20°C. Subsequently, aliquots were thawed at 37°C and assayed in duplicate for the tumor antigens. The diagnoses were obtained from the attending physicians and were based on pathological examination. Patient classifications included (a) no known disease, (b) nonmalignant disease, (c) non mammary cancer, and (d) breast cancer. Cancer patients were classified according to the primary site of the tumor, regardless of the presence or absence of metastases. Since available information on patient therapy was incomplete, statistical analyses were performed on the total patient pool without reference to this.

The normal control subjects were healthy males (100) and females (100) ranging from 18–65 years of age. Their blood samples were collected and processed in the same manner as the patient samples.

RESULTS

***Precision and linearity*—**Quality control samples analyzed over a 3 month period were used to determine intra- and inter-assay precision. The within-run coefficient of variation (%CV) was less than 10% for all but the CA 15-3 assay which was somewhat higher (Table 1). Similarly the between-run coefficient of variation was less than 15% for all the assays (Table 2). Serial dilutions of abnormal pool (sera combined from multiple human donors and spiked with an elevated concentration of tumor antigen) samples exhibited good linearity (Fig.1) with R^2 values equal to or greater than 99% for all the assays.

***Reference intervals*—**The minimum detectable concentration was determined by analyzing approximately 20 replicates of the zero calibrator/diluent and establishing the mean + 2SD as the cut-off value (Table 3). The normal adult reference intervals were established by determining the 95% confidence intervals for healthy control male and female subjects. The intervals (Table 3) were broader than those reported by the manufacturer for both CEA and CA 15-3 and somewhat narrower for the other two assays. There was no significant difference between healthy adults by gender for any of the assays.

Table 1. Within-run precision for CA 15-3, CA 27.29, AFP, and CEA.

Sample	n	Mean	SD	%CV
CA 15-3 Control	50	46.83 U/mL	9.60	20.50
CA 27.29 Control I	42	75.36 U/mL	6.61	8.77
CA 27.29 Control II	37	106.51 U/mL	9.93	9.32
AFP Low Control	10	20.36 ng/mL	2.22	10.90
AFP Medium Control	10	77.87 ng/mL	3.16	4.06
AFP High Control	10	171.22 ng/mL	4.96	2.90
CEA Low Control	43	4.28 ng/mL	0.29	6.78
CEA High Control	40	64.04 ng/mL	2.79	4.36

Table 2. Between-run precision for CA 15-3, CA 27.29, AFP, and CEA.

Sample	n	Mean	SD	%CV
CA 15-3	67	45.21 U/mL	6.61	14.62
CA 27.29 Control I	73	74.99 U/mL	6.95	9.27
CA 27.29 Control II	68	117.76 U/mL	16.38	13.91
AFP Low Control	38	19.60 ng/mL	1.44	7.35
AFP Medium Control	38	78.15 ng/mL	3.88	4.96
AFP High Control	38	167.01 ng/mL	6.28	3.76
CEA Low Control	76	4.44 ng/mL	0.37	8.33
CEA High Control	72	62.64 ng/mL	3.40	5.43

Table 3. Reference intervals for CA 15-3, CA 27.29, AFP, and CEA.

Sample	n	Mean	SD	Range
Zero/Diluent Controls				
CA 15-3	21	0.02 U/mL	0.08	0.00–0.18
CA 27.29	24	0.24 U/mL	1.16	0.00–2.56
AFP	13	0.00 ng/mL	0.01	0.00–0.02
CEA	20	0.00 ng/mL	0.35	0.00–0.70
Healthy Adult Males				
CA 15-3	106	25.36 U/mL	13.92	0.00–53.20
CA 27.29	100	18.94 U/mL	8.28	2.38–35.50
AFP	107	3.47 ng/mL	1.79	0.00–7.05
CEA	133	3.08 ng/mL	2.36	0.00–7.80
Healthy Adult Females				
CA 15-3	108	24.08 U/mL	14.12	0.00–52.32
CA 27.29	100	16.54 U/mL	6.28	3.98–29.10
AFP	107	3.73 ng/mL	2.06	0.00–7.85
CEA	131	2.55 ng/mL	2.89	0.00–8.33
Healthy Adults				
CA 15-3	214	24.71 U/mL	14.00	0.00–52.72
CA 27.29	206	17.74 U/mL	7.42	2.90–32.58
AFP	214	3.60 ng/mL	1.93	0.00–7.46
CEA	264	2.82 ng/mL	2.64	0.00–8.10

Table 4. Comparison of predictive values of CA 15-3, CA27.29, AFP, and CEA for breast cancer.

Parameter	CA 15-3 (n = 515)	CA 27.29 (n = 494)	AFP (n = 418)	CEA (n = 554)
Sensitivity (%)	63.38	39.29	21.82	22.35
Specificity (%)	80.64	83.56	88.01	79.66
Predictive Value (%) (-)	93.25	91.50	88.92	84.93
Predictive Value (%) (+)	34.35	23.40	20.34	16.67
Efficiency (%)	78.30	78.54	79.87	70.83
Cutoff Value	35.0 U/mL	37.7 U/mL	8.9 ng/mL	5.0 ng/mL

***Diagnostic parameters*—**In this study there were 184 patients without disease, 11 patients with non-malignant disease, 87 patients with breast cancer, and 272 patients with other types of cancer including: pancreatic, gastric, small intestinal, esophageal, lung, ovarian, prostatic, renal, colorectal, gallbladder, hepatic, cecal, uterine, testicular, head and neck, leukemia, lymphoma, and all other types. For purposes of this study, patients with breast cancer were considered to be positive for disease. Patients without disease, with non-malignant disease, and with non-mammary cancer were considered to be negative for disease. Similarly, cutoffs between normal

(negative) and abnormal (positive) test results used were those listed by the manufacturers and are cited in Table 4. The predictive values shown in Table 4 compare the ability of four test methods (CA 15-3, CA 27.29, AFP, and CEA) to accurately diagnose/predict the presence or absence of disease (breast cancer). In Table 4, the diagnostic sensitivity of CA 15-3 (63%) is superior to that of the other three markers (CA 27.29 39%, AFP 22%, and CEA 22%). The diagnostic specificities of the four assays range from 80–88% with AFP having the highest value. The negative predictive and positive predictive values range from 85–93% and 17–34% respectively with CA 15-3 having the best values in each case. The efficiencies of the CA 15-3, CA 27.29, and AFP assays (78–80%) were somewhat superior to that of CEA (71%) but were not significantly different from each other.

