TRANSACTIONS OF THE MISSOURI ACADEMY OF SCIENCE

Vol. 27, 1993

About the Academy

Scientists of the State of Missouri organized in 1934 to form the Missouri Academy of Science. By April 6, 1934, a Constitution and By-Laws were prepared and on August 14, 1934, the organization was incorporated.

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"This corporation is organized, not for profit but for the purposes of promoting the increase and the diffusion of scientific spirit, and of promoting cooperation beween the scientific interests of Missouri. It proposes to accomplish these purposes:

a. By holding meetings for the presentation of scientific papers embodying the results of original research, teaching experience, or other information of scientific interest.
b. By fostering public interest in scientific matters, through open meetings, press releases and in such other ways as seem feasible.
c. By encouraging local scientific organizations in every possible way.
d. By promoting acquintance in harmonious relationships between scientists in Missouri, and among all who are interested in science.
e. By supplying, so far as finances permit, a medium for the publication of results of original work, particularly those of special interest in this state.
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Association of Rhizobacteria with Birdsfoot Trefoil Roots

(Received December, 1994; accepted for publication February, 1995)

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Abstract: The association between birdsfoot trefoil (*Lotus corniculatus* L.) seedling roots and selected rhizobacteria was studied by standard bacteriological procedures and scanning electron microscopy (SEM) using nutrient solution culture. Birdsfoot trefoil seedlings inoculated with selected rhizobacteria became chlorotic and developed abnormal root systems compared with noninoculated controls. SEM of birdsfoot trefoil roots inoculated with rhizobacteria revealed that high numbers of rhizobacteria colonized and became established on the epidermal surfaces of seedling roots. Inoculated seedlings had considerably fewer root hairs, confirming inhibitory effects of deleterious rhizobacteria. Further SEM of the rhizoplane revealed characteristic colonization patterns including bacterial alignment along cell junctures. Abundant mucigel production in assocaition with some deleterious rhizobacteria was observed on rhizoplanes.

Key words: Birdsfoot trefoil, forages, microbial ecology, rhizoplane, rhizosphere, scanning electron microscopy, seedling vigor.

INTRODUCTION

Seedling vigor is critical in establishment of birdsfoot trefoil as a forage or seed crop. Seedborne bacteria may cause poor birdsfoot trefoil seedling vigor as well as decreased seed viability (Beuselinck et at., 1989). Once emerged, birdsfoot trefoil seedlings are often susceptible to various soilborne diseases that decrease vigor and result in poor field establishment. Previous research has shown that phytopathogens invade roots of birdsfoot trefoil, causing disease symptoms. Bacteria in the rhizosphere have been shown to have primary roles in root and crown rot (Berkenkamp et al., 1972) and wilt (Lukezic et al., 1983) diseases of birdsfoot trefoil.

The rhizosphere is colonized by various bacteria, which can be either beneficial or detrimental to seedling growth. Although abundant microorganisms have been observed in the soil surrounding plant roots, growth responses of the plant to the bacteria are most pronounced when bacteria are attached to root surfaces (Foster and Bowen, 1982; Bennett and Lynch, 1981; Elliott et al, 1984; Pueppke and Kluepfel, 1985). Often specific bacteria associated with root surfaces (rhizobacteria) occur due to attraction to specific chemicals exuded by the root. This may be very important as one of the steps leading to attachment to the root by rhizobacteria and subsequent disease symptoms.

External plant surfaces such as root surfaces lack uniformity and are composed of several types of cells in various stages of cell differentiation. Therefore, measuring the degree of adsorption or attachment of bacteria to plants is

a very challenging task. In this study, scanning electron microscopy was employed not only because of its high resolution of surface structures and great depth of field, but also because it has been applied in other experiments dealing with bacteria-rhizoplane relationships (Dart, 1971; Foster, 1981; Foster and Bowen, 1982).

Since recent work has shown that rhizobacteria can be detrimental to growth of many crop seedlings (Schroth and Hancock, 1982), a study was conducted to survey the association of various bacteria with the birdsfoot trefoil seedling rhizoplane. The objectives of this study were; 1) to demonstrate the association of rhizobacteria on root surfaces of birdsfoot trefoil seedlings; and 2) to relate these associations to effects of rhizobacteria on growth and root morphology of birdsfoot trefoil seedlings.

MATERIALS AND METHODS

Rhizobacteria accessions *Alcaligenes* sp. 004 and *Pseudomonas putida* 007, isolated from the rhizoplane of birdsfoot trefoil seedlings growing in Boone County, Missouri in 1986, were used in this study. A soil bacterial isolate, *Alcaligenes faecalis* 411, isolated in Knox County, Missouri was also included. Bacterial cultures used for inoculation of seeds were grown in broth culture medium (Sands and Rovira, 1970) for 16 h at 27°C at 100 rpm on a rotary shaker. Stock cultures were maintained on agar slants of the same medium.

Birdsfoot trefoil cv. MU 81 was used as the host plant for rhizobacteria isolated from birdsfoot trefoil. Seeds were surface-sterilized by immersion in 1.25% (w/v) sodium hypochlorite for 12 min, followed by immersion in 70% ethanol (v/v) for 4 min. Seeds were washed thoroughly (at least ten times) with sterile distilled water, then allowed to imbibe water for 24 h at 27°C on germination paper. Imbibed, contaminant-free seeds with emerging radicles were used in inoculation experiments.

Surface-sterilized, imbibed seeds of birdsfoot trefoil were planted in enclosed culture tube assemblies using the method of Araujo et al. (1986) with slight modifications. Each of the assemblies consisted of a larger outer tube (195 mm long, 25 mm diam) containing an inverted smaller test tube (100 mm long, 15 mm dia) and a folded filter paper positioned on one side of the large tube. Each assembly contained 40 ml of plant nutrient solution supplemented with 1.5 mM potassium nitrate (Hoagland and Arnon, 1938). All the assemblies used in this experiment were sterilized by autoclaving at 121°C and 104 kPa for 15 min. One seed was planted in each assembly which was kept enclosed during the two week growth period in order to maintain sterile growth conditions. Seeds in each treatment were inoculated with 0.5 ml of bacterial suspension containing 10^8 cells. Each bacterial culture was inoculated on 10 seeds and the experiment was repeated three times. The control treatment consisted of seeds which were not inoculated. Seedlings were grown in the growth chamber maintained at 28°C during a 16 h light period and at 21°C during an 8 h dark period. Light in the growth chamber was supplied by fluorescent and incandescent lamps at a photon flux density of 250

$\mu molm^{-2}s^{-1}$. At harvest, root systems of each plant were thoroughly rinsed in sterile distilled water after which they were suspended in sterile phosphate-buffered saline (PBS; 0.01 M K_2HPO_4, 0.14 M NaCl, pH 7.2) containing 0.01% (v/v) Tween 20 and agitated vigorously on a vortex shaker for 5 min. Bacterial populations were determined by serially diluting the root suspension in PBS blanks and spread plating onto duplicate plates of King's agar medium. Colonies were enumerated after incubation at 27°C for 3-5 days. In all experiments the development of any abnormality in the seedlings was recorded during the growing period; root length and root and shoot dry weights were determined for each plant at harvest.

For scanning electron microscopy, roots of inoculated and noninoculated seedlings grown in the enclosed culture tube assemblies were sectioned into 2-3 mm lengths and were then fixed in glutaraldehyde (2.5% in 0.1 M PO_4 buffer, pH 7.0) for 24 h at 4°C. The fixed root specimens were rinsed in phosphate buffer for over 1 hr followed by fixing in osmium tetroxide (OsO_4, 1.0% in 0.1 M phosphate buffer) for 24 h at 4°C. The fixed specimens were dehydrated in a graded ethanol series followed by critical point drying in liquid carbon dioxide. Dried specimens were mounted on aluminum holders and sputter coated with gold-palladium (Au-Pd) alloy. Processed specimens were examined and photographed with a JEOL JSM 35 scanning electron microscope operating at 20 kv.

RESULTS AND DISCUSSION

Noninoculated birdsfoot trefoil seedling roots had abundant and turgid root hairs (Fig. 1) compared to the fewer and collapsed root hairs on the inoculated seedlings (Fig. 2) Root surfaces of the noninoculated seedlings showed no detectable surface bacteria (Fig. 3). Particularly abundant colonization was observed on tap root epidermal (Fig. 4) and root hair surfaces (Figs. 6, 7 and 8) of birdsfoot trefoil seedlings inoculated with *P. putida* 007, *Alcaligenes* sp. 004, and *A. faecalis* 411. The bacteria were distributed along crevices and ridges on the tap root epidermal surface (Fig. 4). *Pseudomonas putida* 007 was associated with microfibrils attached to the root surface (Figs. 5 and 6). Closer examination revealed these structures apparently evolving from bacterial cells yet firmly attached to the root surface (Fig. 5). The elaboration of microfibrils by bacteria may result from the binding of the lipopolysaccharide component of bacterial cell envelopes to plant host receptor sites (Whatley et al., 1976; Matthysse et al., 1982). Microfibrils may serve to anchor bacteria to host receptor sites and entrap additional bacteria resulting in establishment of high bacterial populations on root surfaces. Also, recent research with *P. fluorescens* on wheat root surfaces revealed 'rod-like' structures connecting bacterial cells to the root, which were associated with an apparent role in attachment of the bacteria to the root (DeMot and Vanderleyden, 1991). Further examination of root hair surfaces revealed that distribution of *P. putida* 007 (Fig. 6) and *Alcaligenes* sp. 004 (Fig. 7) was similar to the bacterial allignment pattern observed on tap root surfaces.

The bacteria colonizing birdsfoot trefoil root surfaces did not apear to possess enzymatic activity since no tissue degradation was observed. This supports the non-invasive characteristic of rhizobacteria, which distinguishes them from classical plant pathogens (Schroth and Hancock, 1982). Detrimental effects of rhizobacteria may result from production of phytotoxins or predisposing roots for fungal infection (Schroth and Hancock, 1982; Suslow and Schroth, 1982).

Inoculation of birdsfoot trefoil with *P.putida* 007 and *A. faecalis* 411 resulted in shoot and root dry weights and tap root lengths significantly ($P<0.05$) less than the control seedlings (Table 1). Additionally, colonization levels of *P. putida* 007 and *A. faecalis* 411 were significantly higher in inoculated seedling than the controls. The root dry weight and tap root length of seedlings inoculated with *Alcaligenes* sp. 004 were significantly decreased while *Alcaligenes* 004 and *P. putida* 007 had no significant effect on the shoot dry weights of the seedlings. It is interesting to note that the soil isolate *A. facaelis* 411 was detected on seedling tap roots at slightly higher population levels (although not significant) compared to the rhizobacterial isolates. The higher number of *A. faecalis* 411 cells could be due to stimulation of growth in the presence of root exudates since this bacterium, originally isolated from root-free soil, might respond positively to readily available nutrient sources. This is supported by the aggressive colonization of the root surface by this bacterium observed with SEM (Fig. 8).

This investigation demonstrated that high numbers of selected rhizobacteria colonized and became established on the epidermal surfaces of birdsfoot trefoil seedling tap root and root hairs. Additionally, it showed that the association of certain rhizobacteria with root surfaces likely precedes any promotive or deleterious effects on birdsfoot trefoil growth and root morphology. Dart (1971) suggested that high numbers of bacteria concentrated at root surfaces may affect physiology of roots. Previous studies have shown that several bacteria isolated from roots of forage legumes have primary roles in root disease complexes usually associated with fungal pathogens (Berkenkamp et al., 1972; Gaudet et al., 1980; Lukezic et al., 1983). The present SEM evidence showing specific attaachment of rhizobacteria to the root surface of birdsfoot trefoil supports the suggestion of intimate involvement of bacteria in root disorders. Also, certain rhizobacteria are specifically attached to birdsfoot trefoil roots through chemotaxis (Begonia, 1989), which indicates that this mechanism may contribute to microbial-induced seedling disease culminating in the observed poor seedling vigor of this legume in the field.

ACKNOWLEDGMENTS

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Table 1. Effects of bacterial inoculation on the growth of birdsfoot trefoil seedings and on bacterial colonization of roots in nutrient solution.

Bacterial isolate	Shoot dry wt. (mg)	Root dry wt. (mg)	Tap root (cm)	Log number cells/cm root
Alcaligenes sp. 004	2.8	0.8	8.1	4.96
P. putida 007	2.0	0.5	6.7	4.87
A. faecalis 411	2.2	0.8	7.2	5.58
Control	2.9	1.1	9.7	0.00
LSD (0.05)	0.6	0.2	1.4	0.83

FIGURE CAPTIONS

Fig. 1. Segment of a 2-week old noninoculated birdsfoot trefoil seedling root with abundant and turgid root hairs. Magnification, X 130.

Fig. 2. Segment of a 2-week old birdsfoot trefoil seedling root inoculated with *Alcaligenes* 004 exhibiting few and some collapsed root hairs. Magnification, X 130.

Fig. 3. SEM of a 2-week old noninoculated birdsfoot trefoil seedling root hair surface. Magnification, X 6,000.

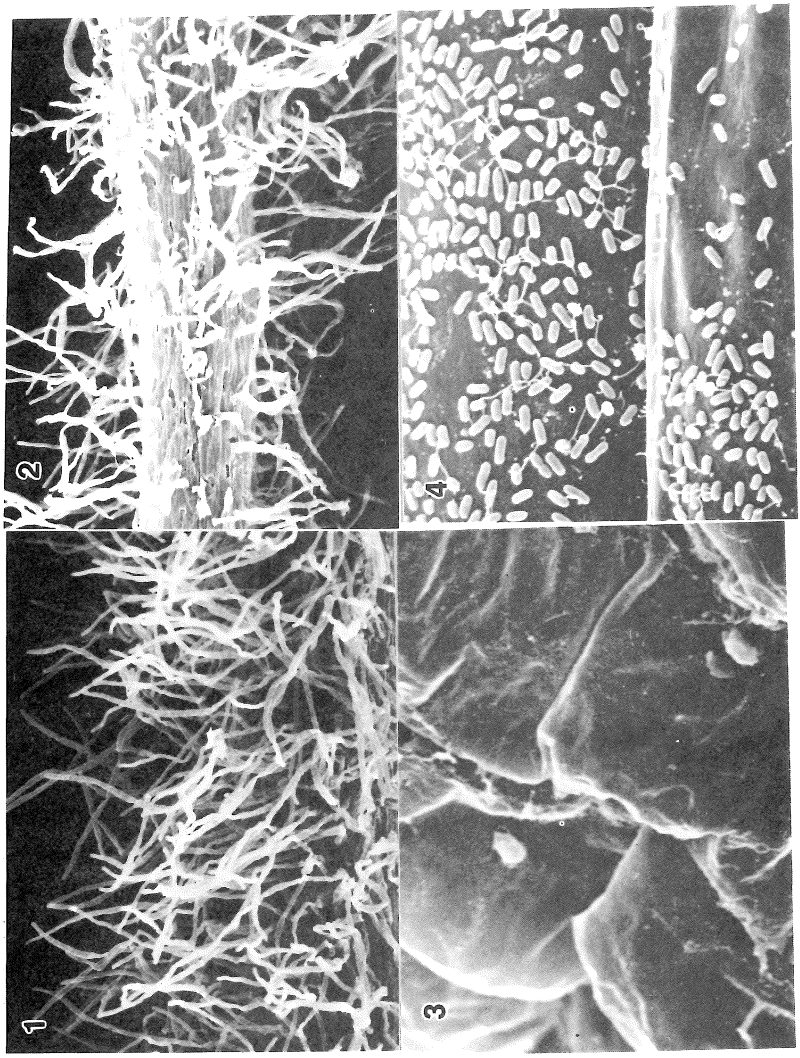
Fig. 4. SEM of a 2-week old birdsfoot trefoil seedling tap root surface inoculated with *P. putida* 007. Magnification, X 14,000.

Fig. 5. A close-up of the microfibrils or appendages associated with bacterial cells of *P. putida* 007 shown in Fig. 4. Magnification, X 5,400.

Fig. 6. SEM of attachment of *P. putida* 007 to root hair surface of a 2-week old birdsfoot trefoil seedling. Magnification, X 6,600.

Fig. 7. SEM of a 2-week old birdsfoot trefoil seedling root hair surface inoculated with *Alcaligenes* sp. 004. Note distribution of bacteria along crevices and ridges of the rhizoplane. Magnification, X 5,400.

Fig. 8. SEM of a 2-week old birdsfoot trefoil seedling root inoculated with *A. faecalis* 411. Magnification, X 8,600.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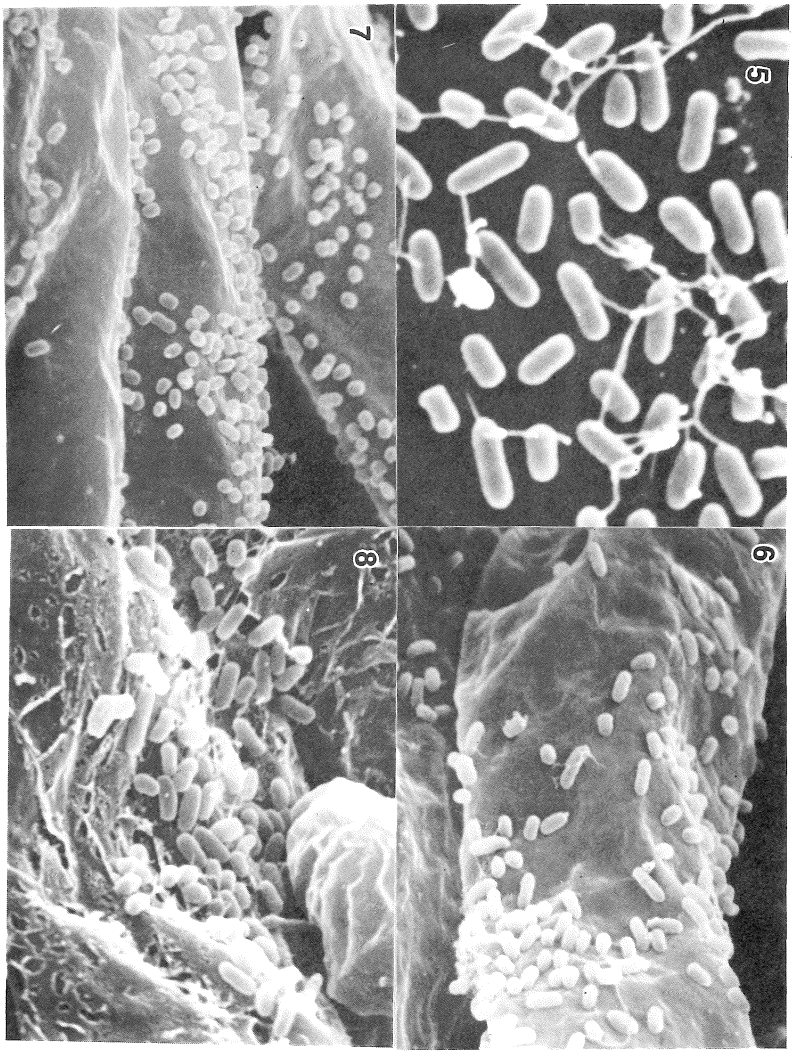
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PROTEIN A AND PROTEIN G IN THE DIAGNOSIS OF DISEASES IN ZOO ANIMALS

(Received June, 1994; accepted for publication July, 1995)

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Abstract. We assessed whether staphylococcal protein A or streptococcal protein G could be used as a secondary antibody in diagnostic assays performed on sera from zoo animals based on the ability of each of these proteins to bind the Fc portion of antibodies without interfering with their antigen binding capacity. Protein A reacted with 101 of 175 sera from zoo animals and protein G reacted with 90 of the 175 sera in an immunodiffusion assay. Although the two proteins reacted with many of the same samples of sera, they also showed some diversity in their binding capability. Some species did not react with either protein A or protein G. Overall the results indicate that the use of protein A or protein B, rather than secondary antibodies made to related domestic animals, may increase the accuracy of certain diagnostic tests in exotic (zoo) animals.

Key Words: protein A, protein G, zoo animals, disease diagnosis.

Introduction

The diagnosis of disease in zoo animals is often dependent on diagnostic tests using secondary antibodies made to closely related domestic animals. Secondary antibodies are needed to bind to and detect antibodies produced in response to a pathogen. They are species specific and usually need to be made for each animal species being tested for antibodies to a pathogen. Since production of secondary antibodies for each species is expensive and time consuming, zoos usually use a secondary antibody produced to a closely related domestic animal. The use of secondary antibodies developed for another species can result in false negatives, so it is desirable to develop another diagnostic system that can be used for relatively uncommon animals.

Protein A and protein G are two surface proteins from *Staphylococcus aureus* and *Streptococcus* C and G strains respectively. They have the unique ability to bind the Fc portion of a broad range of antibodies without interfering with the antigen binding capacity of the antibody (Forsgren and Sjoquist, 1966; Kronvall, 19793). This property may make it possible to use proteins A and G as secondary antibodies in diagnostic tests instead of using secondary antibodies to a domestic animal. In order to use protein A and protein G in a diagnostic test it is necessary to determine whether they bind to serum antibodies of exotic animals.