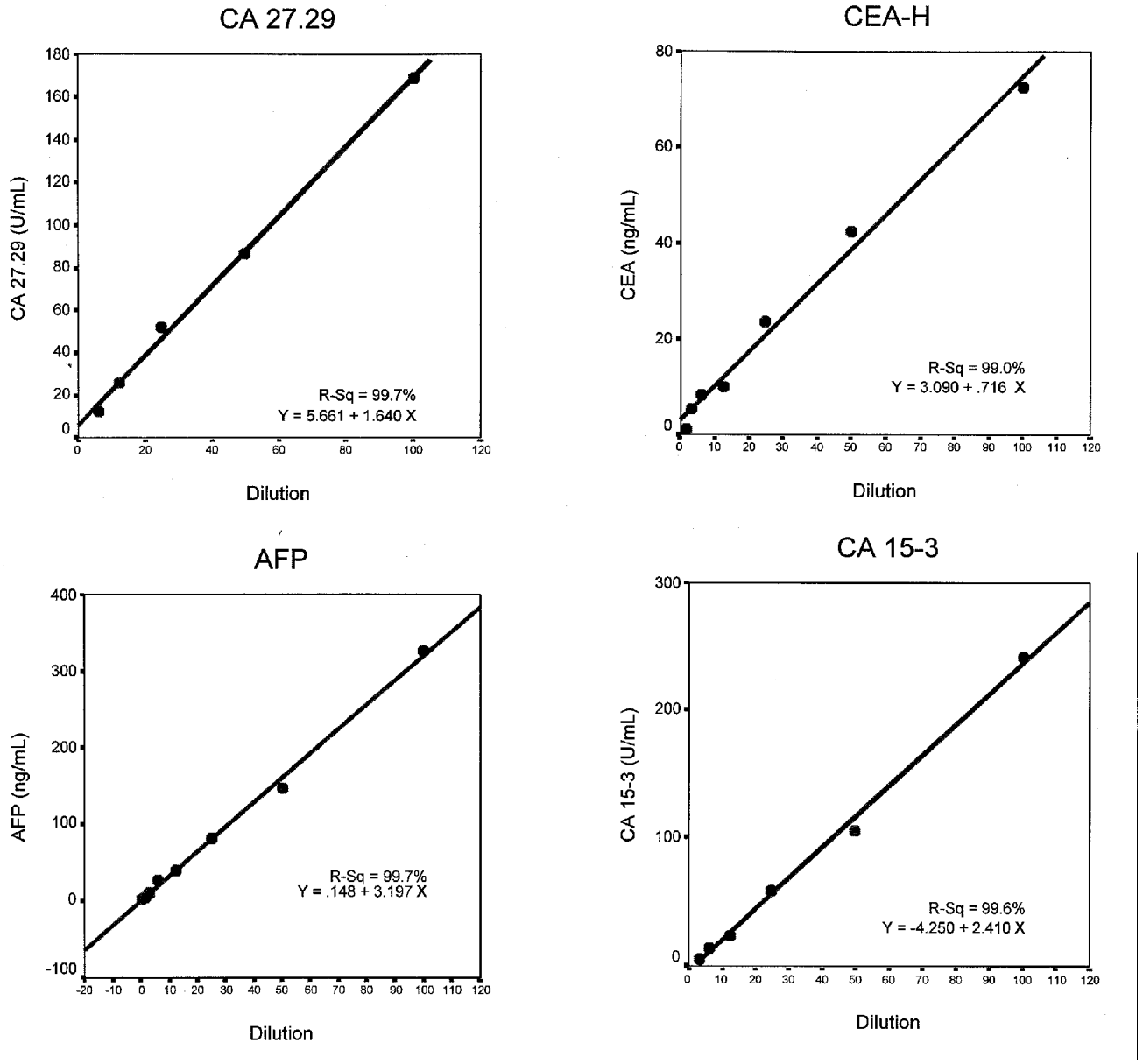

Figure 1. Comparison of the linearity of CA 15-3, CA 27.29, AFP, and CEA tumor markers.

DISCUSSION

Breast cancer is a serious medical problem both nationally and world wide. Clearly, a minimally invasive, inexpensive, early diagnostic test would be beneficial to the medical community. In general, tumor markers have not proven useful as screening tests because they are sometimes present in increased concentrations in patients with benign disease and absent in patients with *in situ* cancer (Roulston and Leonard, 1993; Wu and Nakamura, 1997). However, many tumor antigens have been useful for diagnosis and for therapeutic monitoring and the detection of recurrent disease. In this study we compared four serologic assays (CA 15-3, CA 27.29, AFP, and CEA) for their efficacy at detecting breast cancer. The AFP assay was automated and the other three assays were performed manually. Despite this difference the within-run and between run precision was comparable for all but the CA 15-3 assay which was slightly elevated, and the linearity of all four assays was excellent. The minimum detectable concentration of analyte was established by assaying the zero calibrator/diluent and determining the mean plus two standard deviations. The results for the CA 27.29 assay were slightly more elevated than for the other three assays. The normal (healthy) adult reference intervals were determined by calculating a 95% confidence interval and shown to be somewhat broader (CA 15-3 and CEA) and narrower (CA 27.29 and AFP) than those reported by the manufacturers. There were no significant gender differences for any of the assays. The assays compared favorably for cost and availability of instrumentation. Two of the assays (CA 15-3 and CA 27.29) were radiolabeled (I^{125}) and therefore had shorter shelflives. The turnaround time varied from 1 hour (AFP) to approximately 7 hours (CA 15-3 and CA 27.29) for the assays.

To compare the diagnostic parameters of these assays, 554 patients were randomly selected and their sera tested. The cutoffs suggested by the manufacturers and the diagnoses given by the attending physicians were used to assign them to the categories of true or false positives and negatives. Predictive values were calculated for breast cancer. The most important finding of this study was the observation that CA 15-3 was superior to CA 27.29 for the detection of breast cancer, exhibiting a diagnostic sensitivity of 63% as compared to 39%. This was an important finding since CA 27.29 is more commonly used than CA 15-3 for the serological detection and monitoring of patients with breast cancer. Indeed, in many labs it has replaced CA 15-3. In a similar study, the results of Lauro and his colleagues (Lauro et al., 1999) supported our findings using a large population of patients with metastatic breast cancer. In a study by Gion and Minone (Gion and Minone, 2001) the authors reported CA 15-3 to be comparable to CA 27.29 at higher concentrations of tumor marker and slightly less sensitive than CA 27.29 at lower concentrations of tumor marker. Frenette and co-workers (Frenette et al.,1994) reported that in their study CA 27.29 was more sensitive than CA 15-3 for a large population of breast cancer patients. Discrepancies between their results and ours could be the result of genetic differences in the patient populations, the stage of the tumors, the presence of pathologic complications and/or the use and type(s) of therapies. The diagnostic specificities were comparable for the four assays in our study and the CA 15-3 assay had the best positive and negative predictive values.

In conclusion, four assays (CA 15-3, CA 27.29, AFP, and CEA) were evaluated using 554 patients seen in a local hospital. CA 15-3 proved to be superior to the other three assays for the diagnosis of breast cancer.

ACKNOWLEDGMENTS

The authors thank Ms Jan Oglesby (Kessler AFB) and Mr. Allen Keely (Fujirebio Diagnostics Inc.) for their assistance. This study was partially supported by the Aubrey Keith and Ella Ginn Lucas Research Award. Fujirebio Diagnostics Inc., Hybritech Inc., and Abbott Laboratories donated the reagents. The gift of sera from Keesler AFB Medical Center and Forrest General Hospital is gratefully acknowledged.

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President's Column

"To Build A Cathedral Takes Many Stones"—Anonymous

The 66th Annual Meeting of the Mississippi Academy of Sciences (MAS) was a huge success, due in large part to the very generous and efficient work of so many of you. Let me start by thanking all of you for attending the meeting and for working at the many tasks (both obvious and less visible) which make a meeting run smoothly! First I should like to recognize and thank the **University of Southern Mississippi** for sponsoring this year's meeting. We are deeply indebted to Don Cotten and to Steve Doblin for their support of the Academy both this year and in years past. Next, I should like to mention and personally thank a few of the people who have given me so much help during my year as your president. My thanks go to Bill Lushbaugh, John Boyle, and Rob Rockhold for giving me great advice, helping me with the nuts and bolts of running the Academy, keeping us solvent, and writing what has to be the best and also most amusing job descriptions for the various committee chairs that have ever been put on paper! Special thanks to Ken Curry for doing such a great job as editor of the *Journal of the Mississippi Academy of Sciences* and to Ann Curry for doing beautiful photography and art work for the journal. And my thanks go to Bob Bateman who has already raised the support and made arrangements for us to have next year's meeting in Hattiesburg. We understand that he will be king of the shuttle bus detail... Very special thanks go to Cynthia Huff who answered every e-mail message, took the minutes for the meetings, and steadily and efficiently arranged a multitude of details including preparing hundreds of registration packets and staffing the registration desk.

Thanks go to: a) Hamed Benghuzzi and Clifford Ochs for serving on the board of directors, b) Sarah McGuire for chairing the Awards and Resolutions Committee, c) Maria Begonia and Ibrahim Farah for running the Membership Drive, d) Betsy Sullivan for running the Mississippi Junior Academy of Sciences (MJAS), e) Steve Case and Joan Messer for serving as our link to AAAS/NAAS and the American Junior Academy of Sciences (AJAS), f) Gordon Cannon for running the annual elections and Bill Lushbaugh for taking charge of nominations, g) John Boyle and Ken Curry for being in charge of the abstracts and the program, h) Marcy Petrini for her fabulous job as coordinator of the exhibits, i) Marie Danforth for her excellent job of publicizing the meeting and Rob Rockhold for being in charge of local arrangements, j) Deanna Buckley and Jeff Stafford for organizing and setting up 70 plus easels and poster boards....no mean feat believe me...., and k) Julia and Tom Lytle for finding the wayward (lost) easels and poster boards for us. Last but by no means least let me thank all of the division chairs and vice chairs and all the others who helped to make this year and this meeting such a great success. We are all truly grateful to you and only my incipient old age and failing memory prevents me from thanking each of you personally. Trust me each of you has laid a stone which collectively has and continues to build the edifice which we call the Mississippi Academy of Sciences. Thank you!

This year's meeting was held in Biloxi where over 600 members participated in the symposia, exhibits, and paper and poster presentations. Special presentations/symposia were offered in the following areas: a) Structure Visualization in Biochemistry Education: Seeing is Believing (Robert Bateman), b) Protection of Human Subjects: The Expanding Roles of the Institutional Review Board (Reid Jones, Georgene Clark, and Jane Weare), and c) Mississippi Center for Supercomputing Research (MCSR) User Advisory Group Meeting (David Roach, and Germana Peggion). And of course, the highlight of the meeting was the *Dodgen Lecture*. This year's presentation was entitled **"Vaccine Controversies: Past and Present"** and was given by Dr. Stephanie Cave of Baton Rouge, Louisiana. Dr. Cave is a physician, practicing in Baton Rouge where she treats over 1500 autistic children. Autism and autistic spectrum disease is an exponentially growing pathology among American and foreign children. Dr. Cave and her associate Dr. Amy Holmes recognized that American children receive high levels of ethylmercury in a number of vaccines leading to the neurologic symptoms of autism spectrum disorder. This led them to develop both a protocol for removing the metal from autistic children and a schedule for safely vaccinating children. Dr. Cave has testified in a Congressional hearing on mercury in vaccines (July 2000) and has recently published a book entitled *What Your Doctor May Not Tell You About Children's Vaccinations.* Those of us who were privileged to hear Dr. Cave's lecture will not forget the compelling picture she offered us of

children with serious language and behavioral disabilities, live red measles virus in their guts, and blood mercury levels that were many times higher than the EPA safe limit (for a brief review see the short paper by Dr. Cave in this journal). Dr. Cave's presentation was insightful, provocative, and of profound importance to every parent, educator, and healthcare giver. As a clinical chemist/biochemist and great-aunt to an autistic spectrum child, I can only add three words to what Dr. Cave said: "*Primum Non Nocere*".....First do no harm! I am extremely grateful to Dr. Cave for having shared with us her cutting edge work on autism spectrum disorder.

A review of the annual meeting would not be complete without mentioning the award recipients. The Academy traditionally recognizes outstanding accomplishments in three categories: a) service to the Academy, b) science teaching, and c) contributions to science. This year the Mississippi Academy of Sciences *Dudley F. Peeler Award* was given to Dr. Joan McCoy-Messer. She was recognized for her long term service to the Academy. Joan has served as a member of the MAS Board of Directors, was selected in 1996 as MAS Youth Activities Chair and Director of MJAS, and in 2000 as the national director of the American Junior Academy of Sciences. During her tenure as the MJAS director, she increased the number of students participating in the state junior academy (MJAS), and she increased the attendance of MJAS delegates at the national junior academy (AJAS) annual meeting. Additionally, Joan has published 6 articles, 40 abstracts, and had 10 funded grant proposals, many of which involved helping students in her biology classes at Jones County Junior College. Her accomplishments on behalf of Mississippi science students are unprecedented and will impact the students, MJAS, and MAS for years to come. The 2002 Mississippi Academy of Sciences *Outstanding Secondary Science Teacher Award* was presented to Ms Cynthia Kaye Cook. Cynthia is currently a teacher at Murrach High School where she is certified to teach ALL science disciplines. She has been the lead teacher at Murrach for the Base Pair program, a program funded through the Howard Hughes Medical Institute which pairs high school students with research scientists at the University Medical Center. She teaches the introductory course for the program, where her students not only gain an understanding of biotechnology and its applications, but also gain skills in working with electronic databases, and the tools of biomedical research. Cynthia is well-respected among her colleagues as a leader. She is a founding member of the Mississippi Association of Biology Educators and a contributor to *Mississippi Resource Guide: Cell and Molecular Biology*- a resource book for teachers. Her efforts with students are tireless. A testament to her abilities as a teacher are the accomplishments of one student, who received a 1st place research award at the 21st meeting of the Southeastern Pharmacology Society in 2000-in competition with senior medical and graduate students. The Academy presented to Dr. Timothy J. Ward the Mississippi Academy of Sciences 2002 *Outstanding Contributions to Science Award*. Timothy teaches at Millsaps College and has made a major impact in furthering the cause of science in all three categories of the award. He has a national/international reputation in advances in chemical separations of pharmaceutical enantiomers, and has authored over 22 papers in national/international journals, half of which are co-authored with undergraduate students. He has given numerous invited lectures and workshops at national and international meetings. In 2001, he was selected as Chemist of the Year by the Mississippi Chapter of the American Chemical Society. He is active in education at all levels. He was selected for a HEADWAE Award (Higher education appreciation day-working for academic excellence) in 2000. He has been involved in summer camps for K-8 and high school teachers, and has co-authored numerous science teaching modules. The Academy is happy to recognize Timothy for his impact in furthering science in the areas of research, teaching, and education.[1]

The past year has been an interesting one to say the least. We have been thrilled by the advent of new gene therapy for hemophilliacs, and saddened by the death of our friend and MAS board member, Dr. Johnnie Marie Whitfield (see the Memorial elsewhere in this journal). We extend our condolences to her family and friends. We watched in horror the events of September 11th, and applauded the courage and resolve of so many in the face of this disaster. At the state level, we saw budgets slashed and educators try to do more with less..... And I am reminded of the magnificent cathedral of my childhood (Lausanne, Switzerland) which was built one stone at a time, during a time of adversary, by people who believed in its value. Today I tell my students that I am proud to be an American, a Mississippian, and a member of the Mississippi Academy of Sciences because I believe in

their value. I thank all the members of MAS for your generous support during the past year and I have been truly honored to serve as your president. I look forward to serving the Academy in the future and assisting our President-elect (Dr. Robert Bateman) as he assumes the leadership role. I wish each of you the very best of years!—Margot Hall.