The development of a diagnostic system using protein A and protein G may allow veterinarians to diagnose diseases which could be passed from wild populations to domestic populations. It may also aid in screening for disease in animals being transferred from one zoo to another and thus avoid the simultaneous transfer of a pathogen.

Our objective was to determine whether the immunoglobulins present in 175 samples of animal sera provided by the Saint Louis Zoo, St. Louis, Missouri (USA) would bind to protein A or protein G. This sampling included six orders, 11 families, and 25 species of exotic animals.

Materials and Methods

The reactivity of protein A (Boehringer Mannheim Corporation, Biochemical Products, Indianapolis, Indiana, USA) and Protein G Type II Recombinant (Boehringer Mannheim) with the serum of each animal was determined by using double immunodiffusion. For this procedure Difco noble agar (Fisher Scientific, St. Louis, Missouri, USA) was prepared in special barbital buffer (pH 8.6, Fisher Scientific) at a 1.5% concentration. No preservative or antibacterial agent was added.

Untreated Falcon tissue culture dishes (35 x 10 mm, Fisher Scientific) were rinsed with Tween 20 (Sigma Chemical St. Louis, Missouri, USA) and allowed to air dry. This step helped to reduce surface tension so that a minimal amount of agar could be used in the assay. One ml of the 1.5% agar solution was added to each dish. The dishes were refrigerated on leveling trays for 1 hr to allow the agar to solidify and then the agar was cut in a circular pattern with eight outside wells and one center well (Fig. 1).

Each serum sample provided by the Saint Louis Zoo from their frozen tissue bank was tested as whole serum, a 1:10 dilution, and a 1:100 dilution. A 3 μl sample was placed in six of the outside wells leaving an empty well at the top and the bottom of the dish. Protein A or G was added to the center well at a concentration of 1:10 with veronal buffer (pH 8.6) and to the two remaining outside wells at a 1:20 dilution. This arrangement of solutions made it possible to test two serum samples in the same dish.

The dishes were refrigerated on a leveled tray at 4°C and checked after 48 hours and each day thereafter for 1 wk for the formation of precipitin bands. Precipitin bands were observed with indirect lighting and recorded on a diagram of a tissue culture dish drawn to scale.

The protein concentration of each serum sample was determined using the Biorad protein assay (BioRad Laboratories, Richmond, California, USA) with bovine serum albumin Fr. V as the standard.

To determine the amount of variation within a large group of individuals of the same species in the immunodiffusion procedure, the procedure was done on sera collected from 50 dogs. The sera were provided by Dr. D. Bojrab, a veterinarian in South Saint Louis County, Missouri. Sera from such a large number of individuals of the same species could not be obtained from the zoo population.

Results

Results for the immunodiffusion assay performed with undiluted sera are presented in Table 1. Results varied among species. Sera from some animals, for

example the Asian elephant, did not react with either protein A or protein G. In other cases, for example the ruffed lemur, all serum samples reacted with both protein A and protein G. Additionally sera from some species, for example the macaque, showed variation in reaction with protein A or protein G on the individual level. Forty two percent of the sera reacted with a 1:10 dilution of protein A and thirty one percent reacted with a 1:10 dilution of protein G. Sera from only a few animals (6%) reacted with a 1:100 dilution of protein A. Only one percent of the sera reacted with a 1:100 dilution of protein G.

The protein assays showed some variation among the sera from animals of the same species. However, samples with higher concentrations of protein were not more reactive with either protein A or protein G than other samples from the same species with lower protein concentrations.

All 50 dog sera formed precipitin bands between protein A and whole sera as well as with the 1:10 dilutions of the sera. In addition three sera formed precipitin bands between protein A and the 1:100 serum dilution. There was little difference in the density of bands by visual examination. There was not any evidence of a reaction between protein G and the serum from any dog.

Discussion

In previous research protein A was shown to bind the immunoglobulins of animals in 13 orders and 33 families. Protein G bound to the immunoglobulins of animals in four orders and four families (Forsgren and Sjoquist, 1966; Bjorck and Kronvall, 1984; Goudswaard et al. 1978; Kronvall et al, 1970; Richman et al., 1982; Marchalonis et al., 1978).

There were no phylogenetic relationships among the animals whose sera reacted with protein A or protein G. Variations among individuals of the same species might be due to genetic mutations. The ability to bind protein A or protein G may be coded by a genetic region which is frequently affected by point mutations. This could account for the variation in the ability to bind protein A and protein G by different individuals of the same species. Another possible explanation might be that some of the sera tested were from animals that lacked sufficient levels of circulating antibodies at the time of collection to give a positive reaction in the assay.

None of the impala, Asian elephants, or red kangaroos reacted with either protein A or protein G in the immunodiffusion test. Therefore, protein A and protein G cannot be used reliably in diagnostic tests for exposure to specific pathogens in these animals. Protein A and protein G may be useful to diagnose exposure of the other animals in this study to known pathogens by determining the presence of antibodies to the pathogen. This greatly increases the specificity of diagnostic tools available to veterinarians. The varied results suggest that this test might be most useful for general surveys of animals.

The dog sera were used to determine whether the test results would show much variation among large numbers of individuals within a species. The results

showed a fairly consistent dense precipitin band that formed with protein A. Only three individuals showed a variation from this norm. Their bands were lighter but formed at higher dilutions. The consistent formation of precipitin bands between dog sera and protein A may be due to the long years of domestication leading to a more homogeneous pool of samples than was seen in the exotic animals.

If protein A and protein G are to be used in diagnostic tests it is important to know if a negative result might be due to the non-reactivity of the immunoglobulins of a particular individual or to the absence of the antibodies against a pathogen. Our finding that dogs showed very little variation makes it difficult to explain the individual variation seen within the sera of some zoo animals. Since most of the variation among individuals of the same species occurred in the Bovidae, negative results obtained when testing members of this family for the presence of antibodies against a pathogen using protein A or protein G must be questioned. However, this also brings into question the reliability of previous veterinary testing methods which relied on the use of secondary antibodies developed for the closest domestic relative of the exotic animal. With such variation between individuals of the same species, secondary antibodies from another species would have a much greater chance of giving a false negative result.

Overall, the results have indicated that it may be possible to use protein A and protein G as secondary antibodies for specific diagnostic assays on the sera of some exotic animals. The results also indicate that the use of secondary antibodies developed for the most closely related domestic animal may produce false negative results. The alternative use of protein A and protein G may allow more accurate test results and reduce the number of false negative results.

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Table 1. Reaction of Protein A and Protein G with undiluted Animal Sera (St. Louis Zoo 5/3/83 - 10/31/91)

ORDER Family Genus species	Common name	Positive For PrA	PrG	N*
MARSUPIALA				
Macropodidae				
Megaleia rufa	Red Kangaroo	0	0	7
PRIMATA				
Lemuridae				
Varecia variegata	Ruffed Lemur	4	4	4
Lemur macaca	Black Lemur	8	8	8
Cebidae				
Ateles geoffroyi	Spider Monkey	5	0	5
Cercopithecidae				
Comopithecus hamadryas	Baboon	9	2	9
Macaca silenus	Macaque	7	4	8
Pongidae				
Pan troglodytes	Chimpanzee	1	1	3
Gorilla gorilla	Gorilla	11	7	11
CARNIVORA				
Ursidae				
Melursus ursinus	Sloth Bear	2	0	3
Ursus horribilis	Grizzly Bear	4	1	4
Felidae				
Panthera pardus	Leopard	4	0	4
Acironyx jubatus	Cheetah	10	0	10
Panthera leo	African Lion	2	0	2
PINNIPEDIA				
Otariidae	California			
Zalophus californianus	Sea Lion	5	0	5
PROBOSCIDEA				
Elephantidae				
Elephas indicus	Asian Elephant	0	0	5
PERISSODACTYLA				
Equidae				
Equus grevyi	Grevy's Zebra	1	8	8
Rhinocerodidae				
Diceros bicornis	Black Rhino	9	4	9
ARTIODACTYLA				
Camelidae				
Lama glama	Llama	10	6	10
Camelus bactrianus	Bactrian Camel	6	7	7
Bovidae				
Hippotragus niger	Sable Antelope	1	8	11
Litocranius walleri	Gerenuk	0	6	9
Tragelaphus imberbis	Lesser Kudu	0	9	9
Aepycyeros melanpus	Impala	0	0	7
Gazella spekei	Spekes Gazelle	0	7	7
Antidorcas marsupialis	Springbok	1	9	10

* N is the number of samples tested from each species.

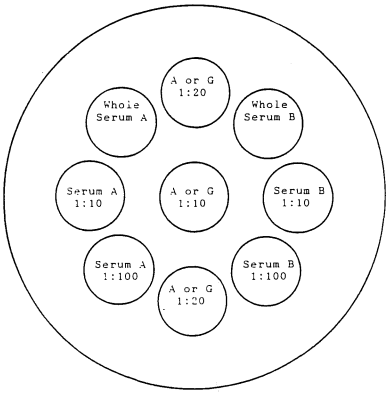

Figure 1a.

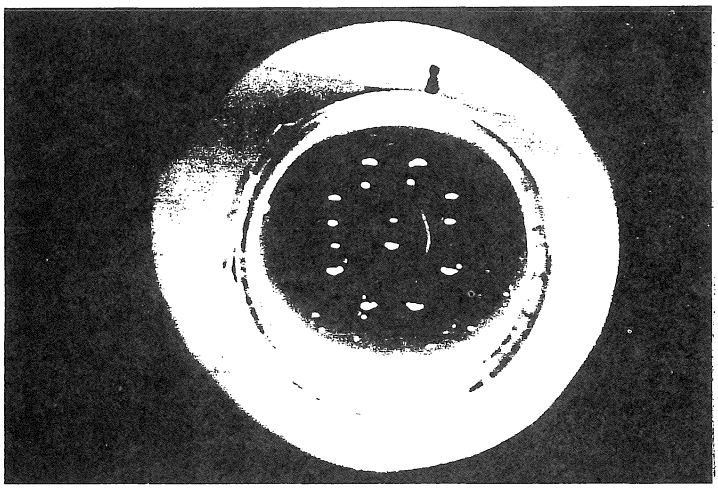

Figure 1b.

Figure 1a. Diagram of the agar plate for an immunodiffusion assay showing the contents of each well. Diamter of a plate is 35 mm. Each well has a diameter of 2 mm. Volume of a well is approximately 3.5 µl.

Figure lb. Photograph of a precipitin band formed between the serum of a lesser kudu and Protein A. In this case precipitin bands have formed between the wells containing protein A at a 1:20 dilution and whole serum B, protein A at a 1:10 dilution and whole serum B as well as protein A at a 1:10 dilution and serum B at a 1:10 dilution.
The concentric rings of light and darker gray around the agar plate are due to the indirect lighting involved in taking the picture.

WAVE TRAPPING IN A STRING-VIBRATING STRING SYSTEM

(Received May 1993; accepted for publication July 1995)

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Abstract: The behavior of waves in a semi-infinite string which has a linear spring attached to it is analyzed in the frequency and time domain. In the case of forced oscillations, it is found that waves are trapped between the spring and the end of the string and that the amplitude of the oscillations between the spring and the wall can be much larger than the amplitude of the incident waves. The solutions are compared to those previously found for waves trapped between a mass and a wall.

Introduction

In a previous paper[1], this author considered the dynamics of a semi-infinite vibrating string in which wave-trapping occurred between a point mass M and the fixed end of the string. It was found that resonant behavior could occur between the mass and the wall. These resonances occurred at approximately equal frequency intervals and had amplitudes which increased linearly with the frequency.

In this paper, a similar system is considered, but the mass M is replaced with a spring of spring constant K. The analysis follows along similar lines, but it is found that the resonances decrease in amplitude with increasing frequency.

Applications of resonant cavities to various fields of physics are described in the previous paper. The reason for considering a simple system is that the mathematical details are reasonably simple, thus providing a better understanding of the trapping phenomena.

Transmission Properties

Before looking at the semi-infinite string, it is helpful to look at the effect of a spring on progressive waves in an infinite string. The physical situation is illustrated in Fig. 1. A spring whose spring constant is K is attached transversely to the string at $x = 0$, in such a way that a restoring force Ku is exerted by the spring when the displacement of the string is u. In actual practice this could be achieved by attaching two counteracting springs at $x = 0$, adjusted so they balance with $u = 0$. Then $K = K_1 + K_2$ where K_1 and K_2 are the spring constants of the two springs. The figure shows this implementation with $K_1 = K_2 = K/2$. At every x other than $x = 0$, the system obeys the wave equation

$$\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0 \qquad (1)$$

where u is the transverse displacement of the string and c is the speed of wave propagation on the string and is related to the tension, F_T and the mass per unit length ρ through the relation

$$c^2 = F_T/\rho. \tag{2}$$

At x = 0, the force exerted by the spring must be balanced by the net force exerted by the string, since there is no point mass to be accelerated. Thus, there is a discontinuity in the derivative of u at that point. For small displacements u, a balance in the transverse forces requires that

$$F_T[(\frac{\partial u}{\partial x})_{0+} - (\frac{\partial u}{\partial x})_{0-}] = Ku(0). \tag{3}$$

For monochromatic waves of frequency ω and wavenumber $k = \omega/c$, these equations become

$$\frac{d^2u}{dx^2} + k^2u = 0 \tag{4}$$

and

$$(\frac{du}{dx})_{0+} - (\frac{du}{dx})_{0-} = Ku(0)/\rho c^2 \tag{5}$$

In particular, for a wave of unit amplitude incident from the left,

$$u(x) = e^{ikx} + Re^{-ikx}, \qquad x < 0 \tag{6}$$

and

$$u(x) = Te^{ikx}, \qquad x > 0 \tag{7}$$

Since the displacement is continuous at x = 0,

$$1 + R = T, \tag{8}$$

and, from Eq. (5),

$$ik\,T - ik\,(1 - R) = K\,T/\rho c^2 \tag{9}$$

Solving

$$T = k/(k + ik_o) \tag{10}$$

and

$$R = -ik_o/(k + ik_o) \tag{11}$$

where

$$k_o = K/2\rho c^2 \tag{12}$$

Figure 2 shows |R| and |T| plotted against k/k_o. The curves for a point mass are exactly the same except that |R|, and |T| are reversed. Thus, while the mass-loaded system is a barrier to short waves and basically transparent to long waves, the spring is a barrier to long waves and transparent to short ones. In the terminology of filters, the mass is a low-pass filter while the spring is a high pass filter. Thus, it can be expected that if waves are incident on a wall and a spring is placed at some distance from the wall, high frequency waves will pass by the spring and reflect from the wall as if the spring were not present. Low frequency waves, on the other hand, would not get through easily in either direction. Since energy leakage occurs, the amplitude remains bounded, and the behavior of the system is similar to that of a damped harmonic oscillator, with radiation providing the damping mechanism. A standing wave forms between the wall and the spring, and the amplitude of the standing waves can be much larger than the amplitude of the incident waves. The behavior is similar to that of forced oscillations in a damped harmonic oscillator, with radiation providing the damping mechanism.

Harmonic Response of the System

To analyze the case of the semi-infinite string in detail, let the spring be located at $x = 0$ and the fixed point at $x = -a$. Take

$$u = e^{-ikx} + Be^{ikx}, \qquad x > 0 \tag{13}$$

and

$$u = A \sin k(x + a), \qquad 0 > x > -a \tag{14}$$

Then, the continuity condition requires that

$$1 + B = A \sin ka \tag{15}$$

and from Eq.(5)

$$- ik(1 - B) - k A \cos ka = K(1 + B)/F_T \tag{16}$$

Solving for A and B,

$$A = -2i/(e^{-i\theta} + \gamma \sin \theta/\theta) \tag{17}$$

and

$$B = -(e^{+i\theta} + \gamma \sin \theta/\theta)/(e^{-i\theta} + \gamma \sin \theta/\theta) \tag{18}$$

where $\theta = ka$ and $\gamma = Ka/F_T$.

No energy is absorbed at the rigid wall, so all of the energy incident on the wall is always reflected. Under steady state conditions, no energy buildup occurs in the space between the spring and the wall, so that $|B|$ must be equal to 1. Equation

(18) agrees with this. The magnitude of A is the amplitude of the wave in the region between the wall and the spring. The maxima of |A| are located at the minima of the denominator, and these occur when

$$(\cos\theta + \gamma \sin\theta/\theta)(\cos\theta + \sin\theta/\theta) = \sin^2\theta \qquad (19)$$

In contrast with the case of the point mass, it is not possible to find simple approximate expressions for the location and magnitude of the maxima. However, for large n, they are located near

$$\theta_n = n\pi - \pi/4 \qquad (20)$$

at which points

$$|A| = 2/[1 - \gamma/\theta_n + \gamma^2/\theta_n^2]^{1/2} \qquad (21)$$

provided $\theta_n >> \gamma$.

Figures 3, 4, and 5 show calculated values of |A| plotted versus ka for different values of Ka/F_T. It can be seen that, in agreement with the discussion given earlier, the amplitude of the resonances decreases as the frequency increases, and the effect is more pronounced as the spring becomes stiffer.

Time Domain Analysis

To analyze the decay of waves initially trapped between the spring and the wall, take

$$u = e^{-st} \sinh s(x + a)/c, \qquad 0 > x > -a \qquad (22)$$

$$u = f(t - x/c), \qquad x > 0 \qquad (23)$$

and

$$u = 0. \qquad x > ct. \qquad (24)$$

These expressions satisfy the condition that $u = 0$ at the wall, and a radiation condition for the region outside the "cavity" region between the spring and the wall.

To satisfy the continuity condition at $x = 0$,

$$f(t) = e^{-st} \sinh sa/c. \qquad (25)$$

A continuity requirement at $x = ct$ will be deferred until later.

To satisfy the force conditions at the spring, it is necessary that

$$F_T(s/c)(\sinh sa/c - \cosh sa/c) = K \sinh sa/c \qquad (26)$$

Let $z = sa/c$. Then Eq.(26) becomes

$$-e^{-z} = (K/\rho cs) \sinh z,$$

$$= (K/2\rho cs)(e^{z} - e^{-z}), \tag{27}$$

Thus

$$e^{2z} = 1 - 2\rho cs/K$$

$$= 1 - 2z/\gamma \tag{28}$$

Equation (28) has only one real root, $z = 0$, which corresponds to no disturbance. Setting $z = \alpha + i\beta$,

$$e^{2\alpha} \cos 2\beta = 1 - 2\alpha/\gamma \tag{29}$$

and

$$e^{2\alpha} \sin 2\beta = -2\beta/\gamma \tag{30}$$

If α is negative, then the right hand side of Eq.(29) is greater than one, while the left side is less than one, so α must be positive. If β is replaced by $-\beta$ in Eq.(30), the equation remains unchanged, showing that the solutions of Eq.(28) occur in complex conjugate pairs and that they have a positive real part. Thus, the solutions decay in time.

Because the solutions occur in conjugate pairs, $\alpha \pm i\beta$, it is possible to superpose them in such a way that the remaining condition, continuity at $x = ct$, can be satisfied.

Let $\omega = \beta c/a$ and $\varepsilon = \alpha c/a$. Taking u as a superposition of the real and imaginary parts of the expression in Eq.(22),

$$u = Ae^{-\varepsilon t} (\cos \omega t \sinh (\varepsilon(x + a)/c) \cos (\omega(x + a)/c)$$

$$+ \sin \omega t \cosh (\varepsilon(x + a)/c) \sin (\omega(x + a)/c))$$

$$+ Be^{-\varepsilon t}(\cos \omega t \cosh (\varepsilon(x + a)/c) \sin (\omega(x + a)/c)$$

$$- \sin \omega t \sinh (\varepsilon(x + a)/c) \cos (\omega(x + a)/c)),$$

$$0 > x > -a \tag{31}$$

Thus

$$f(t) = u(0,t)$$

$$= Ae^{-\varepsilon t}(\cos \omega t \sinh \varepsilon a/c \cos \omega a/c + \sin \omega t \cosh \varepsilon a/c \sin \omega a/c$$

$$+ Be^{-\varepsilon t}(\cos \omega t \cosh \varepsilon a/c \sin \omega a/c - \sin \omega t \sinh \varepsilon a/c \cos \omega a/c \qquad (32)$$

To make u continuous at $x = ct$ it is necessary that $f(0) = 0$, so

$$A \sinh (\varepsilon a/c) \cos (\omega a/c) + B \cosh (\varepsilon a/c) \sin (\omega a/c) = 0 \qquad (33)$$

This sets a condition on the ratio of B/A and the resulting functions satisfy all the conditions necessary for a solution.

Discussion

The system consisting of a semi-infinite string and a spring exhibits the characteristics of a cavity resonator. For a fixed amplitude of incoming waves, the steady-state amplitude of the standing waves in the cavity region exhibits a series of nearly equally-spaced peaks. The larger peaks occur at low frequencies, when waves have greater difficulty entering and leaving the cavity area. Increasing the stiffness of the spring also makes it more difficult for waves to be transmitted, and corresponding peaks become higher as the stiffness is increased.