[1]Excerpted from the report written by Dr.Sarah Lea McGuire.

Executive Officer's Column

It's time to pass along congratulations to some long time academy stalwarts, Rob Rockhold, Joan Messer, and Steve Case. In the October issue of this Journal, MAS President Margot Hall already briefly described the national offices that Joan and Steve hold, but I'd like to reiterate and provide more details.

The Mississippi Academy of Sciences had long been a member of the National Association of Academies of Science (NAAS) <http://astro.physics.sc.edu/NAAS/NAAS.html>. My predecessor as MAS Executive Officer, Dudley Peeler, is a former President of NAAS. Dudley provided a extensive description of this organization, its history and association with the American Association for the Advancement of Science (AAAS) (AAAS is the best known for its publication of the journal SCIENCE), and its relationship with the American Junior Academy of Science (AJAS). This may be found at our web site: <http://www.msacad.org/naasrep.html> . In brief, he points out that NAAS and AAAS share "common interests, common goals, and shared governance." Both groups share a yearly national meeting and NAAS provides AAAS a mechanism for accomplishing one of its missions—namely science outreach. There are 43 academies of science that are members of NAAS.

All of the preceding is preamble to emphasize the importance of NAAS and to emphasize the national prominence of the roles that Steve and Joan have. Steve is President-elect of NAAS and will be taking over the duties of President shortly. This is recognition of his skills as an organizer and leader. We remember his fine term as President of MAS. Steve's list of responsibilities includes helping to organize the national meeting. Joan is in the middle of a three year term as Director of the American Junior Academy of Science. This gives her the responsibility of organizing the annual AJAS meeting held in conjunction with the AAAS/NAAS meeting. (Have we had enough acronyms yet?) This is a reflection of Joan's skills and her long time association with the Mississippi Junior Academy of Sciences. Both Steve and Joan serve on the Board of Directors of NAAS. The MAS is proud to have these two fine members serving at the highest national levels!

Rob Rockhold is the coordinator of the Mississippi Medical Center Base Pair program. This is a mentoring program whose aim is to link scientists at the Medical Center with high school students from Jackson with the goal of fostering more careers in biomedical sciences. It has been particularly successful in involving minority students and for this the Medical Center has been selected as the Year 2001 Role Model Institution by the national organization, Minority Access, Inc. Our congratulations go to Rob for his leading role in this award!

Another meeting has come and gone. We had wonderful weather in Biloxi and discovered the virtues of a fire alarm as wake up call. It's always dangerous to begin to thank people since inevitably someone critical to our success will be left out. Nevertheless, we would be remiss if we did not thank Cynthia Huff, our Associate Executive Officer and Office Manager and Sheila Backstrom, Cynthia's "volunteer" assistant. They maintained a cheery smile and friendly attitude in the face of registration hordes. They also had all the push pins anyone could want for posters. Speaking of posters.... As they become a bigger part of our meeting, we are discovering the non-trivial nature of maintaining numerous easels. We thank Deanna Buckley, Rob Rockhold, Tom and Judy Lytle, Bill Hawkins and the rest of the GCRL crew for making the posters and easels appear and disappear with no great effort for the rest of us (but with lots of perspiration and splinters for them!).—John Boyle

Mississippi Junior Academy of Sciences

Betsy Sullivan

The annual meeting of the Mississippi Junior Academy of Sciences (MJAS) was hosted by Mississippi Gulf Coast Community College at their Perkinston Campus on January 25, 2002. Brenda Anderson and Sarah Tringle of MGCCC-Perkinston coordinated the day's events. Due to a water problem, lunch was not provided. MJAS funds were used to purchase luncheon materials.

The event's guest speaker was Dr. George Bey, anthropologist from Millsaps College, who presented his studies on the excavation of new dig on the Yucatan Peninsula. Dr. Bey is credited with finding the oldest known Mayan city.

Attendance was down this year. Three school pulled out of the competition the week of the competition due to budget restraints.

Attendance report

# presenters	16
# observers	16
# teachers	6
# chaperones	7
Tot. attenden.	45

Schools represented

Jackson Preparatory School (Jackson)
Morton High School (Morton)
Bailey Magnet School (Jackson)
Murrah High School (Jackson)
Jim Hill High School (Jackson)
Callaway High School (Jackson)
Jackson Academy (Jackson)
St. Andrew's Episcopal School (Ridgeland)

Divisional Winners

Class I (9th and 10th grades) Biological Sciences
Peter Clark, The Effect of Simple Sugars on Bioluminescent Dinoflagellates
Teacher: Sandra Hindsman, St. Andrew's Episcopal School, Ridgeland, MS 39157

Class II (11th and 12th grades) Biology/Microbiology
Sheila Sundaram, The Role of Nitric Oxide in Epilepsy
Teacher: Sandra Hindsman, St. Andrew's Episcopal School, Ridgeland, MS 39157

Class II (11th and 12th grades) Behavioral Sciences, Sociology & Psychology
Vijay Brihmadesam, The Effects of Visual Cures Emitted by a Laser Diode on the Variance of Gait Lengths of Patients with Neuromuscular Disorders
Teacher: J. Cox, Jackson Preparatory School, Jackson, MS 39296-4940

Mississippi Junior Academy of Sciences Clyde Sheeley winner:
Class II (11th and 12th grades) Medicine & Health
Gita Subramony, The Effectiveness of Polymerase Chain Reaction for the Detection of Bacteremia
Teacher: Sandra Hindsman, St. Andrew's Episcopal School, Ridgeland, MS 39157

Special Recognition
Cory Carter, Phytoestrogen Modulation of Jurkat T-cell Growth and IL-2 Production
Teacher: Ginnie Ingram, Jackson Academy, Jackson, MS 39211

Mississippi Junior Academy of Sciences Second Place winner:
Class II (11th and 12th grades) Chemistry / Biochemistry
Ruo Peng Zhu, A Study to Verify the Beer-Lambert Law and Determine the Structural Selectivity of Selected Nucleic Acid Binding Ligands
Teacher: Ginnie Ingram, Jackson Academy, Jackson, MS 39211

The 2002–2003 MJAS Executive Board met Saturday, March 16, 2002, at the Mississippi Museum of Natural Science at 10:00 am to discuss the location of the 2003 competition. If you would like to host the MJAS, please refer to "MJAS Location Requirements" for necessary information.

Mrs. Sandra Hindsman and Mrs. Ginnie Ingram have been asked to present a session on MJAS to the Mississippi Science Teachers Association annual meeting in October. Both of these teachers have sponsored winning students in the past. They hope also to have students with them to present their work. These teachers will explain how to gear students

toward research.

MJAS Location Requirements

- Lobby area for Registration, including tables and chairs. An area to the side for a continental breakfast.
- Theater or Large Room for Opening Session. A microphone system will be needed.
- Room for judges to meet and discuss the papers presented.
- Divisional competition rooms. The number of rooms vary, but on the average 7 rooms are needed. Each room must have a screen, slide projector, and an overhead projector. Students using power point presentations are required to provide their own projectors.
- Lunch must be provided by the facility.
- An area is needed for the luncheon / business meeting.
- An additional room for a teacher luncheon. The teachers do like to have a small area set aside so that they may discuss research projects. The past two years we have had a representative from a local company speak to teachers about resources they provide.
- Theater or large room for the overall competition and guest lecture. This is usually the same room as used for the opening session. A microphone system will be needed.
- Parking. Campus or local security need to be notified of "strange" vehicles on site.

Divisional Reports

Agriculture and Plant Science

The Agriculture and Plant Science Division met on Thursday, February 21, 2002. Fifteen divisional talks and 9 posters were presented in this session of the Sixty-Sixth Annual Meeting of the Mississippi Academy of Sciences in Biloxi, MS. Estimates of attendance overall exceeded fifty individuals throughout the meeting.

Subjects of research presented this year included: the effect of muscadine grapefiber and wheatbran fiber on cecal butyric acid, fecal output, and weight gain in rats, phytoremediation of metal contaminated soil and sediments, reducing off-flavor in catfish and risk of Vibrio infection from raw oysters, performance of apple, pear, blueberries, yardlong bean, sweet potato, muscadine, cowpea and other plants under different environmental conditions in Mississippi, enhancing farm efficiency and profitability in selected MS counties, resolving relationships among Narcissus cultivars and other aspects of plant science research.

Awards were presented for two student presentations. D. Marshall won the first place award for graduate student oral presentation. In addition to a certificate, Ms Marshall also received a $100 cash award. K. Shumaker and J. Spiers won the second and third place awards, respectively. Both received certificates plus $60 cash award for Ms Shumaker and $30 cash award for Mr. Spiers. Honorable mention went to Ms A. Butler and Mr. A. Al-qurashi, who both received certificates and $25 cash awards each. Ms A. Jones was awarded $30 in recognition for her oral presentation as an undergraduate student. The cash awards were generously provided by the Mississippi Nurserymen Association, and the Riverhills Bank and the Farmers Cooperative, both of Port Gibson, MS. The certificates were prepared and donated by the Department of Biology, Jackson State University, Jackson, MS.

Left to right, K. Shumaker, A. Butler, A. Jones, D. Marshall, A. Al-qurashi, J. Spiers

During the Divisional Business Meeting, which was held following the final session, Vice-chair Dr. Girish Panicker, USDA Project Coordinator at Alcorn State University was elected to Chair the Division for

2002–2003. Dr. Juan Silva, Professor of Food Science and Technology at Mississippi State University was elected to the Vice-chair position.—Maria F.T. Begonia

Cellular, Molecular and Developmental Biology

The Cellular, Molecular and Developmental Biology (CMDB) Division held its annual divisional meeting in Biloxi at the sixty-sixth annual meeting of the Mississippi Academy of Sciences. The meeting began with a special session entitled "Structure Visualization in Biochemical Education: Seeing is Believing." This special session, which was co-sponsored by the Science Education Division, featured a presentation by Dr. Robert C. Bateman (University of Southern Mississippi) on the use of molecular modeling software in undergraduate biochemistry education. The remainder of the CMDB divisional meeting consisted of four platform presentation sessions and a poster session. The themes of the four sessions were "Molecular Insights from Biophysical Techniques" (four presentations), "The Evolution of Biological Catalysis" (four presentations), "Molecular Toxicology" (five presentations) and "Cytokine Signaling" (four presentations). Despite the cancellation of one poster presentation, our poster session actually had more posters (fifteen) than indicated by the published abstracts. Perhaps this phenomenon was due to the irresistible lure of the poster party, which included door prizes ranging from cheese straws to coffee mugs; the chair notes that further research is needed to determine the cause of this interesting phenomenon.

Karishma A. Parekh (left) receives a Certificate of Honorable Mention from Roy Duhé

The outstanding quality of the platform and poster presentations made it extremely difficult for the judges to select a single winner in the two sponsored categories. The Outstanding Graduate Student Presentation award was won by Ms Tricia M. Coleman (University of Southern Mississippi); this award was accompanied by a fifty dollar prize provided by Fisher Scientific (courtesy of Ms Susie Emfinger). The Outstanding Undergraduate Student Presentation award was won by Ms. Kendria Holt (Jackson State University); this award was accompanied a fifty dollar prize provided by C Squared Corporation (courtesy of Mr. Greg Quillan). In addition, the judges unanimously decided to award Ms Karishma A. Parekh, a high school student mentored by Dr. Hongtao Yu (Jackson State University), with a Certificate of Honorable Mention for her exceptional research presentation.

Dr. Ross E. Whitwam (Mississippi University for Women) was elected as the CMDB Division Chairperson. Dr. Yuan Luo (University of Southern Mississippi) was elected as the CMDB Division Vice-Chairperson.—Roy Duhé

Chemistry and Chemical Engineering

There were 21 oral and 21 poster presentations at the 2002 meeting, a total of 42 presentations in all. There appears to have been a small decline in the number of oral presentations this year compared to the recent past. In my opinion this is an unfortunate trend because most Chemistry and Chemical Engineering Division presentations are by students and posters are a medium for presentations mostly confined to academia. Our students need to hone their presentation skills as they go forward into mainly non-academic careers. The averages for the division for the meetings held during the five year period 1998–2002 are 29 oral and 20 poster presentations for an average 49 total presentations. Over this five year period the number of posters has fluctuated from 16 in 1998 to 23 in 200 and the number of presentations from 21 in 2002 to 35 in 2000. Interestingly if we go back 10 years, the 1992 meeting had 49 oral and 7 poster presentations for a total of 56, a larger total than in the past five years with very few posters. The increase in posters obviously mirrors a trend in national meetings towards more poster and fewer oral presentations. Of course our division has a dilemma which is that if we have too many oral presentations we will have to run parallel sessions, as

we did in 1982, and divide an already small audience!

The oral sessions ran smoothly again this year. Most presenters kept well within their allotted time allowing ample time for questions and discussion. The past two years we have run our poster sessions on Friday mornings. This has the advantage of not clashing with other divisional poster presentations and making life much easier for the MAS, which has a limited number of easels and boards and a limited amount of space. Our poster session this meeting was very well attended, a very encouraging situation for presenters, attendees, and organizers. Attendance at the oral sessions was, as usual, erratic ranging from five or six to around twenty attendees. I always hope for a larger audience for the mostly student speakers. Every year I wonder what happens to all the people who make some sort of presentation. Many do not seem to come to the oral sessions! In addition to wishing for a better attendance at the oral presentations, I always fervently wish for an end to the practice of a group of individuals coming to hear a colleague from the same institution make a presentation and then immediately after the presentation is over disappearing as quickly as they appeared! Another regret that I personally have is that our division does not regularly award prizes for the best student presentations. In the next few months I hope to begin the process of creating a small endowment for this purpose.