References

[1] Venezian, G., "Resonances in a simple continuous system," *Transactions of the Missouri Academy of Science,* Vol. 26, 1992.

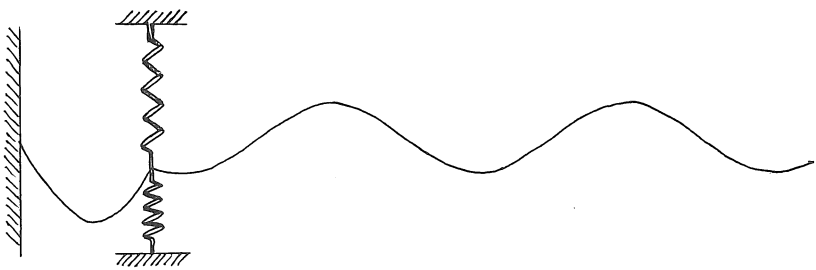

Figure 1. Geometry of the system.

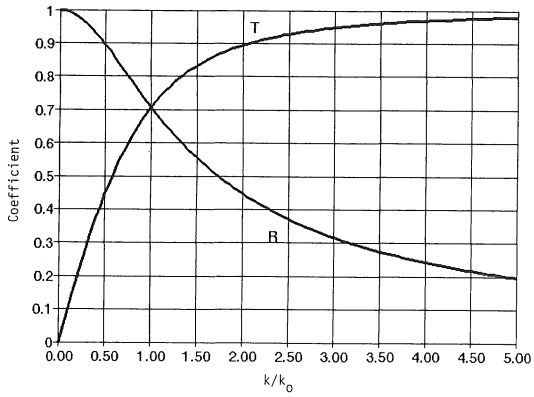

Figure 2. Reflection and Transmission Coefficients vs k/k_o

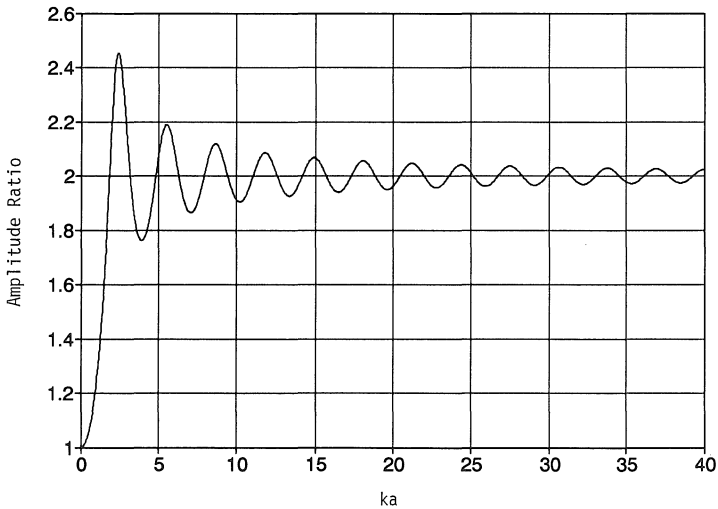

Figure 3. Ratio of Amplitude of Trapped Wave to Amplitude of Incident Wave vs ka for $\gamma = 1$

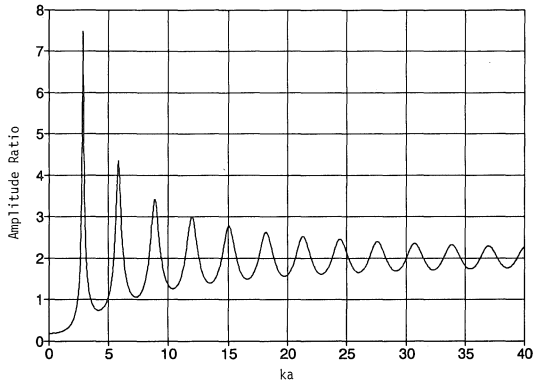

Figure 4. Ratio of Amplitude of Trapped Wave in Amplitude of Incident Wave vs ka $\gamma = 10$

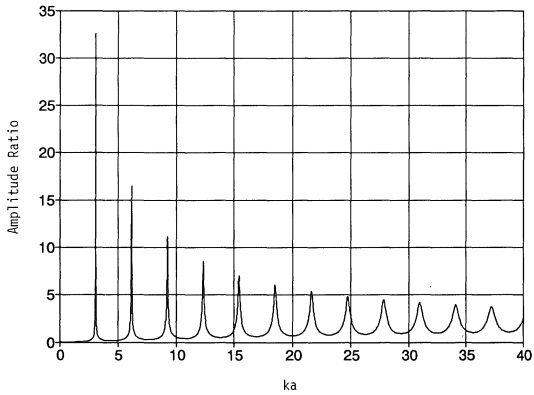

Figure 5. Ratio of Amplitude of Trapped Wave to Amplitude of Incident Wave vs ka for $\gamma = 50$

CHROMIUM (VI) ADSORPTION ON SOILS

(Received October 1993; accepted for publication August 1995)

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Abstract: Chromium is a highly toxic transition metal capable of existing as a relatively inert chromic species and as a highly toxic, mobile chromate species. This study was conducted to observe the effects of pH and phosphate on chromate adsorption in whole soil. Using chromate adsorption isotherms, chromate was partitioned between the aqueous and solid phases. Acidic soil horizons exhibited greater chromate adsorption, which was attributed to an enhanced protonation of the soil's native Al- and Fe-oxide systems. Phosphorus, present as a competing co-solute, did not influence chromate adsorption, a result attributed to a larger population of surface sites than potentially reactive $HCrO_4^-$ and $H_2PO_4^-$ species. It was speculated that organic carbon in surface horizons partially reduced some of the Cr(VI), resulting in higher adsorption values. The Mintega2 simulation model suggests that protonated sites on Fe-oxides and montmorillonite interact with $HCrO_4^-$.

Key Words: Chromium, adsorption isotherms, phosphorus.

Introduction

Bartlett and Kimble (1976) investigated the influence of pH, phosphate and organic matter on the solubility and oxidation-reduction behavior of chromate. They observed that organic matter functioned as an effective electron donor, promoting chromate reduction, while phosphate co-adsorption effectively inhibited chromate adsorption. Bartlett and James (1979) subsequently demonstrated that Mn(IV) would effectively oxidize Cr(III), demonstrating that the more mobile chromate species could be generated in an oxic soil environment.

James and Bartlett (1983) differentiated between chromate's total adsorbate concentration and that displaced by a 10mM K-phosphate buffer, demonstrating differences in Cr(VI) bonding. Gallic acid, an effective reducing agent, was shown to alter adsorbed chromate to Cr(III). Thus, their work suggests that chromate bonding likely involves multiple surface sites and that a range of bonding affinities exist. Eary and Rai (1991) observed that Fe(II) would reduce chromate to Cr(III) in acidic soil environments, forming noncrystalline Fe,Cr mixed hydroxides.

Davis et at., (1978) published a potentiometric method for determining the intrinsic ionization of an oxide surface and for estimating complexation constants, thus permitting surface complexation and pH to have a combined role in the development of surface charge. Providing that an accurate selection of reaction mechanisms completely describes the adsorption phenomena, then this model and similar models may quantitatively describe anionic adsorption onto oxides and clay surfaces.

Goldberg and Sposito (1984) applied the constant capacitance model to the adsorption of phosphate onto Al-oxides. In their usage of the model, two surface proton-dissociation constants, three phosphate complexation constants and a capacitance density parameter were required to quantitatively describe phosphate adsorption. Subsequently, Motta and Miranda (1989) effectively modeled molybdate adsorption onto kaolinite, montmorillonite and illite using the constant capacitance model. Similarly, Singh and Mattigod (1992) modeled boron adsorption onto kaolinite.

Ainsworth et al., (1989) studied chromate adsorption onto Al-substituted Fe-oxides and proposed that proton consumption during chromate adsorption was because of background electrolyte surface reactions, as well as the more traditional surface ionization reactions. Zachara et al., (1988) created pH-chromate adsorption envelopes, using kaolinite as the adsorbing substrate. Protonation of $CrO_4^{=}$ was proposed to explain the observed increased adsorption at lower pH intervals. The authors also observed that sulfate did not significantly affect chromate adsorption if the sulfate concentration was approximately equivalent to the chromate concentration, suggesting that sulfate and chromate are attracted to different reactive sites. Excess sulfate effectively decreased chromate adsorption, suggesting anionic competition is a factor at higher levels of surface coverage. Zachara et al., (1989) investigated chromate adsorption in the presence of reactive co-solutes and at different pH levels. Chromate adsorption increased if the pH was lowered, especially if the reactive sites were associated with kaolinite or crystalline Fe-oxides. Sulfates and carbonate anions were shown to effectively inhibit chromate adsorption.

Makami et al., (1983) investigated chromate adsorption on synthetic Al-oxides, particularly in alkaline media. They proposed two Cr(VI) complexation products at the Al-oxide surface: $AlOH_2$-$HCrO_4$, and $AlOH_2$-CrO_4. The former product predominates in more acidic interfaces.

The purpose of this investigation is to describe the extent of chromate adsorption on montmorillonite-containing soils differing in pH. A secondary purpose is to investigate competitive chromate adsorption in the presence of phosphate.

Materials and Methods

Soil materials were selected to provide a range of soil reaction (pH), without providing a high degree of variation in soil texture, Fe-oxide content, clay mineralogy and other soil parameters. Soil materials were sampled from soil pits using standard methods (Soil Survey Staff, 1984). Three pedons, representing soils from the Crowley series (Fine, montmorillonitic, thermic Typic Albaqualfs), the Calhoun series (Fine-silty, mixed, thermic Typic Glossaqualfs), and the Foley series (Fine-silty, mixed, thermic Albic Glossic Natraqualfs), were assessed for routine chemical and physical properties, as well as noncrystalline and crystalline Fe-oxides (Shuman, 1985).

Chromate equilibrating solutions were factorially designed with chromate concentration and pH as the experimental parameters. Chromate concentrations, prepared from reagent grade $K_2Cr_2O_7$, were set at either 0, 1, 2, 4, 6, 8, or 10 mg Cr(VI)/liter and were buffered to pH levels corresponding to the pH reactions of the various soil horizons. The ionic strength was standardized to 0.05 mole/liter using NaCl. The adjustment of solution pH was with additions of 0.01M HCl or 0.01M NaOH.

Chromate isotherms were prepared (replicated twice) using a batch technique. One gram of soil material was added to weighed screw-capped vials. Approximately 0.01 liter of the Cr(VI) equilibrating solutions were transferred and the vials reweighed to determine the equilibrating solution's volume. The vials were equilibrated for 48 hours at 21°C ± 1°C. Chromate analysis was by the s-diphenyl carbazide method (Bartlett and Kimble, 1976) and the chromate adsorption was calculated using the initial and equilibrium solution concentrations.

Adapting the procedure used for producing the Cr(VI) isotherms, Cr(VI) equilibrating suspensions with initial concentrations either 2 or 4 mg Cr(VI)/liter were used to determine the Cr(VI) adsorption in the presence of equal initial molar concentrations of phosphate. Only soil samples that exhibited a significant degree of Cr(VI) adsorption were employed.

Results and Discussion

Soil textures, Fe-oxide concentrations, and organic carbon contents vary only within a narrow range among the various soil horizons (Table 1). The Crowley series has the greatest clay content expression, particularly in the argillic (Btg) horizons, while the Calhoun and Foley series have similar silt loam textures. The oxalate extractable Mn and Fe concentrations are quite low, suggesting that these high surface area fractions will not dominate the surface chemistry stochiometry. However, sufficient iron oxides exist to provide a variable charge surface for Cr(VI) adsorption to be potentially a significant soil reaction.

Soil reaction varies from very strongly acid (pH 4.8 in the Eg horizons of the Crowley series) to moderately alkaline (pH 8.3 in the Btg4 horizon of the Foley series). The range of pH values among the various soil horizons provides an acceptable pH distribution to assess the influence of pH on Cr(VI) reactivity.

All isotherms reveal that the Cr(VI) adsorption is somewhat directly proportional to the Cr(VI) solution concentration. For soil horizons showing a relatively high degree of Cr(VI) adsorption, no evidence of Cr(VI) saturation of the surface sites is evident, as revealed by the lack of a distinctive adsorption plateau. The isotherms for the Crowley (Figure 1) and Foley (Figure 2) series show that Cr(VI) adsorption is greater for the strongly acid eluvial horizons (Eg), while the acidic and neutral Btg horizons show markedly reduced adsorption values. The Crowley's neutral Ap has appreciable organic carbon and may be effectively reducing Cr(VI) to Cr(III). The adsorption isotherms for the Calhoun series (Figure 3) are quite similar, as are the soil pH levels.

The chromate adsorption isotherms for the Crowley, Calhoun and Foley series strongly suggest that pH is a major variable for predicting the apparent chromate adsorption. Using the equilibrium chromate concentration of 0.1 mmol/dm^3 for the aqueous phase as a basis, the coefficient of correlation for the Cr(VI) adsorption with solution pH is -0.819. Hence, the extent of the Cr(VI) adsorption is inversely correlated with the solution pH. Conversely, organic carbon, oxalate extractable Mn and Fe, oxalate-ascorbic acid extractable Mn and Fe, and clay content were not suitable as predictors of the Cr(VI) adsorption.

Chromate adsorption was either slightly decreased or unaffected when $H_2PO_4^-$ - $HPO_4^=$ was present as a co-solute (Table 2). Thus, $H_2PO_4^-$ - $HPO_4^=$ did not retard Cr(VI) adsorption. Given the observation that the Cr(VI) isotherms did not show an adsorption maximum suggests that the population of surface sites exceeded the combined concentrations of the competing anions.

The detailed treatment of aqueous-solid interfacial phenomena frequently requires the simultaneous assessment of the chemical speciation of the solution phase as well as the charge composition and distribution within the interfacial region. Chromate protonation ($HCrO_4^-$) is substantial in acidic media, while $CrO_4^=$ is considered to be the dominant species in neutral to alkaline solutions (Baes and Mesmer, 1976). Noting that the dimeric species [$Cr_2O_7^=$] is unstable in the dilute concentrations employed in this investigation and using the thermodynamic data of Baes and Mesmer (1976) the concentration of $HCrO_4^-$ in dilute solutions is approximated using:

$$\text{Total Cr} = [HCrO_4^-]\{1 + 10^{-6.51}/[H]\} \qquad 1.$$

Hence, a pH centered around 6.5 roughly indicates the concentration equivalence of the $HCrO_4^-$ and $CrO_4^=$ species.

The chemical speciation model MINTEQA2 (Allison et al., 1991) was employed to simulate the solution equilibria and calculate the distribution of chromate species in the aqueous phase. Underlying the model's calculations were the assumptions that equilibrium conditions were established and that chromate reduction was not appreciable. The total chromate concentration was set at 1.9 x 10^{-5} M and the possible Cr containing species included: $Cr_2O_7^=$, $CrO_4^=$, $NaCrO_4^-$, $KCrO_4^-$, $HCrO_4^-$, and H_2CrO_4. The pH was standardized at 4.0 and at 6.0. Dichromate and the ion-pairs sodium chromate and potassium chromate were not important species. In acidic conditions (pH = 4) $HCrO_4^-$ accounted for 99% of the chromate in the aqueous phase, while at near neutral conditions (pH = 6) the activities of $CrO_4^=$ (6.59×10^{-6}) and $HCrO_4^-$ (9.53×10^{-6}) are nearly equivalent.

Chromate adsorption sites most likely arise from protonated exposed oxygen groups on the broken edges of phylloslicates and protonated surface hydroxyl sites of Al- and Fe- oxides and oxyhydroxides (Barrow, 1987). Such chemical phenomena can be written as:

$$SOH_2^+ = SOH + H^+ \qquad 2.$$

$$SOH = SO^- + H^+ \qquad 3.$$

S = Al- or Fe- reactive surface sites

Equation 2 becomes increasingly more important in acidic media; therefore, the Fe- and Al- oxide surfaces acquire net positive charge distributions at pH = 4. Hence, chromate adsorption in soil should involve a pH-dependent complex formation similar to that observed on synthetic Al oxides (Makami et al., 1983; Zachara et al., 1989).

The modest Cr(VI) adsorption for the organic carbon enriched Ap horizons is likely attributed to both adsorption and reduction. The level of Cr(VI) adsorption in these horizons is greater than that suggested from using only pH as a predictive criterion. No chromium(III) was detected on the clay surface using an unbuffered KCl extraction; however, Cr(III) hydrolysis would likely polymerize any free Cr(III) to a non-extractable $Cr(OH)_x$ species.

Summary

Chromate adsorption on soil materials was shown to be substantially influenced by pH and organic matter. The effect of low pH was to increase Cr(VI) adsorption, while organic carbon was suggested to promote the reduction of Cr(VI) to Cr(III). Laboratory data and Mintega2 simulation using whole soils are similar to the results previously obtained using reference minerals (Zachara et al., 1988, 1989). Phosphorus as a co-solute did not appreciably influence Cr(VI) adsorption, suggesting that the population of available surface sites exceeded the amount of competing Cr(VI) and H_2PO_4. Thermodynamic simulation suggests that protonated oxide surface sites complex with $HCrO_4^-$ to create a stable complex.

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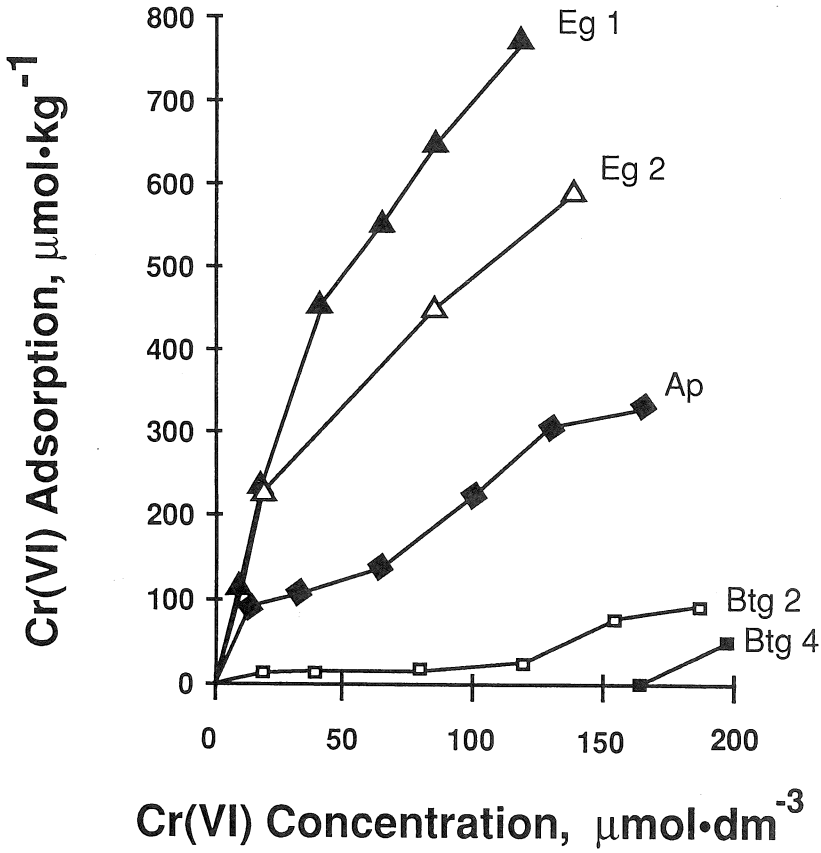

Figure 1. Chromate adsorption isotherms for five soil horizons from the Crowley Series

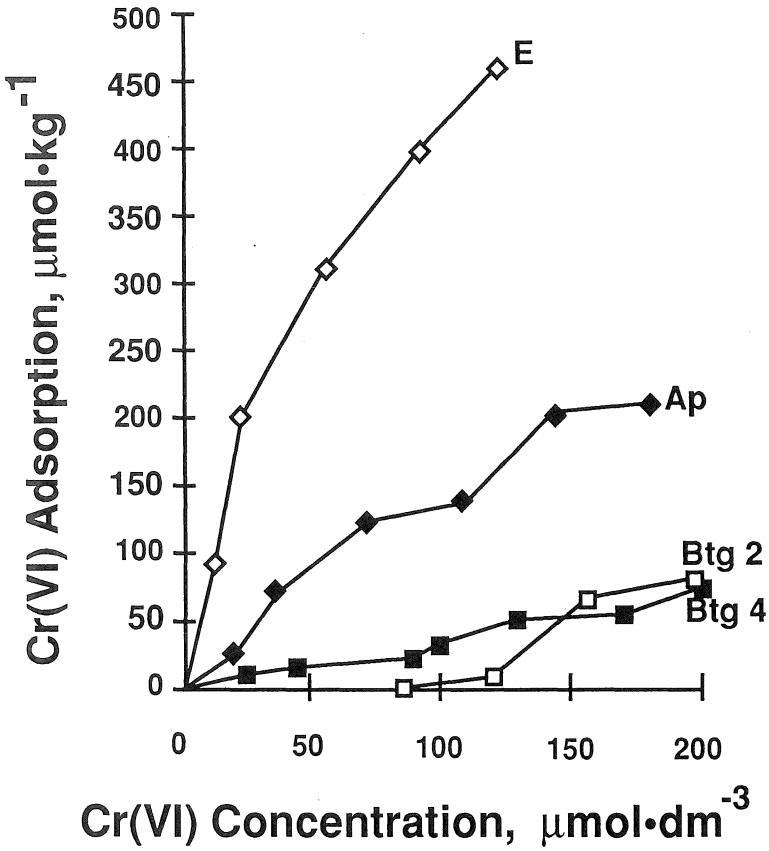

Figure 2. Chromate adsorption isotherms for four horizons from the Foley soil series

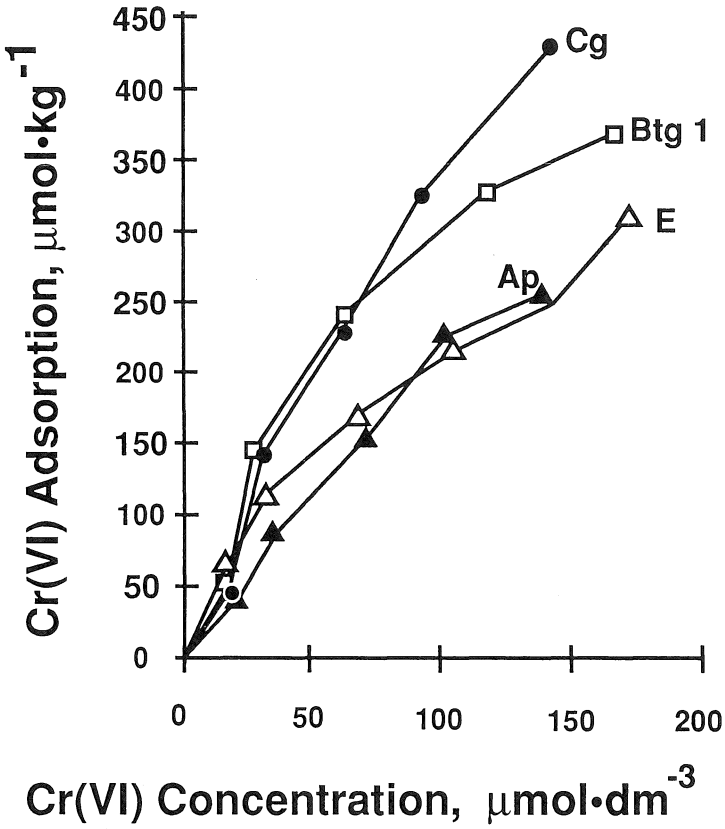

Figure 3. Chromate adsorption isotherms for four horizons from the Calhoun soil series

TABLE 1. Selected chemical and physical properties from three soils.