The divisional business meeting was held after the Thursday oral session. Timothy Ward of the Department of Chemistry at Millsaps College was elected Vice Chair of the division for 2002–2003 and he will be Chair for 2003–2004. The current Vice Chair, John O'Haver of the Department of Chemical Engineering of the University of Mississippi, will assume the Chair's duties for 2002–2003, including chairing the 2003 meeting to be held in Hattiesburg. The Chemistry and Chemical Engineering Division of the MAS is, as far as I know, the only state- wide organization for all of Mississippi's chemists and chemical engineers. I am sure John and Timothy would welcome any suggestions from the members regarding the points raised in this report and especially how to increase state-wide participation in the division in the future.—David Creed

Health Science

The Health Science division accepted five platform and twenty-two poster presentations at the 66th Annual meeting in Biloxi. The sessions were well attended. This year we had a very competitive group of students. We would like to see more student involvement and also encourage more platform presentations. The business meeting was held on Thursday afternoon and Drs. Hamed Benghuzzi and Olga McDaniel were elected chair and vice chair for next year; congratulations. Both individuals are of high caliber and very active researchers and we will be assured of very successful division meetings in the next two years.

The division also awarded (both monetary and certificate awards) the following winners:

Medical/dental category: Asim Haque (UMC-First Place); Michael Cox (UMC-Second Place); John Ward (UMC-Third Place).

Graduate Student category: Shontell Credit (Jackson State-First Place); Corunda Pruitt (Jackson State-Second Place); Felicia Magee (UMC-Third Place); Pam Jones (UMC- Honorable Mention).

Under Graduate Student category: D. Jones (Alcorn State-First Place); U. Hawkins (UMC-Second Place); Kim Parker (Millsaps-Third Place).

Allied Health category: Sandi Zimmerman (UMC-First Place); Veronica Harvey (UMC-Second Place); Tinetta Robinson (UMC-Third Place).

High School Student category: Taylor Butler (Murrah-First Place), and the Douglas Walker Award went to Melanie Pollan (UMC-Overall Winner).

Congratulations. We would like to acknowledge all those who contributed to our monetary awards.—Ibrahim Farah

History and Philosophy of Science

This year's session of the History and Philosophy of Science Division had twelve papers presented and, for the first time, required sessions over a two-day period. Thursday's session addressed the philosophical aspect of science, while Friday's session was devoted to the history of science. One history of science paper, originally scheduled for Friday's session, had to be moved to Thursday because of a scheduling conflict for the speaker. Thursday's philosophy of science session opened with a paper which argued that human freedom is illusory. It was argued that the advances in molecular biology and genetics have shown to some extent and will continue

to show that human behavior and the choices we make are really a causal function of our biology and the environment and that having options does not constitute having free will. The second paper defended the claim that mathematics is a quasi-empirical science, against the traditional view that alleges that science is purely analytic and has no empirical component. It was argued that, while not wholly an empirically based science, the use of computers in proving mathematical theorems, such as the four color theorem, make mathematics more akin to the empirical sciences than previously thought. The third paper addressed some of the problems associated with the Linnaean hierarchy and discussed the alternative classification model, the Phylocode. It was argued that despite the appearance of being a genuine scientific revolution, the adoption of the Phylocode would simply be a change in instrumentation, and not a genuine scientific revolution. The fourth and fifth papers addressed issues relating to the confusions of ontology and epistemology in biological conceptions of species. It was argued in the fourth paper that the commonly accepted view that the Linnaean hierarchy and the concept of species is established *a priori*, or independent of empirical data, is really a myth. The confusion of taxa with species categories has fueled this traditional view, but it was argued that taxa are natural kinds or sets which get classified at the species level via empirical means. The fifth paper provided a detailed analysis of common confusion of ontology and epistemology in the literature of biology and philosophy of biology. The common usage of the term 'species' to indicate both species taxa and species categories has created so much confusion that when the term is used it is unclear whether ontology (i.e., concerning species taxa) or epistemology (i.e., concerning species categories) is at issue. As a result of this confusion, debates about the nature of species have occupied much literature in the philosophy of biology. The sixth paper raised an interesting moral and legal question concerning the extent of responsibility on the part of scientists who developed the means used by terrorists in the 9/11/2001 attack on New York City's World Trade Center. It was noted that the attorneys in trials now often focus on how the defendant(s) acquired the means of committing their crime(s), such as how and where they got a gun, who owned the gun, and even, who manufactured the gun. Thus, a concern was raised about the extent of moral and legal culpability on the part of scientists who harness new energies in nature that get used and misused in potentially unforseen ways. The last paper on Thursday kicked off the history of science section. It addressed the 17th century English scientist, Robert Lower's pioneering experiments in blood transfusions. Lower was presented in sharp contrast to his French counterpart, Jean-Baptiste Denis, a radical scientist for his day who conducted transfusions without the usual prerequisite "academic" studies. A law suit was filed against Denis after a patient died from a transfusion, and this inhibited the advancement in transfusion medicine for decades. Lower did do the expected academic studies, apparently conducted dog-dog and dog-human blood transfusions, but was usurped in the experimental aspects of transfusion medicine by Denis.

Friday's history of science session opened with an interesting discussion of the work of Charles Darwin on evolutionary theory and the independently formulated evolutionary theory of Alfred Russel Wallace. It was argued that Darwin could have suppressed the work of Wallace, but chose not to do so. Consequently, Darwin was forced to publish his own work much earlier than he had planned. The second paper discussed the "Intelligent Design" (ID) movement from its origins in 18th century theology with the views of William Paley through recent 20th and 21st century revivals in the works of mathematician, William Dembski and microbiologist, Michael Behe. It was suggested that while the ID movement may not have significant effect on the way scientific research is carried out, it may indeed affect the way North American science education is conducted. A wary eye was prescribed for the incorporation of ID tenets in science education. The last three presentations examined the significant influence of John Dewey, Booker T. Washington, and George Washington Carver on teaching methodology and science education. It was shown that John Dewey's pragmatism emphasized a practical aspect to science education. He focused on students' needs and stressed the importance of experimental procedure, problem solving strategies, and hypothesis formulation and testing by both the instructor and the students. Thus, it was shown that Dewey's contribution to science education, and agriculture in particular, was a "learning by and through doing" approach. Booker T. Washington, the first president of Tuskegee University, was shown to have had a significant impact on agricultural research programs.

It was argued that Washington was successful in his attempts to facilitate educational opportunities for African-Americans. His practical approach to education sought to provide the students with the means of economic independence. It was shown that Washington successfully incorporated industrial training in the educational environment of Tuskegee University. The last presentation of the session focused on the agricultural successes of George Washington Carver. It was shown that Carver was instrumental in revolutionizing farming through developing new ways to increase crop production and through preservation and crop rotation techniques while at the Tuskegee Institute. In addition, it was shown that Carver was one of the first people to advocate the benefits of recycling and he introduced new ways to use waste products in the form of paints and stains, for example. In addition, it was shown that Carver was a great humanitarian who took his knowledge of agriculture "on the road" to aid poverty-stricken farmers in rural Alabama and Georgia.