Horizon	pH	Clay <0.002 mm	Silt 0.05–0.002 mm	Exchangeable cations					Organic Carbon	Fe and Mn Fraction			
										Oxalate		Oxalate + Ascorbic Acid	
				Na	K	Ca	Mg	Acidity		Mn	Fe	Mn	Fe
	(H_2O)	%	%	c mol·kg^{-1}					%	g·kg^{-1}			
								Crowley					
Ap	6.8	29.2	58.0	0.3	0.9	12.8	6.9	7.8	1.7	0.81	1.85	1.44	12.9
Eg 1	4.8	35.5	58.1	0.7	0.2	2.9	5.9	13.3	0.1	0.09	1.35	0.13	14.5
Eg 2	4.8	38.4	55.6	1.5	0.3	2.4	10.6	12.4	0.1	0.03	1.19	0.09	14.8
Btg 2	5.6	47.9	49.6	3.2	0.4	5.8	22.0	7.4	0.2	0.11	0.42	0.12	9.4
Btg 4	7.3	44.5	51.6	3.0	0.4	6.8	23.5	3.2	0.1	1.08	0.85	1.40	9.0
								Calhoun					
Ap	5.4	19.4	77.0	0.1	0.2	4.3	2.0	7.3	1.0	0.16	1.57	0.31	7.8
E	5.3	14.3	81.7	0.2	0.1	2.4	1.2	5.6	0.2	0.07	0.97	0.06	7.0
Btg 1	5.0	23.4	73.7	0.3	0.1	2.9	2.4	8.6	0.2	0.05	0.80	0.08	4.6
Cg	5.7	22.2	72.8	2.3	0.2	3.8	4.7	6.1	0.1	0.13	0.66	0.21	9.1
								Foley					
Ap	6.5	11.2	69.3	0.6	0.4	4.7	3.5	2.4	0.5	0.26	0.73	0.44	8.2
E	5.3	26.0	64.1	3.4	0.3	4.5	5.0	9.3	0.2	0.08	0.58	0.12	7.4
Btg 2	7.2	26.3	59.3	8.8	0.4	5.4	7.8	5.1	0.1	0.08	0.84	0.19	9.8
Btg 4	8.3	24.1	66.0	10.4	0.5	6.6	9.3	2.9	0.1	0.96	1.24	1.30	13.9

Table 2. Chromium (VI) adsorption on selected soil horizons

Horizon	Cr (VI) Adsorption			
	2mg Cr(VI) / l		4mg Cr(VI) / l	
	control	H_2PO_4	control	H_2PO_4
	μ mol Cr (VI) · kg^{-1}			
	Crowley Series			
Ap	170	140	270	250
Eg^1	300	290	520	480
Eg^2	310	270	500	500
	Calhoun Series			
Ap	290	220	490	480
E	190	200	320	280
Btg^1	230	210	380	390
Cg	200	200	360	300

MISSOURI ACADEMY OF SCIENCE

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Kansas City, Missouri

ABSTRACTS OF PAPERS PRESENTED BY SENIOR AND COLLEGIATE DIVISIONS

ABSTRACTS OF PAPERS PRESENTED AT MAS/MSS SPELEOLOGY SYMPOSIUM

Senior Division

Agriculture and Entomology

Carrel, J. E. Division of Biological Sciences, Missouri University-Columbia. BURROWS OF WOLF SPIDERS IN FLORIDA SCRUB HABITAT. Some spiders endemic to pine-oak scrub throughout central Florida are regarded as rare and a few of them may be threatened by current land management practices that discourage fire and encourage development. For eight years I have been studying the natural history of five wolf spiders (Arancae: Lycosidae) in slash pine scrub at the Archbold Biological Station in Highlands County, south of Lake Placid. The rare Archbold wolf spider, *Geolycosa xera archboldi*, and the common micanopy wolf spider, *G. micanopy*, both construct vertical retreats that are shaped like a bud vase or a small volumetric flask sunken in the sandy soil. The wolf spider *Lycosa ceratiola* excavates a simple, tubular burrow that extends vertically for several cm in sand. A related species, *L. ceratiola*, one of the largest wolf spiders in North America, builds a burrow that curves backwards to form a large cavernous retreat beneath shrubs and tree roots. In contrast, the Lake Placid wold spider, *Sossipus placidus*, builds an unusual funnel-shaped web that opens into a retreat or burrow made by a small mammal or another animal. I suspect *G. xera* and *S. placidus* are rare or threatened species, unlike the other three, because both are particularly adapted to open sand scrub habitat that is maintained by frequent wildfires.

Edwards, R.M., D.E. Terry and K.A. Callahan. Department of Agriculture, Central Missouri State University. CONSUMERS' PREFERENCES FOR MISSOURI WINES: A SURVEY OF MISSOURI'S METROPOLITAN REGIONS. From 1,898 surveys, consumers' preferences and attitudes toward Missouri wines were evaluated. Samples from the two major metropolitan areas of Kansas City and St. Louis were compared. Objectives were to determine if statistical differences between Kansas City and St. Louis samples existed in relationship to: (1) occasions for drinking wine; (2) perceived quality and value of Missouri wines; (3) incentives to purchase wine made in Missouri; (4) the ability to recall the names of Missouri wineries; and (5) familiarity with Missouri wines. The results indicated significant differences in the perceived quality and value associated with Missouri wines. Over 50% of St. Louis respondents rated Missouri wines as excellent, while less that 8% of Kansas City respondents rated the quality and value of Missouri wines as equally high. Also, results indicated that St. Louis respondents possessed a significantly greater familiarity with Missouri wines. In general, it appears that St. Louis consumers are more sensitive to quality and value of wines. They also seem more knowledgeable about Missouri wines. Further studies could be conducted to evaluate possible effects of additional advertising on awareness and perception of Missouri wine in Missouri's metropolitan areas.

Knueven, T.L. and D.E. Allen, Jr. Department of Agriculture, Central Missouri State University. A COMPARATIVE STUDY AMONG FOUR COMMERCIAL BROILER DIETS. This study was undertaken to examine the relationships among the costs of broiler starters and their subsequent effects on chick performance. Also under investigation was the effect of the antibiotic Amprolium. One hundred and eighteen, day-old broiler cockerels were randomly alloted to 16 wire mesh pens where they were fed one of four commercial broiler diets. Each diet was then replicated four times in a Latin Square design. Purina, Farmland, Wayne, and MFA brand broiler starters were fed *at libitum* for 21 days. Feed usage and chick weights were recorded weekly to determine growth weights and feed usage. Chicks fed the Farmland and MFA diets used significantly more feed than the Wayne diet ($P<.01$), however no significant difference in the overall growth rate from the four diets was noted ($P<.01$). The presence of the coccidiostat Amprolium had no effect on the health of the chicks ($P<.01$). Supported by a Willard North Research Award.

McElroy, D.L., D.E. Terry and F.D. Worman. Department of Agriculture, Central Missouri State University. CUSTOMER PREFERENCE IN DIEFFENBACHIA (DUMBCANE) PLANT SALES INVOLVING CARE TAGS AND THE POT TO PLANT SIZE RELATIONSHIPS. This study was conducted in the form of a plant sale targeting college students to ascertain their preference on care tags and the relationship between pot size and plant size. Forty-five of sixty-eight plants were sold. The plants were split into eight groups and were color coded to record sales more accurately. Tests were run on individual factors such as the amount of time it took to sell each plant, pot size, plant size, presence or absence of tags, and gender. Males bought 29% and females purchased 71% of the plants sold; however there was no statistically significant relationship between the gender and specific group sales. In fact, none of these factors were significantly different from one another at .05 level. This study suggests that other factors which were difficult to control, such as individual plant variations, were very inherent in plant sales.

Nichols, B.J. and R.W. Sites. Department of Entomology, University of Missouri. AQUATIC INSECT COMMUNITY STRUCTURE IN RELATION TO LANDSCAPE AND HABITAT. Three streams in the Meramec River Basin were sampled at quarterly intervals for one year (1992-93) to obtain data on species assemblages and community structure of lotic insects. Each steam was examined in a cleared/grazed watershed, containing a narrow natural riparian zone, and in a forested area. Within these landscapes, quantitative samples were taken with a Surber sampler in riffles and marginal areas of the stream. These land use patterns appear to have an influence on lotic insect species assemblages. Analysis of variance revealed significant differences in lotic insect densities among the three rivers. With discriminant function analysis (DFA), pairwise F-tests resulted in significant differences in taxonomic community composition between forested and grazed landscapes of all rivers. Nearly 50% of the total taxa collected were Ephemeroptera, with *Stenonema mediopunctatum, S. femoratum,* and *Trikcorythodes sp.* being the most commonly collected. Future work will involve elucidation of the life history patterns of this group.

Wilson, M.A., Department of Agriculture, Southeast Missouri State University and **Victor Khan** and **Clauzell Stevens**. George Washington Carver Experiment Station, Tuskegg University. RESPONSE OF ROW COVERS ON EARLINES AND YIELD OF TWO POTATO CULTIVARS. Our studies have revealed four row covers on two cultivars of potatoes ('Atlantic" and "Frito-Lay 795') at Charleston, Missouri on sandy entisol. Crop covers used were spunbonded polyester, clear and white slitted and VisPore. Significant interactions occurred in the sub-plot (row cover x varieties) and sub-subplots (varieties x flower treatments) for numbers of grade A potatoes. The total numbers of potatoes for 'Atlantic' and 'Frito-Lay 795' cultivars as influenced by flower removal and row cover treatments showed significant interactions of row covers x varieties and varieties x flower treatments. Yield of grade A potatoes for both cultivars as influenced by flower removal and row cover treatments showed a significant interaction between row covers x varieties. Genetic differences occurred among potato cultivars in response to flower removal. Cultivar response to row covers was also different based on genetic makeup. The clear and spunbonded polyester row covers were superior to other types for numbers and yield of potatoes.

Yen, Jyh-herng and Terry L. Niblack. Department of Plant Pathology, University of Missouri-Columbia. THE EFFECT OF SOYBEAN MATURITY DATE ON DORMANCY OF *Heterodera glycines* IN MISSOURI. Studies were conducted to determine the effect of soybean phenology on the induction of dormancy *in H. glycine*. Dormancy was measured by determining the hatching rate of *H. glycines* and infectivity rates of hatched juveniles. Four soybean isolines differing for maturity were planted in field microplots with two initial population (Pi) density classes of *H. glycines*. Soil samples were collected from each microplot at monthly intervals. The *H. glycines* hatching rate was determined by counting the number of hatched juveniles from 1,000 eggs held in glass distilled water at 27°C for 14 days. Infectivity was determined on soybean seedlings inoculated with 1,000 eggs/100cm^3 and maintained in the greenhouse at 28°C. After 5 days, the nematodes within roots were strained with acid fuchsin and counted, and root length was determined by a line intersect method. The hatching rate of the 'HIGH' and 'LOW' Pi both decreased gradually from Auguest 1991 to June 1992, increased from June

1992 to July 1992 (HIGH Pi) or August 1992 (LOW Pi). Hatching rates differed among isolines, demonstrating an effect of host phenology on dormancy induction. The number of juveniles detected in the roots was less than 0.1 per cm and there were no differences among the four soybean isolines at either Pi. Studies are continuing through the winter in 1991 and 1992. This research was supported by the Msisouri Soybean Merchandising Council, Research agreement No. 078.

ATOMOSPHERIC SCIENCES

Zamarripa, G.T., and C.A. Perry. U.S. Geological Survey. MULTIPLE-REGRESSION ANALYSIS OF CLIMATIC FACTORS AND KANSAS REGIONAL PRECIPITTION. Variations in total solar irradiance and subsequent changes in energy available to the atmosphere through the Earth's oceans may force climate and precipitation patterns on a global scale. A multiple-regression analysis was conducted correlating several climatic factors with Kansas regional annual precipitation for 1950-88. Factors were time lagged to provide a basis for long-range precipitation forecasting. The most significant factors were the following: (1) solar-irradiance differences lagged 2 years; (2) 700-mb heights at 30 N, 120 E lagged 1 year; (3) solar-irradiance differences lagged 5 years; and (4) the Southern Oscillation Index lagged 1 year. Each of these factors proved to be more significant statistically than persistence (annual precipitation lagged one year). Solar-irradiance variations lagged 2 years were significant at the 95% confidence level in six out of the nine Kansas climate divisions. In the remaining three climate divisions, the significance was at the 90% confidence level.

BIOLOGY

Ash, R.J., E. Pardee, and R.E. Johnson. Department of Biology, Washburn University. PROTEINS OF OAK TREES. The proteins of four species of oaks were examined in an attempt to explore the phylogeny of these trees at the molecular level. A number of extraction methods were evaluated with leaves of red, black, bur, and chestnut oaks. Reproducible protein profiles were obtained by SDS gel electrophoresis of leaf extracts prepared in aqueous phosphate buffers containing protease inhibitors. Both common and unique proteins were present among the leaves studied. The patterns of leaf proteins displayed consistency over the past three years with the methods used. Major differences in profiles of spring leaf proteins compared to fall leaf proteins were evident. The proteins identified will serve as useful markers for further work. Supported by a grant from Washburn University.

Babrakzal, N. and T. Archibald. Department of Biology and the Directorate of Information Services. Central Missouri State University. INTRODUCTION OF A NEW TELECOMMUNICATION TECHNOLOGY IN BIOLOGICAL RESEARCH AND/OR INSTRUCTION. We tested the applicability of the Visual Intregrated Technology (VISIT) products (a new personal multimedia communication system, developed by Northern Telecom and being marketed by the Sprint Corporation), in biological research and instruction. Our conclusions are: (1) "Live" NTSC video output from a compound or a stereo microscope, can be connected to the VISIT hardware (a 256 grey scale frame grabber with compression/decompression capability), installed in a Macintosh llci/llsi NuBus Slot, and driven by means of the VISIT/Video utility. (2) The digital imagery is sent by a 'Data Path' communication unit (56kb/sec), connected to a business telephone via a centrally located Northern Telelcom' DMS-100 digital switch, and then to any other site. Hence, researchers thousands of miles apart can talk and view each other and/or examine various types of digital imagery in a real time mode and at a fairly low cost. (3) No appreciable loss of resolution was detected when digitized biological research/instructional images (8/24 bit color or grey scale PICT files) were sent to a distant location, by utilizing the File Exchange function of the software. (4) The digital imagery can be captured, stored, retrieved, manipulated, merged with other software applications, and hard copied by a distant location. (5) A computer graphics/image can be simultaneously viewed in an interactive way with the help of VISIT's Screen Share software function. This interface of instruction/research and telecommunication

technologies opens a new avenue of lab-to-lab conectivity, in image intensive collaborative research at distant locations.

Ellis, J.C., and D.G. Fautin. Department of Systematics and Ecology, University of Kansas. BRYOZOANS OF NORTHEAST KANSAS AND THEIR FEEDING. We have found at least three species of bryozoans in northeast Kansas, the first record of the phylum in this area. In an effort to understand the reasons for differences in their habitat distributions, we are simultaneously conducting field studies on food availability and laboratory studies on feeding. The effect on feeding of particle size, density, and composition are being studied with bryozoans that vary in size and age (both colonies and individuals), and number of tentacles (both between and within species).

Fleharty, E.D. Department of Biological Sciences and Allied Health, Fort Hays State University. HISTORICAL IMPLICATIONS AND CHARACTERISTICS OF ASSEMBLAGES OF SMALL MAMMALS IN WEST-CENTRAL KANSAS. Small mammals were trapped on four habitats; cropland, roadside ditch, pasture, and remnant grassland. The small mammal community of each of these habitats were compared on the basis of richness, evenness, diversity, and similarity. The cropland was found to most resemble the pasture. When richness, evenness, and diversity were comparison characters the ditch most resembled the remnant grassland; however, when similarity was the comparison character the ditch most closely resembled the pasture. Population dynamics, habitat preference, probable historical occurrence, and impact on human activities on individual species were also examined. The only species that was permanent in all four habitats was the deer mouse, Peromyscuss maniculatus. The cotton rat, Sigmodon hispidus was a permanent species in the remnant grassland and a semi-permanent species in the ditch. Reithrodontomys megalotis, western harvest mouse, was a transient on all of the habitats but the remnant grassland where it was a permanent species.

Fukuike, A. and K.N. Smalley. Division of Biological Sciences, Emporia State University. PREGNENOLONE METABILISM IN DEVELOPING FOLLICLES OF THE FROG,. RANA PIPIENS. Ovarian follicles of the frog, Rana pipiens, secrete estradiol early in development but switch to testosterone secretion at later stages. To study the mechanisms involved in this switch, total steroid metabolism was investigated by incubating follicles with ^{3}H-pregnenolone for 6 hours and then identifying the radioactive metabolites by thin layer chromatography. Estradiol and testosterone were the major metabolites. Estradiol made up 7-31% of the total metabolites, with the percentage decreasing in older follicles. Testosterone made up 4-40%s of total metabolites, with the percentage increasing in older follicles. Androstenedione, progesterone and estrone were also identifed. Together they made up 13-22% of total metabolites. Several peaks that did not correspond to any major metabolite are currently under investigation. Steroidogenesis in the frog ovary appears to use pathways which are similar to those described for the mammalian ovary.

Geyer, W.A. and D.F. Bresnan. Division of Forestry. Kansas State University. ENVIRONMENTAL VARIATION & WOODY BIOMASS PRODUCTIVITY IN KANSAS. Studies were conducted to evaluate the productivity of short-rotation tree plantations. Many sites representing a wide range of ecological zones in the central Great Plains were planted to 6 rapid-growing, coppicing, deciduous tree species: black locust, catalpa, cottonwood, honeylocust, silver maple, and Siberian elm. Environmental factors were tested for their relationship to biomass yield. Climate and geographic location greatly influenced biomass, while site and soil factors were poorly related. Other factors affecting 3-year productivity were days between summer storms and frost-free days. Survival was over 80 percent, and 3rd year yields, based upon nondestructive measurements, of 3 to 5 MG/ha/yr were common. Tree growth was adversely affected in the drier zones. Tree species greatly influenced yield. Many hold promise for energy production in the central plains area of the United States: elm, locust, cottonwood and maple.

Gregory, J.M., E.J. Finck, and S.L. Brown. Division of Biological Sciences, Emporia State University and Department of Biology, Southwestern University. PARASITISM RATES OF THE

BROWN-HEADED COWBIRD ON GRASSLAND NESTING BIRDS. The brown-headed cowbird (Molothrus ater), a brood parasite, has expanded its range in North America and threatens those species it parasitizes with extinction. We investigated the parasitism rates of four grassland nesting species that are hosts of the brown-headed cowbird in the Flint Hills of Kansas in four grassland habitat types: Conservation Reserve Program (CRP) fields, hay fields, fragmented pastures, and open pastures. The fragmented pastures had the lowest parasitism rates (33%), while the unfragmented open pastures had the highest parasitism rates (52%). A chi-square test indicated no significant difference in terms of parasitism rates among the four habitat types ($p>0.05$). The dickcissel (Spiza americana) had a parasitism rate of 47%, while the grasshopper sparrow (Ammodramus savannarum) had the highest rate with 55%. Supported by ESU Faculty and Research Grant and Kansas Department of Wildlife and Parks.

Hess, L.A. and D.E. Bowen. Department of Biology, Benedictine College. FEEDING PREFERENCES OF NORTHEASTERN KANSAS WOODPECKERS AND THEIR ALLIES. Surprising little has been published concerning scientific assays of woodpecker guild members in artificial settings. This study used two brush shelters in determining preference, using stumps with holes drilled by a 5/8" wood bit in four columns of four. The control held all plain raw suet and the experimentals held either plain suet or mixed with sunflower seed, mixed seed, or peanut butter (by column) and random holes within the column to test hole depth (1" or 1.5") and raw versus rent suet. Woodpeckers prefer suet mixed with peanut butter (41%), followed by plain suet (32%), with seed-mixed suet unpopular (each 14%). They prefer deeply drilled holes (70%). Thus, a person who wished to feed woodpeckers effectively could use a stump and fill deep holes with a combination of plain and peanut-butter mixed suet.

Locklear, J.H. Dyck Arboretum of the Plains, Hesston College. VASCULAR PLANT ENDEMISM IN THE GREAT PLAINS. Botanists and biogeographers have long regarded the Great Plains as a region relatively poor in endemic plants. However, an extensive literature review has revealed that there are approximately 40 taxa of vascular plants endemic to the Great Plains, some of which are rare and very poorly known by botanists. The majority of these endemics occur at the western edge of the Great Plains Physiographic Province in areas where shortgrass parairie is the dominant vegetation. Field observations of these plants have revealed that most occur in association with unique habitats. Observations of distribution, ecology, and phylogenetic relationships suggest that most Great Plains endemics are of relatively recent origin.

Mathews, P.L., and T.L. Bultman. Department of Science, Northeast Missouri State University. MATING BEHAVIOR OF A PARAJULID MILLIPEDE, ANIULUS BOLLMANI CAUSEY. Taxonomic studies of parajulid millipedes in North America have described male mating structures called gonopods, however the function of these structures had not been reported until now. This study was conducted to ascertain the function of the gonopods during mating, and to describe the use of the enlarged first pair of legs of males. Mature A. bolllmani were collected from a small woodlot in northern Missouri, and pairs were placed into chambers so that mating could be observed through a dissecting microscope. Five complete matings were observed out of 10 pairings. We found males used their enlarge first anterior pair of legs to grasp the female before and during copulation, and used their anterior and posterior gonopods articulated to transfer sperm to the female. Age distribution data from a 10 month sampling and collecting period indicate the possibility of multiple mating seasons and long maturation times for this millipede.

Merrill, G. Field Museum of Natural History. OZOBRYUM OGALENSE, A NEW MOSS GENUS FROM THE AMERICAN GREAT PLAINS. The recently described Ozobryum ogalalense is the first endemic genus of mosses to be discovered in the Great Plains, a region not known for endemism of either bryophytes or vascular plants. The plants grow in soft, compact cushions on moist lime-rich rock outcrops know locally as "mortarbeds." Ozobrykum has been collected at several stations in Decataur and Rawlins Counties, Kansas and in Hitchcock County, Nebraska. Male plants and sporophytes are unknown. The ecology, relationships, and biogeographbical significance of the species are discussed.

Mills, S.H. and E. VanTol. Department of Biology, Central Missouri State University. RESPONSES TO COOLING IN THE 13-LINED GROUND SQUIRREL BEFORE AND AFTER HIBERNATION. Nine ground squirrels (Spermophilus tridecemlineatus) were exposed to 20 minute intervals of 25, 20, 15, and 10°C ambient temperatures before and after hibernation. The animals' temperature responses were monitored via computer interface. Behavior was monitored by video recording. Body temperatures detected by abdominal transmitters were significantly higher before hibernation compared to after hibernation using analysis of covariance with state as the covariant ($p<0.05$). These temperatures differed significantly over time as ambient temperature was changed ($p<0.05$). Before hibernation, ground squirrels were less active and more lethargic. Ambient cooling elicited increased activity and oscillations in skin temperatures. Before hibernation ground squirrels were more passive and succeptible to cooling. Standing, reclining, and remaining burrowed were most prevalent. After hibernation, activity was higher and core temperature decreased less following ambient cooling. Ball posture, reclining, and burrowing were increased after hibernation. Anterior skin temperatures (AST) were higher than posterior (PST) before and after hibernation. Although PST decreased rapidly at 10°C before hibernation, it was more constant at 10°C after hibernation. The AST's were significantly higher than PST before and after hibernation. ($p<0.05$). Behavior and posture also varied over the temprature exposures as the animals were compared before and after hibernation ($p<0.05$).

Newfeld, G.J., L.L. Heskett and J.A. Holland. Divison of Biological Sciences, Emporia State University. MITOCHONDRIAL AND MICROSOMAL BICORBONATE-ATPASE IN GILLS OF *ORCONECTES NAIS*. It is well established that an ATP-driven cation pump (Na,K-ATPase) in gills of many aquatic organisms contributes to osmoregulation. An ATPase which transports anions has been proposed for anion-transporting tissues from several sources but the studies have been inconclusive and controversial. Anion ATPase activity may be contamination of microsomes by mitochondrial fragments from homogenization and represents F_1 -ATPase. Microsomes and mitochondria were prepared from gills of the crayfish, *Orconectes nais*. Anion ATPase was measured using bicarbonate as anion and ATP as substrate. Responses to the inhibitors thiocyanate, oligomycin, azide, vanadate, ouabain, and PCMBS were virtually identical. Cytochrome c oxidase (mitochondrial inner membrane enzyme) was present in the microsomes. K_m values for bicarbonate and ATP suggested the same enzyme. These microsomal preparations appeared to be contaminated with mitochondrial fragments. It maybe, however, that a plasma membrane anion ATPase was overwhelmed by the mitochondrial enzyme.

Osborn, J.M., C.J. Smith, and T.N. Taylor. Division of Science, Northeast Missouri State University and Department of Plant Biology, The Ohio State University. STRUCTURALLY PRESERVED SPHENOPHYTES FROM THE TRIASSIC OF ANTARCTICA: REPRODUCTIVE REMAINS OF *SPACIINODUM*. Sphenophyte remains are important components of the Early-Middle Triassic silicified flora from the Fremouw Formation of Antarctica. *Spaciinodum collinsonii* is currently known only from vegetative organs, represented by ribbed, jointed stems with characteristic pith and carinal canals. However, permineralized cones with *in situ* spores have recently been discovered organically attached to *S. collinsonii* stems. Cones are relatively small, averaging 3.5 mm in diameter, and lack secondary tissues. The internodal vascular system consists of 31-33 collateral bundles, each of which apparently transects the nodal regions independently. Xylem is endarch and composed of elements ranging from annular to scalariform. Internodal distances within the cones are short, with alternating whorls of sporangia and bracts at the nodes. Spores are spherical and average 9 μm in diameter. Observations in transmitted light indicate that many spores are surrounded gy a thickened band, suggesting the presence of elaters. The antarctic fossils are anatomically and ultrastructurally compared with other extinct sphenophytes, as well as with modern *Equisetum*. *Spaciinodum* now represents the most complete structually preserved sphenophyte of Triassic age known, and provides the opportunity to consider a number of salient questions concerning evolution of the group.

Perez, K.E.,and G.A. Kaufman. Division of Biology, Kansas State University. *PEROMYSCUS* AND PRAIRIE, PIGMENT AND PATHS. Deer mice *(Peromyscus maniculatus)* respond positively to removal of plant litter and standing dead vegetation by prairie fires. Our objectives were to describe

paths that deer mice travel through grassland habitats and to ascertain whether these path characteristics are influenced by conditions created by fire or by nighttime illumination. Twenty-five mice were dusted with fluorescent pigments and then trailed in either burned or unburned sites on Konza Prairie Research Natural Area near Manhattan, Kansas. Both distance between turns and angle of turns were measured for the first 50 turns. Surface cover was measured at each turn along the trail and at random points along and near trails. Mice traveled an average of 29.4 m during the first 50 turns with no difference in trail distances between turns 1-25 and turns 26-50. Age of mice and illumination affected distance between turns. Turning angles were not random as mice selected angles that continued their travel in a forward direction. Mice turned more often in open than expected from the proportion of open area found in the habitat.

Spiker, C.M., and J.H. Shaddy. Department of Biology, Northeast Missouri State University. PRELIMINARY ANALYSIS OF THE EFFECTS OF THINNING IN AN OAK-HICKORY FOREST. In 1976, two separate stands of trees from an oak-hickory forest in northeastern Missouri were each subdivided into four plots. The plots were thinned to 40, 60, and 80 square feet of timber per acre with the fourth plot used as a control. Over a span of 16 years, these trees were periodically measured in order to study the growth of the trees at the different levels of thinning. The DBH (diameter at breast height) was recorded for each tree in the two stands and conclusions regarding the growth of the trees in each plot were made using statistical analysis.

Thornton, E.L. Depaartment of Biology, Pittsburg State University. CENSUS METHODS FOR SMALL COLONIES OF THE GRAY MYOTIS. The goal of this experiment was to attempt to increae the accuracy of visual censuses of the gray myotis as they emerged from the storm sewers at dusk. Various colored lights were placed over the sewer entrance to illuminate the bats. Each of four treatments was used once a week. Observers stood a short distance from the entrance and counted the bats with mechanical clickers. Temperature, humidity, number of bats leaving and returning, and length of exodus were recorded and analyzed in pre-determined blocks to account for variation in colony size and composition. Preliminary results indicate that green light increases the accuracy of inexperienced counters (3.35% difference) over the use of no light (24.52% difference). No effect was observed in the bats exiting behavior due to the treatments. This study suggests that colored light does not affect bats behavior but does tend to increase the accuracy of inexperienced observers. A laser device was constructed in the summer of 1992 as a means of augmenting or replacing the visual counting method. Preliminary field testing has shown promise.

Timme, S.L. and F.D. Bowers. Sperry Herbarium, Department of Biology, Pittsburg State University and Department of Biology, University of Wisconsin, Stevens-Point. ADDITIONS TO THE BRYOFLORA OF KANSAS: MONTGOMERY COUNTY. Previous studies of the bryoflora of Montgomery County, Kansas have resulted in 39 species of moss, 27 species of liverwort, and 1 species of hornwort. Recent field studies were conducted to determine if other species exist in the county. Results of the study here report 13 additional species for Mongomery County, one hepatic and 12 mosses. *Philonotis fontana* (Hedw.) Brid., *Bryoandersonia illecebra* (Hedw.) Robins., and *Calypogeia muellereiana* (Schiffn.) K. Muell. are reported only for the second time. Because Kansas is bryologically poorly known, further studies throughout the state are needed to validate the taxa present and their distribution.

Warriner, M.D., J.M. Gregory, and W.H. Baltosser. Department of Biology, University of Arkansas at Little Rock. NECTAR PRODUCTION AND THE POLLINATION BIOLOGY OF TWO SPECIES OF FLOWERING VINE. Initial investigations have focused on quantifying the floral nectar reward of two species of flowering vine, the Japanese honeysuckle (Lonicera japonica) and the trumpet honeysuckle (Lonicera sempervirens). Nectar was sampled from the flowers of both species at 24 hour intervals using a pocket refractometer. In general, the flowers of both species lasted only 3 days. Nectar reward for both species was found to be highest the first 24 hours following anthesis and declined thereafter. The trumpet honeysuckle was found to produce larger volumes of nectar with higher concentrations of sugar compared to the Japanese honeysuckle. The two species provide a basis of

comparison for the hypothesis that red-flowered plants, such as the trumpet honeysuckle, are hummingbird pollinated, whereas white-flowered plants, such as the Japanese honeysuckle, rely upon insects for pollination.

Wurtz, R.P., T.S. Plotnik, H.A. Klingele, D.E. Bowen. Department of Biology, Benedictine College. BEHAVIOR OF JUVENILE SNOW GEESE IN WINTER AND SPRING MIGRATION. Wintering and spring-migrating Snow Geese (*Chen caerulescens*) were studied in the middle Missouri River Valley during the winter of 1992-93. Scan samples were made of flocks numbering 10,000-120,000 birds. At roosting sites such as Squaw Creek National Wildlife Refuge, a greater percentage of juveniles were observed exhibiting feeding behaviors (27%) and drinking behaviors (17%), while a larger percentage of adult geese were observed in alert postures (49%). In feed fields, significantly more juveniles advanced ($P<.01$ Mann-Whitney U Test) to the edge of the feeding flock by walking, with 0-4 juveniles per 100 advancing in the air and 4-8 juveniles per 100 advancing on the ground. Supported by a Benedictine College Board of Directors' grant.

BIO-MEDICAL AND HEALTH

Ash, R.J. Department of Biology, Washburn University. INHIBITION OF ACETYLCHOLINESTERASE BY DIMETHYL SULFOXIDE AND RELATED COMPOUNDS. Dimethyl sulfoxide (DMSO) appears to be well tolerated in experimental animals but toxicity to the human central nervous system has been reported. Effects on the CNS have been ascribed to inhibition of acetylcholinesterase (AChE) but quantitative data on this point are lacking. The effects of DMSO and closely related compounds on in vitro inhibition of AChE and butyrylcholinesterase (BuChE) were studied. The results were: 1) DMSO and dimethyl sulfone were of equal potency in inhibiting AChE with Ki values around 50 mM at 22°C. 2) Ethyl sulfone was about 10X more potent than DMSO as an inhibitor of AChE. 3) The inhibition of AChE by all compounds was temperature dependent with the greatest inhibition observed at low temperature (10°C). 4) Butyryl-cholinesterase was inhibited about 5-fold less by DMSO and the related compounds when compared to AChE. Inhibition of AChE by these compounds appears to be of the mixed type. Supported by a grant from Washburn University.

Barnes, C.S., J. Landuyt, F. Pacheco and J. Portnoy. Section of Allergy/Immunology, Children's Mercy Hospital, Department of Pediatrics, University of Missouri-Kansas City Medical School. 2-DIMENSIONAL ELECTROPHORESIS AND IMMUNOBLOTTING OF PROTEINS FROM *ALTERNARIA ALTERNATA*. Spores and mycelia from fungi of the genus Alternaria are a major cause of mold allergy. Isolation and purification of proteins from fungal material is complicated by the number of proteins present. Two dimensional electrophoresis has the ability to resolve these extremely complex mixtures of proteins. The following study was performed to accumulate a comprehensive picture of the protein content of Alternaria. Alternaria alternata was grown on minimum salts and sucrose. Fungal mats were dried, powdered and extracted in distilled water. Filtered extracts were dialyzed and lyophilized. 2D SDSPAGE was by the method of O'Farell. Gels were silver stained or blotted onto nitrocellulose. The composit map emphasizes the overall similarity of the spot patterns. Often a pattern of 2 or more spots appears at the same molecluar weight varying slightly in isoelectric point. These patterns could indicate the presence of multiple alleles or spontaneous mutations. Immunoblotting using sera collected from ALT sensitive individuals indicates the presence of at leasts 4 IgE binding proteins. Supported by NIH grant R29 AI27476-01A1 and by the Kathrine B, Richardson Fund.

Bean, T.A., G.A. Lindsey, W.C. Zhuang, P.Y. Tong, and D.M. Yourtee. School of Pharmacy, University of Missouri-Kansas City. AN INVESTIGATION OF THE INTERNAL HYDROLYSIS OF MEDICAL BIOPOLYMERS BY ESTERASE. The possible importance of enzyme hydrolysis of dental biomaterials was investigated. Traditional methods of monitoring polymer degradation are hampered by leached monomers requiring the analyst to distinguish between identical breakdown structures resulting

from polymer and leachate. In the present study, the susceptibility of ester bonds to enzyme hydrolysis was investigated in a homologous series of polymers characterized by increasing side chain length. In the first series, 10 mg each of poly(methyl, ethyl, isopropyl, cyclohexyl, isobutyl, butyl, hexyl, and lauryl)-metharcylate homopolymers were subjected to porcine liver esterase (1 ml, 5 Units, 0.2 M phosphate buffer, pH 7.4) for 90 days and analyzed by gas chromatography (GC) for the cleavage of substituted groups. Breakdown of these polymers was not evident by periodic GC analysis. In addition, studies were conducted with dimethacrylates homopolymers containing ethylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, 1,3-butanediol and 1,4-butanediol internal units. Efforts were made to determine if a potential breakdown product 2,2,4-trimethylglutaric acid (TMGA) could be detected by high performance thin-layer chromatography. Ester hydrolysis was attempted with 10 ml of esterase (50 U) at pH 7.4 (0.2 M phosphate buffer) for 2 weeks. The acid fragment is a theoretical possibility in a linear chain conformation and would provide an unambiguous marker of internal polymer breakdown. The acid, TMGA, was not detected (<1/30,000 by wt.) in any of the homopolymers challenged. Methods with lower limits of detection are being sought, however the current observations do not indicate active enzyme hydrolysis of internal ester bonds adjacent to covalently bonded methacrylates. These data provide a better understanding of the steric hindrance to esterase hydrolysis in multi and di-functional biopolymer conformations. This study was supported by NIH/NIDR Grant No. DE09696.

Bean, T.A., W.C. Zhuang, P.Y. Tong, and D.M. Yourtee. School of Pharmacy, University of Missouri-Kansas City. ADVANTAGES OF CELL EXTENSION RATIOS AS A BIOCOMPATIBILITY PARAMETER. It is well recognized that cell adhesion, extension, and migration are important considerations of biomaterial biocompatibility, however, these parameters can vary widely depending on sample preparation and methodology. This study explores two parameters, cell adhesion and cell extension, for possible improvement of standard cytotoxicity testing. The effects of preincubation in water and medium and the effects of sample preparation were investigated. Three commercial dental materials P-50, Silux, and Heliomolar were investigated. Samples were polmerized with light in 0.5 cm glass tubes and cut into disks with a diamond saw. Heliomolar was also prepared by glass to glass compression to form a disk shape prior to light polymerization. Preincubation in water or medium increased the number of adhered cells and the extension ratio. Mechanical preparation of Heliomolar by diamond cutting resulted in an increase of cell adhesion as compared to Heliomolar samples prepared by glass to glass compression, however, the ratio of cell extension for a given incubation was nearly identical for both disk prepartion methods. These observations stress the need for uniformity of sample preparation if either cell adhesion or cell extension are used in comparing biocompatibility parameters between different laboratories. The ratio of cell extension appears to be a more consistend parameter of cell interaction with biomatereials. This study was supported by NIH/NIDR Grant No. DE09696.

Bean, T.A., W.C. Zhuang, P.Y. Tong, and D.M. Yourtee. School of Pharmacy, University of Missouri-Kansas City. A METHOD FOR CONFIRMING SURFACE STRUCTURAL UNIT HYDROLYSIS OF MEDICAL BIOPOLYMERS BY ENZYMES. In this study an effort was made to evaluate the decomposition of the suporting structure of biomaterials and the influence of enzymes on the homopolymers of diethylene glycol dimethacrylate (DEGDMA) and triethylene glycol dimethacrylate (TEGDMA). After polymerization (heat + 1% benzyl peroxide) the polymers were ground to a particle size of approximately 0.1-0.5 μm. Subsequently, 300 mg of each polymer was subjected to porcine liver esterase (30 units in 3 ml, 0.2 M phosphate buffer pH 7.9) and lipase (30 units in 3 ml, 0.2 M phosphate buffer pH 7.9) for up to 30 days. The supernatant was removed after each 24 to 48 hours and the homopolymer samples were then suspended in a fresh buffer-enzyme media. Supernatant samples were analyzed by capillalry gas chromatography equipped with flame ionization detection. Hydrolytic tests of the homopolymer polyDEGDMA were compared to methacrylic acid, diethylene glycol, and DEGDMA incubations. Similarly, polyTEGDMA was compared to methacrylic acid, triethylene glycol, and TEGDMA. The expected ratio of degradation from leached monomer, only, is 2:1 (methacrylic acid:diol). Variations of this ratio are suggestive of a polymeric hydrolysis. While no detectable hydrolysis resulted due to the incubations with lipase there was evidence of hydrolysis by esterase within

the polymer samples; during the first 15 days DEGDMA showed ratios of methacrylic acid:diol that approximately equaled 2, but after 30 days only diethylene glycol was detected. The ethylene glycol appeared at about 10 μg/ml with no detectable methacrylic acid. A similar pattern was observed for TEGDMA on day 21 with 50 μg/ml of triethylene glycol detected. The use of ratios of expected breakdown products provides insight for determining actual polymer hydrolysis compared to hydrolysis of leached monomers. This study was supported by NIH/NIDR Grant No. DE09696.