Maritza Abril, the current vice-chair of our division, was elected chair of the division for next year. Professor Kant Vajpayee was elected vice-chair for next year. We are encouraged and pleased about the growing interest and participation in our division and we are anticipating an even more successful History and Philosophy of Science division at next year's meeting.—Paula Smithka

Mathematics, Computer Science and Statistics

As chair of the 2002 MAS Annual Meeting I am writing to report on the election of chairs and vice-chairs. The chair for the 2003 Annual Meeting is:

Walter T. Brehm
Clinical Research Laboratory
Keesler Medical Center
1-228-377-7926
Walter.Brehm@keesler.af.mil

and the vice-chair for the 2003 Annual Meeting was selected to be

Ravinder Kumar
Alcorn State University
Alcorn State, MS 39096

In regard to the annual summary, it was a low-key meeting:

The Mathematics, Statistics and Computer Science Division meeting in 2002 went well with covering a large range of material. It was encouraging to note that several excellent presentations were made by undergraduate students, and there was active participation in the program from several schools in Mississippi, equaled by a strong showing by the Naval Laboratory at Stennis, and by the Mississippi Supercomputer Research Center.

Many of the presentations were being given on computer, and although this has meant that the quality has improved, it also means that more time is required as projectors, and computers are stitched over. The Academy should provide greater direction on this, and I know that we discussed the possibility of having and ftp site available for collecting presentation software, and making available a single computer on which all presentation software can be loaded before the sessions begin. I will pass these points on to the chair for next year's meeting.—Joseph Kolibal

Physics and Engineering

The meeting on Feb. 2002 in Biloxi for the Physics and Engineering Division was very successful. Twenty oral presentations were scheduled and distributed over two sessions. In addition six papers were in the poster presentations. The contributions were from all over the state institutions and also from industry. The lion's share was from the Department of Electrical Engineering at the University of Mississippi. This department contributed a total of twelve presentations. I hope this will encourage other institutions to contribute more to the Division and the annual meeting. The chairperson for the 2002–2003 is Dr. T. M. Parchure, US Army Engineer Research and Development Center. The elected vice chair is Dr. Atef Z. Elsherbeni, Department of Electrical Engineering, University of Mississippi. I wish them good luck and a successful year.—Ahmed A. Kishk

Psychology and Social Science

At the 66th Annual Meeting of the Mississippi Academy of Sciences, held in Biloxi, MS, the Division of Psychology and Social Science demonstrated sizable growth in papers and participation this year. We are proud to report a total of 18 scientific papers, from five Ph.D. scientists, three graduate students and eight undergraduate students. There were sixteen

slide presentations and two posters featured in our division. Participants were from Jackson State University, Tougaloo College, University of Southern Mississippi, University of Mississippi and the University of Mississippi Medical Center.

Monetary awards were given to the graduate and undergraduate students who presented the most outstanding scientific presentations. Chris Strawbridge, a graduate student in Chemistry at the University of Southern Mississippi was presented with the "Outstanding Graduate Student Paper Award". His paper was entitled, " *The opiate precursor Tetrahydropapaveroline as a possible causal agent of alcohol craving in male Sprague-Dawley rats"*. Chris' work was supervised by USM scientists, Dr. John McCoy and Dr. Kenneth McMurtrey. For the "Outstanding Undergraduate Student Paper Award, there was a tie for first place; thus, two awards were made. Kumari Hardy, a senior psychology major at Jackson State University, received the undergraduate award for a research paper she completed during a summer research experience at New York University. Kumari's paper examined the "*Practices and perceptions of racial socialization among African American families."* She was supervised by Dr. Diane Hughes at NYU and Dr. Pamela Banks at JSU. Johnathan Hayes, a senior biology major at Jackson State University, was the recipient of the Outstanding Undergraduate Paper Award. He was mentored by Dr. John Piletz from the University of Mississippi Medical Center. His paper was entitled, "*Imidazoline receptors: Improved antiserum-based blood test for depression?"* Both Kumari and Johnathan are honors undergraduate research trainees in a training grant funded by the National Institute of Mental Health at Jackson State University. Congratulations to our emerging scientists! Special thanks is also to be given to the judges: Dr. Billy Barrios (University of Mississippi), Dr. Sheree Watson (JSU), Dr. Ann Marie Kinnell (USM), Heather Sullivan and Joan Elders (MS Museum of Natural Sciences).

At the Business meeting, USM Sociology Professor, Dr. Ann Marie Kinnell was elected Divisional Chair, with Dr. Billy Barrios from the University of Mississippi elected as the Alternate. Dr. Pamela Banks, who has been Chair for three or four years will now serve as Vice Chair. The Division is growing and our committment to the Academy is stronger than ever as was evident by the successful meeting we experienced at MAS 2002.—Pamela G. Banks

Science Education

The new officers for the Science Education Division is Chair, Willie R. Heard, Vice Chair, Aimee T. Lee. We are planning on having awards next year. The committee is made up of myself, Ellen Maples, and Becky Sullivan. This committee will listen to all presentations for Science Education, then judge the best presenter for podium and poster presentations, for graduate and undergraduate category. We did not have any awards for this year.—Willie Heard

2002 Annual Meeting Abstracts

Chemistry and Chemical Engineering

Oral presentation

SEPARATION OF DANSYL AMINO ACIDS USING 18-CROWN-6 ETHER AND VANCOMYCIN VIA CAPILLARY ELECTROPHORESIS

Colette Rabai* and Timothy J. Ward, Millsaps College, Jackson MS 39210

The macrocyclic antibiotic vancomycin has been used as a powerful chiral selector, specifically in capillary electrophoresis. It has previously been determined that the secondary amine in the aglycone basket of vancomycin is essential in stereoselectivity. The role of the primary amine on the pendant sugar moiety for enantiorecognition is unknown. Since 18-crown-6 ether selectively complexes with primary amines, a mixture of vancomycin and 18-crown-6 was used in CE to test the stereoselective role of the primary amine in vancomycin. Using two different concentrations, dansyl amino acids were separated both with 2 mM vancomycin and 2 mM 18-crown-6 ether. This implies the primary amine on vancomycin is not essential in enantiorecognition. This research aids in determining the role of functional groups in chiral separations.

Poster presentations

SEPARATION OF BACTERIA IN THE MANNER OF MOLECULES UTILIZING CAPILLARY ELECTROPHORESIS

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The ability to rapidly and efficiently identify and

quantitate bacteria and other microbes is a difficult, but increasingly important problem. Recent events in this country have clearly illustrated the need to rapidly and accurately identify microbes such as bacteria, viruses, etc. Presently, there are no broadly applicable, reproducible, efficient techniques for the separation and identification of intact microbes. The traditional method for characterizing bacteria is by isolation of pure cultures. Compounding this problem is that fact that the throughput for this technique is low and the process is time-consuming. Recently a number of groups have shown that it may be possible to separate intact microorganisms such as bacteria and viruses using capillary electrophoresis. Since most microbes in general are amphoteric containing multiple charges, they may be ideally suited for analysis by electrophoresis. Electrophoretic techniques would have the advantage of allowing the bacteria to remain intact, be analyzed quickly, efficiently, and with broad applicability. We will present a number of examples of separation of via capillary electrophoresis and discuss the relevant characteristics associated with microorganisms that must be carefully controlled before a practical and useful separation can be achieved.