Igwe, O.J. Division of Pharmacology, School of Pharmacy, University of Missouri-Kansas City. REGULATION OF INOSITOL 1,4,5-TRISPHOSPHATE SYSTEM IN THE CEREBELLUM DURING AGING. Numerous processes associated with intracellular calcium homeostasis have been found to be modulated with age. To determine whether the intracellular calcium-mobilizing second messenger, inositol 1,4,5-trisphosphate ($InsP_3$), and its receptor ($InsP_3R$) display age-related regulation, $InsP_3$ contents and ^3H-$InsP_3$ binding site density were quantified in cerebellar membranes prepared from young (3 months), middle aged (12 months) and senescent (25 months) male Fischer 344 rats. $InsP_3$ contents were significantly increased ($p<0.05$), but $InsP_3R$ affinity and density were significantly reduced ($p<0.01$) in 12- and 24-month old compared to 3-month-old rats. With the age-dependent change in $InsP_3R$ affinity, the present data suggest the existence of at least two distinct types of cerebellar $InsP_3R$ and/or molecular modification (e.g., phosphorylation) for $InsP_3R$ in cerebellar Purkinje cell neurons with age. Taken together with the recent report of senesent changes in cerebellar protein kinase C activitiy, the age-dependent reduction in $InsP_3R$ affinity and density indicate that disruption of phosphoinositide second messenger system may be contributory to the impairment of neuronal responsiveness and behavioral deficits associated with the aging process. Supported by Grant from Scientific Education Partnership through Marion Merrell Dow Foundation.

Love, S.D. and R.W. Piepho. Department of Pharmacology, University of Missouri-Kansas City School of Pharmacy. EFFECTS OF NEUROPEPTIDE Y ON VASCULAR ATP-SENSITIVE POTASSIUM CHANNELS. In vitro investigations of Neuropeptide Y (NPY) have resulted in rsponses that might be associated with inhibition of an outward potassium channel. The goal of this study was to investigate whether NPY had an effect on the ATP-sensitive potassium (K_{ATP}) channel in vascular smooth muscle. NPY alone (10^{-9}, 10^{-7} M) did not affect spontaneous portal (PV) contractile activity. The specific K_{ATP} channel opener, lemakalim, produces 75% inhibition of PV activity at $6x10^{-8}$ M. NPY ($4.5x10^{-7}$ M) produces almost complete reversal of the inhibitory effects of lemakalim. Lemakalim (10^{-7} M) also reduces serotonin contractions of the mesenteric artery by 75% Equimolar NPY administration returned contractions to within 30% of normal levels. These results suggest that some of the effects of NPY in isolated vascular smooth muscle may be due to inhibition of the K_{APT} channel. Supported in part by Marion Merrell Dow Foundation.

Manning, A., V. Evans, L. Bernard, B. Chronwall and W. Millington. School of Biological Sciences and Department of Anesthesiology, University of Missouri-Kansas City. N-ACETYLATION OF ß-ENDORPHIN IN NEURAL LOBE AXONS AND ANTERIOR LOBE COURTICOTROPHS OF THE HUMAN PITUITARY GLAND. The N-terminal acetylation of ß-endorphin (ß-End) is an intriguing post-translational modification which abolishes the peptide's opioid activity. The objective of this study was to determine if ß-End is N-acetylated in the human pituitary using both immunohistochemistry and HPLC. N-acetyl-ß-endorphin immunoreactivity (iAc-ß-End) was localized in the remnants of the intermediate lobe along the border of the anterior and neural lobes. Unexpectedly, however, iAc-ß-End was also observed within neural lobe axons. Axons also contained immunoreactive ß-End, ACTH, and α-MSH, indicating hypothalamic pro-ACTH/ß-End neurons innervate the neural lobe. Unlike most mammalian species, iAc-ß-End was also localized in a subpopulation of corticotrophs dispersed throughout the anterior lobe. HPLC analysis confirmed that small amounts of N-Ac-ß-End peptides are present in the human pituitary. N-Ac-ß-End, while lacking opioid receptor affinity, apparently activates non-opioid receptors although its specific function in neural lobe axons and anterior lobe corticotrophs remains to be determined. Supported by NIDA/DA-04598.

Marerat, B. Department of Physics, Fort Hays State University, PHYSICS IN OPHTHALMOLOGY. The role of physics in transforming ophthalmic procedures by the introduction of surgical lasers, with specific interest in Photorefractive Keratectomy (PRK) and Laser ThermoKeratoplasty (LTK). PRK and LTK are used for myopic and hyperopic corrections respectively. In PRK myopic correction is achieved by ablation of approximately 40 microns of central corneal tissue. A rapid succession of laser pulses is used. Each pulse removes as little as 2 microns of tissue. With each succeding pulse the beam spot widens, ablating a slightly larger ring of tisue. A newer technique uses an erodible mask, which ablates at the same rate as the corneal tissue, is used to copy the shape of a fresnel lens on the surface of the cornea. LTK uses a Holmium:Yitrium-Aluminum-Garnet operating at 2.1 microns wavelength. LTK, through photocoagulation points, with a depth of approximately 300 to 400 microns, achieves hyperopic correction. Controlled coagulation of corneal tissue causes shrinking and the tissue surrounded by the coagulation zone bulges out, thus, correcting hyperopia. This study was conducted using data compiled by Summit Technologies.

Murti, S.K., and M.Z. Badr. School of Pharmacy, University of Missouri-Kansas City. THERMAL ANALYSIS AND X-RAY POWDER DIFRACTOMETRY OF THE CHOLINE SALTS OF IBUPROFEN AND NAPROXEN. The choline salts of ibuprofen and naproxen were synthesized to enhance the water solubility of these practically insoluble compounds. Differential scanning calorimetry of ibuprofen choline showed that it had two melting endotherms at 90.3 and 123.2 °C, the sum of their enthalpies of fusion being 5.45 x 10^3 J/mole. Only one exotherm at 90.0 °C was observed on cooling. There was no concomitant weight loss associated with these phase transitions, as seen from thermogravimetric analysis. Remelting the sample gave results of two peaks at 72.5 and 112.5 °C. Naproxen choline melted at 146.4 °C with an enthalpy of fusion of 9.20 x 10^3 J/mole; the presence of a pre-melting peak suggested the presence of a polymorph. No associated loss in weight was observed. The molar enthalpy of fusion of both salts were lowered relative to their respective free acids. X-ray powder diffraction qualitatively showed that ibuprofen choline was amorphous while the naproxen salt was relatively crystalline in nature. The increase in water solubility of the drugs by salt formation may be partially explained by their thermal behavior, which, in turn, is dependent upon their degree of crystallinity.

Nalvarte, E.L. and D.M. Yourtee. Division of Pharmacology, School of Pharmacy, University of Missouri-Kansas City. MUTAGENIC EFFECT OF DOXORUBICIN AND FERRITIN IN A REDUCING ENVIRONMENT. Understanding the mutagenic mechanism of the anticancer drug Doxorubicin (DOX) and the relationship to free radical genesis is important to improving cancer chemotherapy. Doxorubicin has been shown to be mutagenic in the strain TA102 of the salmonella/microsome mutagenicity assay. In these experiments it has been demonstrated that ferritin (Fr) and post-mitochondrial fraction of rat liver (S9-mix) increase the number of TA102 revertants in combination with a single does of 100 DOX (100 μM). However, when using the same Fr and S9-mix with eight doses of DOX ranging from 1 to 200 μM, under the same preincubation conditions (1 hour at 37°C), the dose response of DOX-Fr-S9 was of a biphasic nature. These results show that at doses below 10 μM there is a decrease in mutagenicity of the drug, but at higher doses the mutagenicity of doxorubicin is increased. At higher doses, however, the combination appears to suppress the cytotoxicity. These data support implications in the literature that doxorubicin can participate in free radical reactions and that these may be potentiated by biological iron systems, however, the phenomenon is apparently dose dependent. This study was supported by NIH/NIDR Grant No. DE09696.

Pacheco, R., C.S. Barnes, J. Landuyt and J. Portnoy. Section of Allergy/Immunology, Children's Mercy Hospital, Department of Pediatrics, University of Missouri-Kansas City Medical School. AFFINITY PURIFICATION OF ALLERGENIC PROTEINS FROM *ALTERNATA ALTERNATA*. Exposure to allergenic proteins results in human disease ranging from allergic rhinitis to asthma. The mold, *Alternaria alternata* (ALT) is ubiquitous in the outdoor environment. This mold produces several substances known to be allergenic in humans. This study was conducted in order to identify and purify specific allergic material from ALT. *Altlernaria alternata* was grown on minimum salts and sucrose. Fungal mats were dried, powdered and extracted in distilled water. Filtered extracts were dialysed and

lyophilized. Lyophilized preparations were reconstituted in distilled water. Hybredomas were produced using spleen cells from mice injected with either whole ALT or electrophoretically purified fractions. Monoclonal antibodies produced were purified with protein A and immobilized on CNBr Sepharose. At least two specific proteins have been purified. These proteins are positive in epicutaneous skin tests on ALT sensitive individuals and bind IGE from sera collected from these patients. Affinity chromatography studies indicate that these proteins share a common epitope and sequence studies provided evidence that they are structurally similar. Supported by NIH grant R29 Al27476-01A1 and by the Katherine B. Richardson Fund

Sands, S.A., and B.M. Chronwall. School of Biological Sciences, University of Missouri-Kansas City. DEVELOPMENTAL EXPRRESSION OF ß-ENDORPHIN, S-100 AND VIMENTIN IN THE RAT PITUITARY INTERMEDIATE LOBE: CORRELATIONS BETWEEN MELANOTROPES AND GLIA. This study was conducted to simultaneously demonstrate gene expression in the two major cell types in the pituitary intermediate lobe; ß-endorphin was used as a melanotrope and vimentin as a glial marker on pituitary sections from postnatal day (PN) 1-14 rat pups. Immunohistochemistry showed two distinct cell populations with no co-localization of the melanotrope and glial markers. The cells expressing ß-endorphin were polyhedral at all times; their number and levels of expression increased from PN 1 until PN 4, remained unchanged till PN 7, and then increased through PN 14. Vimentin was evident at PN 1 at high levels in very elongated cells with a radial orientation. At PN 5, vimentin expression was found in stellate cells. Levels of vimentin decreases from PN 5 through PN 14, at which time most vimentin cells were stellate. S-100, a protein expressed by several cell types, was evident at PN 1 at high levels in polyhedral cells, at PN 6 fewer polyhedral cells showed S-100; instead it was expressed in stellate cells. This trend continued through PN 14, when many stellate cells and only very few polyhedral cells expressed S-100. Thus it appeared that melanotropes could transiently expess S-100..

Schmidt, N.D., and C.G. Twitchell. Department of Biology, Pittsburg State University. IN VITRO INSULIN-RELEASING ACTIVITY OF *MOMORDICA CHARANTIA* EXTRACTS ON PERINATAL RAT ISLETS. Fruit extracts of *Momordica charantia* (bitter gourd) possessing hypoglycemic activity and associated with increased insulin levels *in vivo* were used to conduct acute *in vitro* experiments to assess their insulin secretory activity. The chloroform soluble extract (CSE), alkaloid extract (AE), crude extract (CE) and a known insulin secretogogue (tolbutamide) were dissolved in CMRL 1066, 100 mg% glucose (G-100) at concentrations of 0.1, 0.5 and 1 mg/ml. Islets from 6-12 day old Wistar rats were isolated according to Lacy and Kostianovsky's collagenase technique. Groups of twenty islets in the presence of either G-100 (control) or G-100 plus extract or tolbutamide were incubated at 5% CO_2 in air. Two hundred microliter samples were taken at the end of an initial 90 minute incubation period. Following a media change and incubation in G-100 for 30 minutes, all groups of islets were incubated in CMRL 1066, 300 mg% glucose (G-300) for another 90 minutes culminating with collection of samples. Radioimmunoassays for insulin showed all extracts at 1 mg/ml stimulated insulin release. Mean insulin secretory responses to the AE and CSE were greater than 43 ng/ml. and that of tolbutamide 30 ng/ml. The mean control value was found to be 4 ng/ml. These results further support the possible existence within bitter gourd of hypoglycemic principles with pancreatic effects. Supported by Great Plains Diabetes Research Incorporated.

Venkateswari, Y. and S. Melethil. School of Pharmacy. University of Missouri-Kansas City. EFFECT OF ALUMINUM ON BLOOD-BRAIN BARRIER PERMEABILITY. The specific objective of this study was to understand the effect of aluminum chloride ($AlCl_3$) on blood-brain barrier (BBB) permeability using ^{14}C-sucrose as a marker. Conscious rats were injected with i.v. (1.0 mg/kg of elemental aluminum) or i.p. (100 mg/kg). Two hours post aluminum administration, ^{14}C-sucrose (5 µci) was injected. Serial blood samples (femoral artery) were collected for aluminum (0-170 min.) and ^{14}C-sucrose (120-170 min.) analyses. The animals were decpitated and radioactivity was measured from the 9 different brain regions. The cerebral permeability-capillary surface area product (PA) was calculated by standard methods. No significant difference in PA values was observed in the i.v. group as compared with controls (rats injected with normal saline). The i.p. group showeed 2-to 3-fold increase ($p<0.05$) in

PA values. Such a BBB permeability enhancement by intravenous aluminum might be due to transient and/or reversible nature of the effect. It might also be due to differences in blood aluminum concentrations. Further time course experiments with $AlCl_3$ in the two groups should provide information regarding the dynamics of aluminum effect on BBB permeability between the i.v. and i.p. routes. Partial support by Marion Merrell Dow-SEP.

Watts, E.D. University of Texas at Arlington. OBSTACLES TO A CANADIAN-STYLE NATIONAL HEALTH PLAN IN THE U.S. This paper discusses several obstacles to the development of a Canadian style national health plan in the U.S.: (1) Communitarian ethic in Canada vs. individualistic ethic in the U.S.; (2) U.S. anti-communist past and distrust of government; (3) Weaker labor union strength in the U.S.; (4) Interest group dominance in the U.S., particularly by health insurance, and health corporation industries, the A.M.A., and related; (5) Entrenched privatization in health care (and other) sectors; (6) Budgetary problems in Washington and in state governments; (7) Weakness of the U.S. Left; (8) Other factors. This historic outcome of the national U.S. debate on the future of U.S. health care will be influenced by these seminal factors. The ultimate outcome is likely to be moderate, incremental policies, with large-scale private sector particpation.

Xu, L., M. Ash and M. Badr. Division of Pharmacology, School of Pharmacy, University of Missouri-Kansas City. MECHANISM OF INCREASES IN PEROXISOMAL ß-OXIDATION IN DIABETIC RATS. Diabetes mellitus is accompanied by enhanced hepatic peroxisomal ß-oxidation. Mechanisms involved in this phenomenon have not been elucidated. Therefore, this study was undertaken to investigate whether hyperglycemia per se is responsible for the increased enzyme activity which is ascribed to diabetes. To induce diabetews, male Sprague-Dawley rats were treated with streptozotocin (80 mg/kg, i.p.). Seven days following the induction of diaabetes, hepatic peroxisomal ß-oxidation was significantly elevated above values observed in control rats (1.586 ± 0.12 vs 0.8610 ± 0.047 U/g) C0ontrol rats had blood glucose levels of 83 ± 8 mg/dl, while diabetic rats had levels of 311 ± 22 mg/dl. In other experiments, control rats recieved intravenous infusions of either 30% glucose or normal saline for 7 days, which resulted in blood glucose levels of 377± 33 and 106 ± 9 mg/dl, respectively. In rats which received saline infusions, peroxisomal ß-oxidation activity was 0.97 ± 0.10 U/g, while activity was only 0.42 ± 0.03 U/g in livers of glucose-infused rats. These data indicate that factors other than high blood glucose levels are responsible for the enhanced peroxizxomal ß-oxidation observed in diabetic rats.

Zhuang, W.C., D.M. Yourtee, P.Y. Tong, and T.A. Bean. School of Pharmacy, University of Missouri-Kansas City. EVALUATION OF A TETRAZOLIUM BASED COLORIMETRIC TEST FOR BIOMATERIAL CYTOTOXICITY DETERMINATION. The standard method for measuring cytotoxicity of biomaterials is ^{51}Cr release from labeled cells. A different determination of cell viability and function uses 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT). The MTT test is based upon the reduction of a tetrazolium salt by viable cells to an intracellular purple formazan metabolite after exposure and incubation of a test chemical or device. In this study, seven different materials (4,4-octyloxyphenyl) phenyliodonium hexafluoroantimonate (OPIA), Bis-GMA, HEMA, the monomer and homopolymer of methyl alpha isocyanatoacrylate, and the monomer and homopolymer of trans/trans 2,3,8,9-di(tetramethylene)-1,5,7,11-tetraoxaspiro-[5,5] undecane were tested in both the ^{51}Cr release, MTT cytotoxicity tests tube method and microplate method. Dose response cytotoxicity profiles were performed in both tests on each compound using identically prepared samples. Studies included TC_{50} sensitvity, variability, and binding comparisons. Both cytotoxicity tests gave clear end points of cell survival or death, however, the MTT results indicated a lower limit of detection and TC_{50} values. The correlation coefficient matrix (Pearson's r) between ^{51}Cr release, MTT cytotoxicity tests tube method and microplate method for the TC_{50} of 7 combined samples $r>0.9$ $p<0.001$. In addition the MTT cytotoxicity test has the advantage of safety, a simpler procedure, and the 96 well tissue culture plates result in reduced sample test amounts and rapid analysis. This study was supported by NIH/NIDR Grant No. DE09696.

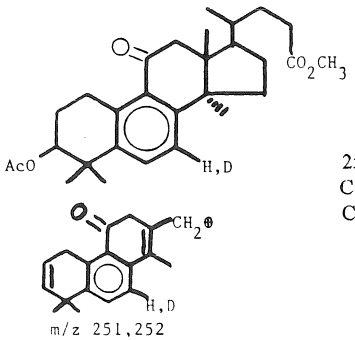
CHEMISTRY

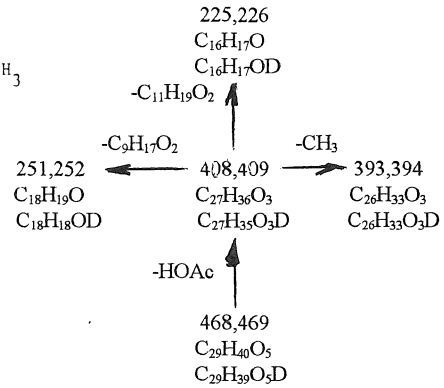
Biagioni, R.N., B.M. Simpson, A. Luna. Department of Chemistry, Southwest Missouri State University. RING-SLIPPAGE REACTIONS OF n6-FLUORENYL MANGANESE CARBONYL CMPLEXES. Pentahapto indenyl and fluorenyl transition metal complexes have attracted much attention because of their ability to undergo reactions involving ring slippage. Less well studied are related n^6-indenyl and n^6-flluorenyl complexes. We have synthesized substituted fluorenyl complexes of the formula $(n^6\text{-}C_{13}H_9)Mn(CO)_2L$ (L = phosphines, phosphites) and have determined activation parameters for their $n^6 \rightarrow n^5$ isomerization. We have also measured activation parameters for the reaction:

$$(n^6\text{-}C_{13}H_9)Mn(CO)_3 + 2PR_3 \quad (n^1\text{-}C_{13}H_9)Mn(CO)_3(PR_3)_2 \quad (R = Et, n\text{-}Bu)$$

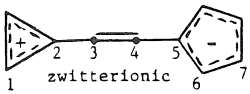
a novel reaction in which the fluorenyl moiety slips from its six-membered ring to its five-membered ring.

DeWitt, Dale T. and J.R. Dias, Department of Chemistry, University of Missouri-Kansas City. MASS SPECTROMETRIC STUDY OF B-RING AROMATIC TETRACYCLIC TRITERPENOIDS HAVING THE BILE ACID 17-SIDECHAIN. The mass spectral fragmentation and following genesis schemes will be detailed.





Dias, J. R. Department of Chemistry, University of Missouri-Kansas City. A STEP-BY-STEP HMO SOLUTION OF A CALICENE ANALOG. The total solution to problem 8 of Chapter 2 in J.R. Dias, "Molecular Orbital Calculations Using Chemical Graph Theory", Springer, Berlin, 1993 will be presented.