POLYMER NANOSTRUCTURE FORMATION IN LYOTROPIC LIQUID CRYSTALLINE SYSTEMS
Kalena D. Stovall*, Demetrius T. McCormick, and C. Allan Guymon, University of Southern Mississippi, Hattiesburg, MS 39406

Lyotropic liquid crystalline systems (LLCs) offer exciting potential as templating agents, in that discrete nanometer sized domains can be generated using the ordered LLC morphologies as templates. This study focuses on the polymerization of polar and non-polar monomers in Pluronic® LLC systems and understanding how the varying degree of LLC order affects the polymerization mechanism as well as the resultant polymer morphology. Initial studies demonstrate that the order of the LLC mesophase has significant impact on the polymerization rate of polar monomers with accelerated polymerization rates being observed in more ordered LLC phases. For non-polar monomers, there appears to be an opposite trend with faster polymerization rates occurring in the less ordered LLC phases. This indicates that differences in monomer structure affect the monomer segregation behavior which has a significant effect on the polymerization rate and will have an ultimate effect on the resultant polymer morphology. In addition, when the textures of the LLCs are examined there is a general retention of the original LLC morphology both upon addition of monomer and after polymerization. This is important because to successfully template the LLC morphology the LLC structure must be retained during the course of polymerization. This study has allowed for further understanding of the factors relating to polymerizations in ordered systems and for further development of Pluronic® LLCs as templating agents.

Geology and Geography

Correction in bold

11:15 SOLID-PHASE GEOCHEMICAL SURVEY OF THE STATE OF MISSISSIPPI: ON THE NATURE AND DISTRIBUTION OF AS, SE, HG, CU, PB, AND ZN IN STREAM SEDIMENTS AND SOILS

David E. Thompson[1]*, Andrew E. Grosz[2], Paul G. Schruben[2], and Jeffrey N. Grossman[2], [1]Mississippi Office of Geology, Jackson, MS 39289, and [2]U.S. Geological Survey, Reston, VA 20192

Over 1500 samples were collected statewide on a 100-km^2 grid-cell-based survey to determine baseline geochemical values for a suite of metallic elements in stream sediment (drainage basins up to 10 km^2) and soil samples (about 300) from the "Delta" and **Gulf Coast** regions, and to prepare statistically reliable geochemical maps. Samples were analyzed by a number of analytical techniques as detailed by Thompson and others (1998). Salient statistics for stream sediment and soil samples are given below in parts per million. The "Delta" and **Black Prairie** regions have significantly higher baseline values of these potentially toxic elements with respect to adjacent terranes, in part because soils were the sampled media. A strong spatial correlation is shown to exist between regions of elevated values of these metals and land (broadly) classified as agricultural, irrespective of media sampled. Cretaceous sediments in the State, as throughout the continent, also exhibit higher baseline geochemical values than adjacent geologic units.

Health Sciences

Correction of affiliation in bold

3D ORIENTATION AND DYNAMICS OF PRIMARY SEMICIRCULAR CANAL AFFERENTS IN THE RHESUS MONKEY

Asim Haque[1]*, Dora E. Angelaki[2], and J. David Dickman[1], [1]**Washington University Medical**

Center, St. Louis, MO 63110, and [2]Washington University, St. Louis, MO 63110

AFFERENT INNVERVATION PATTERNS OF THE HORIZONTAL CRISTA AMPULLARIS IN PIGEONS

Asim Haque* and J. David Dickman, **Washington University Medical Center, St. Louis, MO 63110**
Psychology and Social Science

Poster presentation

BEHAVIORAL AND PHYSIOLOGICAL EFFECTS OF ENVIRONMENTAL ENRICHMENT FOR GARNETT'S BUSHBABY (*OTOLEMUR GARNETTII*)

S. Watson*, A. Gray, E. Taylor, B. Johnson, B. Fahm, A. McGee, W. Bingham, and P. Banks.
Jackson State University, Jackson, MS 39217

The Animal Welfare Act requires researchers who use nonhuman primates as research subjects to provide a physical environment adequate to reduce stress and promote the psychological well being of the captive primates. A strategy for providing an enriched environment, which includes provision of manipulanda (e.g., toys) and opportunities for species-typical behavior, has been prescribed by the United States Department of Agriculture. However, little empirical evidence has been collected to establish whether these techniques are beneficial for prosimians. This study assessed the usefulness of three specific enrichment interventions for captive bushbabies. We examined 10 male and 8 female Garnett's bushbabies to determine the extent of their interaction with 3 levels of environmental enrichment. Level 1 consisted of manipulanda only, Level 2 consisted of swinging and climbing apparati only, and Level 3 consisted of manipulanda and swinging/climbing apparati combined. The animals' behavior was video recorded for 15/min day for six days over a three week period. Baseline levels of cortisol were assessed as a physiological indicator of stress. The bushbabies interacted with the swinging/climbing toys significantly more than with manipulanda ($p=.04$). Animals that had access to swinging/climbing apparati spent less time grooming than those with manipulanda only ($p=.02$). Further, all animals spent significantly more time at the top than at the bottom of their cages ($p=.004$). Cortisol levels did not differ among the groups. These results indicate that cage configuration and swinging/climbing opportunities are more effective forms of enrichment for bushbabies than the provision of manipulanda.

2003 Annual Meeting
13, 14 February
Hattiesburg, Mississippi

In Memory of Dr. Johnnie-Marie Whitfield
May 25, 1943–January 13, 2002

Dr. Johnnie-Marie Whitfield, beloved Millsaps professor and Membership Director of the Mississippi Academy of Sciences, died January 13, 2002. Dr. Whitfield leaves a legacy of dedication to science and science education in Mississippi.

We note with regret the passing of one of the Director's of the MAS, Dr. Johnnie-Marie Whitfield. She died on January 13, 2002 at the University of Washington Medical Center in Seattle. Johnnie-Marie was an Assistant Professor of Chemistry at Millsaps College and devoted her life to science education. She was Councilor of the Mississippi Section of the American Chemical Society (ACS) and was sponsor of the Student Affiliates Chapter of the ACS at Millsaps. During summers she was Director of the Science Teachers Institute, the Summer Research Institute, and the Master Teachers' Program for K-12 students and teachers. Johnnie-Marie was dedicated to teaching and to helping others become better teachers. We will miss her greatly, but her impact on science in Mississippi will continue into our future.

Dr. Whitfield earned her Baccalaureate degree with Honors in Chemistry from Millsaps College in 1965, and her Ph.D. in inorganic chemistry from Louisiana State University in 1973. She taught chemistry at the University of Montevallo, Louisiana State University, California Polytechnic State University at San Luis Obispo, and Peace College before joining the faculty of Millsaps as an Assistant Professor of Chemistry in 1988.

Dr. Whitfield, or "J-M", as she was called by her colleagues, was dedicated to improving science education across Mississippi, for students of all ages. She was director of the Millsaps Science Teachers' Institute, the Summer Research Institute, and the Master Teacher Program. She directed research and teaching workshops for K-12 teachers and students that were innovative and exciting. In recognition of her achievements in chemistry and chemical education, Dr. Whitfield was chosen in 2000 as a Scholar in Chemical Education at the Chemical Heritage Foundation, spending a semester at the foundation headquarters in Pennsylvania.

Dr. Whitfield's compassion for inner-city

children—her commitment to improving their education, to sparking their interests in science, to helping them realize that they can dream—serves as a role model to us all. She helped many children realize that even though they may not have the advantages afforded others, that if they work from the courage within themselves, their dreams are attainable.

As a member of the Mississippi Academy of Sciences, Dr. Whitfield was active for many years in the Science Education Division as well as being the Academy's Director of Membership. She was an inspiration to all, and her presence and leadership will be greatly missed.—Sarah Lea McGuire and John Boyle