$X^{10} - 11X^8 - 2X^7 + 41X^6 + 12X^5 - 59X^4 - 16X^3 + 31X^2 + 4X - 5$

characteristic polynomial

eigenvalues	charge density		bond order		topological RE
-2.0104	1	+0.28	1-2	0.57	
-1.6180	2	+0.24	2-3	0.49	0.39 ß
-1.5287	3	-0.15	3-4	0.77	
-1.0	4	+0.13	4-5	0.50	percent ionicity
-0.5578	5	-0.15	5-6	0.56	
0.4951	6	-0.16	6-7	0.70	79%
0.6180	7	-0.16	1-1	0.72	
1.2412			7-7	0.71	
2.089					
2.2715					

Ritter, D. Department of Chemistry, Southeast Missouri State University. **J.C. Weisshaar,** Department of Chemistry, University of Wisconsin-Madison. KINETICS OF TRANSITION METAL ATOMS IN THE GAS PHASE: REACTIONS OF Sc THROUGH Cu WITH ALKANES AND ALKENES. The reactions of 3d-series transition-metal atoms with 11 small alkanes and alkenes have been studied in a fast-flow reactor at 0.5-0.8 Torr of He and 300 K. Reactions of specific spin-orbit levels are monitored via laser-induced fluorescence. None of the nine metal atoms reacts with linear alkanes. Sc, Ti, and V react moderately with larger alkenes. Ni reacts efficiently with all of the alkenes. The absence of a measurable pressure dependence of the rate constant over the pressure range 0.5-0.8 Torr of He is used to infer bimolecular elimination chemistry. The pattern of reactivity of metal atoms with alkenes in interpreted using a donor-acceptor bonding model.

Robbins, M.D., R.E. Popham and J.M. Readnour. Department of Chemistry, Southeast Missouri State University. INVESTIGATION OF METHODS OF QUALITATIVE ANALYSIS FOR LEAD IN LEAD-BASED PAINT. One of the leading sources of lead poisoning in children is lead-based paint. An investigation was made of the commercial Lead Zone and Lead Check Swabs and also the sodium sulfide qualitative methods of analysis for lead in paint. Paint samples were collected from old houses and tested for lead using these three types of analyses for each sample. Each of these samples was then analyzed for lead using flame atomic absorption spectrometry. The results from the two commercial tests and the sodium sulfide analyses were compared with the atomic absorption results. Even though the Lead Zone, Lead Check Swabs and sodium sulfide analyses ordinarily were positive when lead was present and showed negative when lead was absent, there were cases for each of the three types of analyses in which the results were unreliable.

Simpson, B.M. and C.C. Thompson. Department of Chemistry, Southwest Missouri State University. STRUCTURE AND STABILITY OF BORANES AND *CLOSO*-BORANES COMPUTED BY SEMIEMPIRICAL MOLECULAR ORBITAL METHODS. Boron clusters are theoretically interesting species because of their ability to form "nonclassical" molecular structures. However, due to difficulties in parameterizing the electron deficient center, boron-containing compounds have presented a particular challenge to treatments by semiempirical molecular orbital methods. With the development of more advanced semiempirical methods such computations are now feasible. In this study structural analyses of five boranes and four *closo*-boranes have been carried out using AM1 and MNDO parameterizations implemented through MOPAC Version 6.0. Optimized geometries for the boranes and *closo*-boranes show good agreement with reported experimental structures; ionization potentials and heats of formation display greater variability with some quite close to and others differing significantly from the corresponding experimental values.

Trump, E.L. and S.K. Wurm. Department of Chemistry, Emporia State University. SYNTHESIS OF SUBSTITUTED ISOPROPYLIDENE-BRIDGED TRIARYLMETHANES. The compound tris-((2,6')(2',6")(2",6))-isopropylidene triphenylmethane forms a planar cation which is 10^{12} times more stable than the unsubstituted nonplanar triphenylmethyl cation. Triphenylmethyl cations are also stabilized by electron-donating groups, such as $-OCH_3$, at the 4,4', and 4" positions. The purpose for this research is to combine the stabilizing effects of isopropylidene bridges and electorn-donating groups. Both electrophilic and nucleophilic substitution reactions were employed to prepare these compounds.

Willingham, T.R., I. Morishima and L.A. Andersson. Department of Biochemistry, Kansas State University; Division of Molecular Engineering, Kyoto University. CHMERIC MYOGLOBIN: COMPARATIVE SPECTRAL ANALYSIS OF NATIVE MYOGLOBIN, CATALASE, AND THE ENGINEERED H93Y MUTANT. The axial ligand in native human myoglobin (Mb) is His 93 (H93H), which is on the proximal side of the heme (iron porphyrin). In genetically engineered human Mb, Morishima & coworkers (*Biochem. Biophys. Res. Commun.* (1991) 180, 138) replaced His93 with Tyr (H93Y), in analogy to the tyrosine-ligation of the heme enzyme catalase. To investigate the effect(s) of the H93Y substitution, magnetic circular dichroism (MCD) spectroscopy was utilized to compare the mutant with native Mb and catalase. Different states were explored, varying pH and axial (6th) ligands

The results suggest a unique, chimeric protein having spectral and structural characteristics of both proteins. Thus, heme and axial ligation are insufficient to determine function.

Witherspoon, David and Michael A. Lawson, Department of Biology, **Katherine E. Sheridan and Melvyn W. Mosher.** Department of Chemistry, Missouri Southern State College. BIOCHEMICAL COMPARISON OF CRAYFISH BY THE METHOD OF CELLULOSE ACETATE ELECTROPHORESIS. Five species of crayfish from 3 different genera (*Orconectes neglectus, O. ozarkae, O. longidigitus, Procambarus gracilus,* and *Cambrarus setosus*) have been studied with regard to variations of their lactate dehydrogenase (LDH), glucose-6-phosphate dehydrogenase, malate dehydrogenase, isocitrate dehydrogenase, malic enzyme. and carbonic anhydrase emzyme systems by the method of cellulose acetate electrophoresis. The protein banding patterns for the stream crayfish (*O. neglectus, O. ozarkae,* and *O. longidigitus*) were identical between and within species for all of the enzyme systems studied. The LDH banding pattern for the cave crayfish (*C. setosus*) was found to be different than for the stream crayfish. The prairie crayfish (*P. gracilis*) was found to have LDH patterns similar to the stream crayfish. This work with the stream crayfish supports the view that these crayfish are more closely related biochemically than is suggested by their physical appearance.

COMPUTER SCIENCE

LaLonde, Donna E. Department of Mathematics and Statistics, Washburn University. EXPLORING THE POTENTIAL FOR CASE-BASED REASONING IN MATHEMATICS AND SCIENCE TEACHER EDUCATION. This presentation will discuss case-based reasoning and its implications for preservice and inservice teacher mentoring. We describe a research plan to build a CBR expert system. Our project, like much research in Artificial Intelligence, is characterized by two goals (1) to build a useful and intelligent application and (2) to contribute to the research in human learning and memory. We are interested in the field of education because of the need and the challenge associated with working in a domain characterized by significant uncertainty. The foundation of case-based reasoning is that humans store models or cases of past problem solving situations and utilize these cases when new but related problem situations are encountered. Our work will involve acquiring teaching knowledge from master teachers and from novice teachers, modeling the decision making process and building an intelligent application.. Case-based systems have been developed in several domains but our project is significant because it has not been applied to teaching. We believe this is, in part, because we do not have an adequate model of the teacher as decision maker. Developing a cognitive model of the teacher will have implications for teacher education. In addition existing systems have viewed the expert as the person with a long history of working in the domain. We believe that shifting the focus and recognizing that a novice in the domain also has expertise will make a major contribution to the system. We will acquire and utilize both types of expertise. We have the following goals for our project. First, we will apply the case-based reasoning paradigm to a new area which will add to the CBR discourse. Second, we will contribute to making the knowledge base of teaching explicit and in the process contribute to the research on teaching and learning.

Naugler, David R. Department of Computer Science, Southeast Missouri State University. WHAT DOES EVERY NON-SCIENCE FRESHMAN NEED TO KNOW ABOUT COMPUTERS? Computer Science departments do a good job of teaching the introductory computer science to computer science majors. What do we have to offer to non-technical non-computer science majors? What level of computer literacy is needed for success in college and in the workplace? Most college students will take at most one computer class and very few will take a programming class. How do we design the one general education computer class that students might well take so they can achieve a survival computer literacy level? After considering what "what everyone needs to know" means from the perspective of different philosophies of education, the design and implementation of an introductory computing class as part of Southeast Missouri State's University Studies program is considered. Successes and failures of various approaches and topics will be discused.

Shade, E. Department of Computer Science, Southwest Missouri State University. OPTIMIZATION OF "ALMOST" TAIL-RECURSIVE FUNCTIONS IN IMPERATIVE LANGUAGES. Recursion is a very powerful mechanism that can greatly simplify complex programming tasks. Despite its methodological advantages, many programmers avoid recursion due to the "housekeeping" overhead associated with recursive function calls, which typically consist of pushing parameters on the stack, allocating space for local variables, and saving the return address. However, many recursive functions are *tail-recursive*, which means that any recursive calls are followed immediatly by an implicit or explicit return statement. The body of a tail-recursive function can be transformed by the compiler into an efficient loop, avoiding the recursive calls. Unfortunately, there are a number of simple functions, like the factorial function, whose natural recursive definition is not quite tail-recursive. In some cases these "almost" tail-recursive functions can be transformed into equivalent tail-recursive functions with one or more additional arguments. In languages like Scheme that support first-class continuations, *any* recursion function can be converted into a tail-recursive one using the (Continuation-Passing Style) transformation. Since traditional imperative languages like Pascal and C++ do not support continuations, the CPS transformation cannot be implemented for them directly. However, the CPS transformation is still a valuable theoretical tool. Using it, I will provide some general conditions under which the optimization of "almost" tail-recursive functions can be performed in imperative languages, and illustrate the techniques with a number of examples.

Trigg, Joseph W. Department of Computer Science, Southwest Missouri State University. THE 1992 ACM MID-CENTRAL REGIONAL SCHOLASTIC PROGRAMMING CONTEST. The Association for Computing Machinery (ACM) sponsors each year two computer programming contests: 15 Regional Programming Contests and one National Programming Contest. These contests are international in scope, including universities in the United States as well as several universities from Australia, New Zealand, Taiwan, Great Britain, Germany, etc. Two top teams from each Regional Contest area participate in the National Programming Contest. The Mid-Central Contest Region consists of Missouri, Illinois, Kentucky, Tennessee, and Arkansas. In 1992, 67 institutions partook in the Mid-Central Regional Contest. All Regional Contests are held in October or November. Although two teams are usually chosen from each region, the Mid-Central Region, because of its size, was allowed to send three teams to the National Contest: The University of Missouri-Rolla, Vanderbilt University, and Arkansas Technical University. The top teams were chosen on the basis of their ability to solve seven problems in five hours. Each team of three students (no more than one graduate student) was placed in individual classrooms with one AT&T Personal Computer. Individual team success depended heavily on team coordination and ability to think clearly, accurately and rapidly. The contest problems are generally designed to stress these traits rather than the ability to focus on particular scientific or mathematical formulas. Team composition was predominately white males with minorties and women being conspicuously absent. The purpose of this abstrct is, therefore, to increase an awareness in the Missouri family of universities that these scholastic programming contests do exist and that more of our schools and students are invited to participate.

ENGINEERING

Ambirajan, A. and D.C. Look, Jr. Mechanical and Aerospace Engineering and Engineering Mechanics, University of Missouri-Rolla. POLARIZATION OF MULTIPLE FORWARD SCATTERED LASER RADIATION. This paper presents an experimental study of the forward scattering of a laser beam which is incident normally on a plane parallel layer of latex particles suspended in water and a container of glass. The aim of this investigation was to study the anisotropies in the forward scattrered radiation from the view point of polarization. Earlier experimental studies have suggested that the back-scattered intensity due to multiple scattering of a linearly polarized laser beam was strongly polarized in optically thin media. The transmitted intensity distributions presented will be mapped out as a function of position for both parallel and perpendicular polarized radiation for the

forward scattered component of incident radiation. The appplicable parameters are particle size and optical thickness. The results are not appreciably different from that of the back-scattered radiation except for the effect of optical depth. The optical depth of one or more depolarizes the laser beam very effectively. Supported by NSF CTS-9103971.

Chaudhry, G.M. Computer Engineering Research Laboratory, Department of Electrical & Computer Engineering, University of Missouri-Columbia. MICROPROCESSOR-BASED SYSTEM DESIGN AND EVALUATION Microprocessor chips containing more than 2 million transistors and keeping speed in the range of 50-60 megahertz are expected as a next generation products. System design maker and strategists are faced with the selection of particular elements (i.e., microprocessor, system architecture) according to a set of objectives and constraints. The objective of methodology is to provide evaluation techniques which are being effectively used. Common to many decision processes, there are two classes of criteria: technical and non-technical. For example a company developing products based on microprocessors, these products can be, e.g data processing systems, office systems, switching equipment, . . . The company is faced with the selection of one or a few number of microprocessors and a choice of system architectures to fulfill its needs. This talk will focus on microprocessor-based system design methodologies.

Jung, H.J., and J.F. Kunze. Nuclear Engineering Program, University of Missouri-Columbia. CS-137 CONTENT OF WOOD ASH IN MISSOURI. Growing trees concentrate the alkali metals from the soil. Cs-137, a man-made radioactive isotope found in the atmosphere has been found to be present in unusually high concentrations in some wood ash, particularly in the New England area. (Farber, HPS Newsletter, April, 1990) Some of these radioactive levels have been above what is considered within the regulations for disposal of low level radioactive waste in land fills. The levels are so low that dose to the population is negligible (well below normal background), but the concern is that the presence of such radiation would be interpreted as a release from one of our power plants. The atmospheric levels of Cs-137 primarily remain from nuclear bomb testing, and the remnants of the Chernobyl disaster in 1986 in the Ukraine. We have obtained 8 samples of a variety of wood and charcoal in Missouri, burned these to ash, and measured the low levels of Cs-137, as well as of natrually occurring K-40. Our K-40 results are similar to those reported for the ashes in New England, but the Cs-137 levels are about an order of magnitude less in Missouri (200 to 1100 pCi/kg of ash) compared to results as high as 15,000 pCi/kg in New England. The levels found in Missouri are less than the natural K-40 content in the human body.

Liou, J. and Dong Y. Jang. Mechanical and Aerospace Engineering Department, University of Missouri-Columbia. THEORETICAL ANALYSIS OF RESIDUAL STRESS DISTRIBUTION IN MACHINED STAINLESS STEEL. Residual stresses on machined surfaces can decide component performance, longevity, and reliability. Although stainless steel is an important material with wide application, it is not easy to obtain a favorable surface condition due to its sensitivity to thermal and mechanical operations. In order to develop a machinability chart which can provide suitable cutting parameters for high production rate and good quality surface, residual stress distributions in the machined stainless steel were studied using a nonlinear finite element method package. A thin-zone model of cutting process was selected in the finite element modeling and shear plane was used as the boundary condition for the cutting zone. Stainless steel was asumed to be elastic-linear-isotropic hardening-plastic material. The results obtained using this finite element model was compared with the published data and showed good correlations with the experimental data.

Look, D.C. Jr. Mechanical and Aerospace Engineering and Engineering Mechanics, University of Missouri-Rolla. PRESSURE/INTENSITY EFFECTS ON THE OPERATION OF A SOLAR RADIOMETER. An experiment was set up to investigate the effects of ambient pressure and incident intensity on the operation of a solar radiometer. The results of a preliminary experimental effort were inconclusive down to pressure of 0.15 mm of mercury (i.e., 0.15 torr); interesting qualitative information was obtained. Based upon the preliminary results, a refined experiment was developed using a fair quality glass vacuum chamber to reduce the pressure to 0.0001 torr. The data collected in this revised experimental effort showed a trend that supports the particle theory. The particle theory is based upon

particles of air more energetically "jumping away" from the rough black surface of the radiometer than from the rougn silver surface. A fourth order polynomial expression describing the rotational rate as a function of chamber pressure was defined by this latest experiment, and it is now possible to predict the rotational rate characteristics as a function of pressure variation down to a pressure of 10^{-4} torr ($1.32(10^{-7})$ atm). The results of the pressure experiment indicate that the vane rotation frequency of the radiometer increases as the pressure is decreased down to a pressure of approximately 0.0001 torr. As the pressure continues to decrease, the vane rotation frequency also decreases. Even at the lowest pressure obtained (10^{-4} torr), the effects of the classical radiation pressure were not detected.

Pulse, D.L. EJL Electronics and the Empire District Electric Company. DRANSOFT 5.0 - GRAPHICAL DATA ANALYSIS SOFTWARE FOR USE WITH THE DRANETZ 626 UNIVERSAL DISTURBANCE ANALYZER. Power Quality is becoming a very important issue in the 1990's. Many companies find it important to be able to monitor the incoming power to a piece of equipment or facility. The Dranetz 626 Disturbance Analyzer equipped with a 6003 and 6006 plug-in module is a commonly used piece of test equipment by utilities, equipment manufacturers and service technicians. The 626 is capable of providing detailed data concerning voltage and frequency. The data, as provided by the 626, is hard to interpret without significant time investment. Dransoft 5.0 is a personal computer based software package, compiled in Fortran 77, capable of transforming raw 626 data into written reports and graphical screens. Data correlation to the CBEMA curve, transitory energy content and percent voltage variation are calculated. Dransoft 5.0 can reduce data analysis time and, when employed on site in the field, help to characterize the power profile before equipment installation or the application of mitigation techniques.

Vosnidis, G., J.F. Kunze. Nuclear Engineering, and **J.S. Morris,** Research Reactor, University of Missouri-Columbia. DETERMINING PARTS PER TRILLION CONTENT OF NON-RADIOACTIVE METAL IONS IN SPENT FUEL POOL WATER. As reported previously (MAS, 1992), spent fuel shipping casks adsorb slight amounts of radioactive metal ions while being loaded in the spent fuel pool. These ions bind themselves into the surface, and present themselves as a "fixed", low level source of contamination, undetectable in the presence of the higher levels of radioactivity coming from the contents of the shipping cask. If some of the atoms become unbound and loosely attached on the surface, then this removable contamination, usually only about 1% of the total, can be detected by a health physics swipe. Attempts to remove or loosen the fixed contamination have been unsatisfactory. Current efforts are to pacify the surface before immersion into the pool. But first we need to know the concentrations of non-radioactive metal ion species in the water. The radioactive levels of Co-60 and Cs-137 are in the range of picograms per cc. The non-radioactive species are expected to be about a factor of 10 higher. Determining these very low levels can be done by neutron activation analysis, except for the problems of impurity contamination, and the potential of rupturing of the sample container from boiling of the water in the high neutron flux needed. Measurement methods at levels of a few atoms per 10^{12} water molecules will be reported. Supported by Sandia National Labs, USDOE, 05-5889.

Zarkasi, A. and J.F. Kunze, Nuclear Engineering Program, University of Missouri-Columbia. CORRELATION TO PREDICT THE ENHANCEMENT OF THE HEAT TRANSFER FROM DISSOLVED GAS. The water coolant in most operating power reactor systems is kept free of dissolved gas. However, in most research reactors, which operate at temperature below 70°C and low pressure, the dissolved gas remains present in the water coolant system. The presence of dissolved gas in the water coolant would affect the boiling mechanism and enhance the heat transfer coefficient of the water coolant. This dissolved gas might have a major effect, during accident conditions, when the fluid quickly reaches boiling, and flow reversal must occur. In spite of the significant effect of the dissolved gas on the thermal hydraulics behavior of a reactor cooling system, none of the heat transfer correlations in the reactor thermal hydraulics safety computer codes consider this effect. To predict the enhancement of the heat transfer due to dissolved gas, we have used the heat transfer correlation of Bjorge. This correlation is based on the superposition technique and permits the inclusion of the incipient boiling criterion.

ENVIRONMENTAL SCIENCE AND CONSERVATION

Baum, A.S., G.K. Murdock and J.R. Jackson, Biology and Psychology Departments, Missouri Southern State College. TECHNIQUES OF BISON (Bison bison) GRAZING PREFERENCE DETERMINATON AT PRAIRIE STATE PARK. Two grazing preference analysis techniques are being used to determine the value of bison as a prairie management tool. The first is field observations of bison grazing preference and behavior. Also, all of the occurrence of defecation during the field observations are noted. The second is an analysis of fecal material. The fecal analysis involves the preparation of a reference set of microscope slides with know prairie species. Dried bison fecal material is then compared to the reference slides enabling the fecal species composition to be quantitatively determined. The results combine the two techniques and describe grazing preference as it effects pressure on exotic species, native species, cool season, and warm season grasses.

Campbell, T.A. and J.A. Arruda. Department of Biology, Pittsburg State University. THE EFFECT OF LAND USE ON WATER QUALITY IN TWO SOUTHEAST KANSAS WATERSHEDS. The purpose of this study was to evaluate the effect of land use on water quality in southeast Kansas. Two watersheds were identified as having primary land use that differed. The first is used primarily as low density cattle pasture (70%) and the second as cropland (60%). Four sample sites were chosen along the main channel of both streams. These sites were chosen with respect to geographic and habitat characteristics. Each was sampled monthly for chemical and biolgical water quality. There was a significant difference between watersheds ($P<0.05$) in dissolved oxygen (lower in the cropland watershed) and turbidity, ammonia, and total phosphorus (all higher in the rowcrop watershed). Intolerant and fairly intolerant fish species make up 26.32% of the population in the pastured watershed and none of the other. Species tolerant of pollution made up 84.67% of the community in the cropland watershed compared to 26.98% of the pastured.

Mantei, E.J., R.L. Ernst and Y. Zhou. Department of Geosciences and Chemistry, Southwest Missouri State University. HOMOGENEITY OF METAL QUANTITIES SPECIATED IN CHEMICAL PHASES IN STREAM SEDIMENTS. Restricted grain size sediment samples were collected along two streams. Metal content in some samples may have been influenced by landfill emissions. Each sample was divided into a grab portion, a quartered portion, and a portion crushed and sieved to a smaller size and then quartered. A duplicate sample from each of these portions was extracted. The Cu, Pb, Zn, Co, Ba, Fe. Mn and Ca quantities were determined for each duplicate sample. Atomic absorption analyses procedures were used. Relative standard deviation was used to reflect homogeneity of metal content. Metal occurrence represented speciated metals or major components of chemical phases. Results indicated variation of metal content among portions was uniform and did not vary as a function of absolute metal quantity. Homogeneity was similar in the same size grab and quartered samples. A more homogeneous metal state was displayed by the crushed and sieved sediments. However, this activity enriched softer chemical phases and associated speciated metals. It was concluded that sediments need not be quartered to obtain a better homogeneity of metal distribution, and field samples should not be crushed and sieved prior to chemical analyses. Assessment of sediments affected by metal emission sources must include a knowledge of metal homogeneity in individual samples.

Pastore, RJ. and S.P. Singh. Division of Science, Mathematics and Allied Health, Kansas Newman College. GROUNDWATER CONTAMINATION IN WICHITA/SEDGWICK COUNTY REVISITED. There are 1315 known groundwater contamination sites in Kansas and 80 percent of these are located in Wichita/Sedgwick County. This study was conducted in an attempt to better understand the nature and extent of groundwater contamination. A contaminated site located within 5 miles southeast of Wichita was the primary focus of this investigation. The pipeline operators' error caused major leaks releasing over 40,000 gallons of benzene, a well know potent carcinogen. Kansas Action Level for benzene is 5 parts per billion and the water tested after 14 months of the spill at the site for benzene far exceeded by 3,400 times the cancer causing level. All this time, nearby residents were not

notified of contamination, and today, the site is not posted and is freely accessable. Although remediation is presently in progress at the site, the decontamination process would take approximately 15-30 years. It appears that the Petroleum Pipeline Industry is loosly regulated and the agencies reponsible to protect public health are not given the power of enforcement and are influenced to foster economic enterprise.

Sadler, J.L., S.H. Taylor and G.J. Cwick. Departments of Biology and Geosciences, Southeast Missouri State University. MAPPING FOREST VEGETATION IN SOUTHEASTERN MISSOURI USING GIS TECHNIQUES. Two studies, each designed to demonstrate the effectiveness of using remotely sensed data and geographic information system techniques to map vegetative patterns and canopy composition, were conducted at two different sites in Southeast Missouri. Multidate Lansat Thematic Mapper data of an area in the Mark Twain National Forest and airborne color IR imagery of Big Oak Tree State Park were computer processed using IDRISI and TOSCA software programs. Supervised and unsupervised classification maps were then intergrated with compartmental records from the Missouri Department of Natural Resources and field data in a GIS to test the validity of employing such techniques to accurately denote the distribution and composition of tree species at these locations. Preliminary results indicate that such an approach is effective for mapping in this regard.

Sharp, J.R. Department of Biology, Southeast Missouri State University. THE EMBRYOTOXIC EFFECTS OF MERCURY TO THE PERCID SPECIES: *ETHEOSTOMA CAERULEUM*. Cleavage embryos (8-16 cell stage) were exposed to mercury, as Hg++ (HgC_2 -Sigma) throughout developemnt. Five replicates of 10 embryos each were exposed to 0, 10, 20, 40, 60, 80 and 100 ppb Hg++. A 24-h static renewal toxicity test was used. Embryos were observed for mortality, abnormal development, hatching success, and viability of hatch. Embryonic abnormalities, e.g., synophthalmia, hemorphaging, caridiac malformation, and dwarfism, were observed. Spinal curvature, frayed fins, and synarthrodic jaws were detected following successful hatch. Statistical differences (from control data) in the embryos were noted for mortality, abnormal development, hatching success, and viability of hatch at 40, 20, 20, and 10 ppb, respectively. The resulting 96-h LC50, AB50, SH50 and VH50 werre 51.6, 29.7, 26.9, and 16.2 ppb. Embryonic heart rates were determined on the day prior to hatch. A significant reduction in beats per minute was noted for embryos exposed to concentrations greater than 10 ppb. First day larvae were measured to assess the influence of mercury on enbryonic growth. Larvae exposed to 10 ppb, and all higher concentrations,were significantly shorter than the control. Supported by EPA.R-810112.

Sheets, R.W. and A.D. Luna. Department of Chemistry, Southwest Missouri State University. MEASUREMENT OF AIRBORNE NITRATES DURING A TWO-YEAR PERIOD AT SPRINGFIELD, MISSOURI. Nitrate concentrations in airborne particulate material were monitored during a two-year period (August, 1986-Auguest, 1988) at Springfield, Missouri. Nitrates werre extracted from glass-fiber filters and determined by the Brucine method. Atmospheric concentrations ranged from below detection limit to 3.1 micrograms/m^3 with a mean value of 1.0 microgram/m^3 for the period. Average nitrate content of the total suspended particulate material collected was 2.7% by mass, but no correlation was found between mass of nitrate and total mass in individual samples. Airborne nitrate concentration showed a seasonal dependence with highest values in mid-winter and lowest values in mid-summer. This time dependence is attributed to the thermal stability of the atmosphere. Washout by rainfall was found to be an important mechanism for removal of particulate nitrates from air.

Sivalingam, S. ANALYTICAL ELECTRON MICROSCOPY AND X-RAY DIFFRACTION OF COMMON CLAY MINERALS IN ASBESTOS CONTAINING MATERIALS. Accurate characterization of clay minerals is essential for product identification in cost recovery litigation. Chrysotile, montmorillonite, vermiculite, kaolinite and talc are the most common clay minerals identified in asbestos containing materials. Chrysotile and talc are 1:1 Mg-silicate with different morphology and electron diffraction (ED) pattern. Chrysotile has a Mg/Si ratio ranging from 0.7 to 0.9, but talc has a ratio of about 0.4. The cylindrical nature of chrysotile fiber produces a unique ED pattern with streaked layer line distance ranging from 5.03A to 5.56A. However, talc has a pseudo-hexagonal ED pattern

similar to mica. Montmorillonite is a 2:1 hydrous Al-silicate with Al/Si ratio ranging from 0.3 to 0.42. Vermiculite and montorillonite can be distinguished by x-ray diffraction. The basal reflection of Na-montmorillonite swells to 17.67A upon glycerol saturation. With vermiculite, when Mg-saturated, the 002 reflection about 14.3A collapses upon K-saturation to 10.2A. Koalinite is a platy Al-silicate with pseudohexagonal ED pattern.

Spellman, E.E., Department of Physical Sciences, Emporia State University. ENVIRONMENTAL STUDY OF DEVILS LAKE, NORTH DAKOTA, USING LANDSAT MULTISPECTAL IMAGERY. Landsat multispectral scanner (MSS) imagery was used to document enviromental changes that have occurred in Devils Lake f rom 1973-1991. Devils Lake, a terminal lake with glacial origins, is the focus of this study due to its climatically controlled and fluctuating water level. As the lake has no drainage outlet, much concern was expressed by local citizens in 1988 when the water level rose to an elevation which threatened to flood the community of Devils Lake, a national guard camp, roads, fields and sewage lagoons. Citizens of the area are interested in identifying a way to stabilize the water level so as to eliminate futrue flood threats. Special image enhancement techniques were used to emphasize land and water details. A technique for isolating the lake surface from the remainder of the image was also developed. The processed images were viewed chronologically to document the historical surface area changes of the lake. Also, climatological data were examined as a means to explain the observed lake water levels. Other notable observations include the detection of vegetation patterns, algal blooms, and water turbidity pattern.

Spratt. J.G., Jr. and K.W. Lee. Department of Biology, Southeast Missouri State University. MICROBIAL SULFUR TRANSFORMATIONS IN A-HORIZON SOILS OF A SOUTHEAST MISSOURI FOREST. Sulfur transformations in A-horizon soils were determined for soils collected from sites in Deer Run State Forest near Ellington, MO. Samples were collected during July, Sept. and Oct., 1992. Sulfur pools detemined included: total sulfur, soluble sulfate, adsorbed sulfate, and organic sulfur fractions (ester sufate and carbon bonded sulfur). Sulfur transformations were quantified using trace additions of $^{35}SO_4^{2-}$ to aliquots of sieved soils, followed by 48 hour aerobic incubations at field temperatures. The microbial nature of the transformations was determined using aliquots of soils amended with sodium azide or formalin, to which label was added after a brief pre-incubation. Total sufur ranged from 19.2 ± 3.9 to 21.2 ± 5.8 μmol/g dry mass (± ISE) After incubation with $^{35}SO_4^{2-}$ label was recovered in each of the sulfur fractions determined (as % total label added, mean ±ISE); soluble sulfate, 61.5 ± 3.5%; adsorbed sulfate, 19.5 ± 3.4%; and organic sulfur, 6.6 ± 2.2%. Total label recovered ranged from 80.3% to 96.5%. Recovery of label from poisoned soil samples was different in only the organic sulfur fraction. Comparison of this data with published data for forested soils in New Hampshsire or North Carolina indicates that sufur cycling in these Missouri soils follows similar pathways.

FORENSIC SCIENCE

Finnegan, M. and J. Finnegan. Osteology Laboratory, Kansas State University. ANALYSIS OF TURKEY CARCASSES: A TEST OF DISCRIMINANT CLASSIFICATION ACCURACY. Earlier studies have developed univariate and multivariate discriminant functions for classifying turkey *Meleagris gallopayo* carcasses as to gender and wild versus domestic. This study is a test of the accuracy of those classification techniques. Measurements of various skeletal elements taken on 16 wild and 54 domestic turkeys, evenly divided between the sexes, were applied to the discriminant functions and classification error was obtained. The results show the caropmetacarpus (a wing bone) is the best single discriminator of gender in both wild and domestic birds. The ratio of sternal (breast bone) length to breadth, while most accurate in classification of wild versus domestic birds, suffers from reduced sample sizes. Following the sternum, variables on the tibiotarsus (drumstick) produce the best discriminators.

Thomas, K.R., J. Gregory, L. Cregan, and L. Love. Department of Biology, Kansas Newman College. CONGENITAL PORPHYRIA AND THE LEGEND OF THE WEREWOLF. Porphyria is a genetic disorder characterized by a disturbance in the biosynthesis of porphyrin, the precursor of the hemes. Two general types of porphyria have been described; both are the result of a unique enzyme defect. Sufferers of porphyria show, among other symptoms, an extreme photosensitivity, mottled skin with vesicles and bullae, hypertrichosis, disfiguration (or loss) of digits, the nose, or the ears, cutaneousensitivity to garlic, a cubicund glow within the mouth, and deterioration of gingival tissue (resulting in a fang-like appearance of the teeth). Today several chemotherapeutic regimens are available; historically, however, sufferers of the disease could find relief from their torment by drinking animal or, preferentially, human blood. The legend of the werewolf, who "wandered about at night, disclosed bestial habits, had excesive hair on the face and hands; and whose skin bore score-marks and sores. . ." dates from ancient times, and has been prominent in Celtic, Nordic, Slavic, Russion, Japanese, and Chinese folklore. After an extensive literature search, we suggest that historical accounts of werewolf (and vampire) sightings and attacks were accurate--the "monsters" themselves were victims of porphyria. We will present summaries of the works of several researchers which support our speculatioin.

GEOGRAPHY

Barnes, C. Taylor, Department of Geology and Geography, Northwest Missouri State University. STUCKEY'S: A SPATIAL LOOK AT THE CLASSICAL HOTELLING MODEL. The locational interdependence model of spatial economic analysis as outlined by Hotelling (1929) has application to changing locational pattern of Stuckey's establishments along interstate 70 between Goodland and Topeka, KS. Although there are inconsistencies in the Stuckey's case relating to duopolists, in this case Nickerson Farms, an argument can be made for its agglomeration implications. Time series analysis reveals firms competing along a linear market (I-70) under conditions of imperfect competition can survive by relocating to the quartiles as suggested by Chamberlain (1936). With entry of a third firm, there has been a tendency toward market saturatioin. However, this research reveals that through adherence to agglomeration principles, product differentiation and changing dietary preferences, Stuckey's has partially survived the competition and is reclaiming some market share.

Bradley, Jeffrey D. Department of Geology/Geography, Northwest Missouri State University. RURAL LAND USE CHANGES AND LOCAL CLIMATE IN THE CROSS TIMBERS OF OKLAHOMA. Human impact on climate is a topic which has been receiving increased attention in the literature. Such literature, however, has often focused on urban processes such as carbon dioxide emisison and the development of heat islands. The link between human activity and climate in rural environments has rarrely been discussed. This research focused on the Cross Timbers of Oklahoma to determine the linkage between land use changes and local temperature trends in rural areas. This region of central Oklahoma has undergone significant alteration of the landscape during the past 100 years. It was hypothesized that land use change would be reflected in the climate record at the county level. To test this, land use categories of cropland, woodland and pasturedland were established. Climatic data were composed of mean monthly temperatures for months of January and June. Linear and polynomial trends for temperature and land use were analyzed to determine general relationships. In addition, Spearman correlation coefficients were generated for the land use categories and mean monthly temperatures. The results indicated that regional cooling trends were enhanced in counties experiencing increases in vegetal cover and moderated in counties experiencing decreases in vegetal cover.

Corcoran, W.T. Department of Geography, Southwest Missouri State University. CHANGES IN PLANT DISTRIBUTIONS SINCE PUBLICATION OF STEYERMARK'S *FLORA OF MISSOURI*. Since Julien Steyermark published his *Flora of Missouri* in 1963, it has been the authority for the

occurrence and distribution of vascular plants in Missouri. Steyermark recorded 79,411 county occurrences (the occurrence of a taxon in a county) for 3080 plant taxa. For over a decade, the Missouri Native Plant Society has been publishing supplementary distribution lists of plants which occur in counties outside the range Steyermark delineated. Over 5,000 of these records have been added to Steyermark's data, changing the distribution maps markedly. The mean number of taxa in a county has gone from 726 to 776, the minimum from 344 to 405, and the maximum from 1814 to 1829. Although the rank order of the five counties with the greatest number of taxa remains the same, the five counties with the fewest taxa have changed significantly, both in relative rank and in number of taxa, perhaps reflecting a concerted effort by collectors to concentrate on areas where knowlede is less complete. The tendency stll remains for counties with high human population densities to record high numbers of plant taxa. A series of maps illustrates these distributions and their changes.

De Bres, K.J. Department of Geography, Kansas State University. CORRIDOR TOURISM: THE CHALLENGES OF TOURISM IN KANSAS. Great Plains tourism focuses on corridor interstate travel; in Kansas the main corridor is Interstate 70. Tourism is now the third largest industry in the state, and this paper discusses the efforts made to lure the tourist off the highway. The strength of the concept of distance decay as it relates to Kansas tourism is also evaluated. In 1991 Kansas led the nation in the rate of growth of overseas tourism, and international visitors, like the Americans, are drawn to the "cowboy and Indians" image of frontier Kansas. This paper also discusses the ways in which Kansas towns, particularly Abilene, work to enhance their frontier image, and the success or lack of success that the recreation of "cowtowns" has had in the Kansas tourist industry as it enters the last decade of the twentieth century.

Dodds, Charles. Department of Geology/Geography, Northwest Missouri State University. ANALYSIS OF REQUIRED, CORE AND TOTAL COURSE OFFERINGS IN GEOGRAPHY AT THE BACCALAUREATE LEVEL IN SELECTED U.S. COLLEGES AND UNIVERSITIES. Demands for major field assessment in Geography at the regional and national level have led naturally to the question of what a geographer should know. To some extent, what a student graduating with a baccalaureate degee knows is based on the curriculum offered by the program just completed. The objective of this study is to collect and present data about course offerings from 2 specific populations and a composite of those two, plus some additional programs. The two specific program populations are the 20 identified in the study by Darrall A. Norris, SUNY Genesco, as the most effective national programs in attracting students and producing majors, and Midwestern universities which offer baccalaureate degees in geography. In addition, a non-scientific sample of baccalaureate programs nationwide, based on either size or reputation as significant programs is included. The results show the typical core requirements for majors, required courses in corollary fields, and all the courses offered, which will help identify what is being taught in geography. Courses are identified by content since there are large numbers of course names applied to courses with similar content at different institutions. This study can then provide a springboard for discussion of what areas of common content could be assessed at a scale larger than the individual program.

Hawkins, R.S. and B. Becker. Departments of Technology and Geosciences, Southwest Missouri State University. HOW COMMUNITIES ARE TO RESPOND TO THE GROWING NUMBER OF FEDERALLY MANDATED REGULATIONS. Communities in the United Sttes are facing difficult decisions as federal government requirements mandate compliance of regulations often based on high technical choices. Regardless of the technical and scientific knowledge required to make decisions, it is the citizens of communities that ultimately must live with and finance the actions taken by local governing entities. This study analyzes the issue of citizen participation in technical decision making through the use of a case study involving the federal mandates of solid waste flow control and the use of a Materials Recovery Facility. Citizen participation, solicited and unsolicited, is analyzed. Professionals and students in professional programs are surveyed to determine where each group sees the proper points of citizen participation and the degree of information which citizens must have to be involved. Also considered in this study is the amount of mis-information which is generated around such a controversial yet technical issue. It is hoped that such studies will assist governing bodies and citizens to find ways in

which to facilitate arriving at public policies that center more and more around technical issues. It is anticipated that more and more decisions in the future will be based on highly technical information, yet those people most affected by policies will continue to be active in the process. As these issues become more complicated, there must be a way to allow untrained citizens to participate effectively in the process.

Ratzlaff, J.R., Department of Geosciences, Fort Hays State University. AN ISOLINE MAP OF AVERAGE RUNOFF RATIO IN KANSAS 1971-90. Runoff rato is the proportion of precipitation which becomes streamflow. The runoff ratio map was derived from isoline maps of mean annual precipitation and mean annual runoff for the period from 1971-1990. Precipitation data from 120 weather stations were used to construct the isohyetal map. The isohyets trend north-south, decreasing rather uniformly from 110 cm in the southeast to 40 cm in the southwest. Streamflow data from nearly 100 gaging stations were used to construct the isolinemap of mean annual runoff. Runoff varies from 40 cm (southeast) to .05 cm (west). In general, the isoline pattern mirrors the pattern of isohyets, although it is more complex; the otherwise strong east-west gradient is interrupted in several places by closed contours and north-south gradations. These complexities reflect the effects of variations in land use, soil, and slope. Runoff ratio varies from 40 precent (southeast) to 0.1 percent (southwest).

Schmiedeler, Tom. Department of Geology/Geography, Northwest Missouri State University. ORIGIN AND EVOLUTION OF CENTRAL COUTHOUSE SQUARE TOWNS IN KANSAS. The Midwest of the late nineteenth century had a diversity of urban morphologies including a variety of central courthouse square plans. This paper discusses the origin and evolution of this urban form, and its introduction into a six county area of north-central Kansas. In this region, the central courthouse square plan occupied an intermediate historical and geographical position between the older, and clearly potitical core region of the square in Virginia and other Southern states, and the newer, obviously speculative versions of the form in the Northern Plains. Historical accounts, biographies, original plat map, Sanborn maps, and deed records provided an adequate basis for determining the changing motivation underlying usage of the form from its inception in the South to its implantation in north-central Kansas. Midwestern speculators used the form in north-central Kansas because it appealed to voters in county seat elections who viewed the plan as symbolic of the civic and social functions of the American county seat. Planners utilized only one type of central courthouse square in north-central Kansas--the block square--but individual forms of the block squares maintained a diversity that was expressive of the pervasive individualism that characterized town founding in Kansas.

Tindall, R.W. Department of Geography, Kansas State University. IMPACT OF THE RIVER MARKET PROJECT ON SURROUNDING NEIGHBORHOODS IN KANSAS CITY, MISSOURI. This study compares pre-rehabilitation and post-rehabilitation indicies of population and economic change in the River Market Area (census tract 2) and surrounding tracts to determine the effect of rehabilitation. Results are based on census tract data for 1980 and 1990. Change from 1980 to 1990 was converted to percentages of change within individual tracts then compared to percentages of change of the overall study area. Personal interviewes were also conductd to determine perceptions of change. Results suggest that change in number of residents, number of families, marital status of area residents, income levels, and rents can be attributed to rehabilitation, predominantly in tract 2, to a lesser extent, in adjacent tracts.

Weller, Kay E. Department of Education, Kansas State University. CHILDREN'S PERCEPTIONS OF WATER RESOURCES. The purpose of this research was data generation concerning perceptions children have toward water resources. This research will assist geographers to assess the needs of children as environmental education components are integrated into the geography curriculum. Education regarding natural resources is essential to produce citizens possessing knowledge of the biophysical environment, having an awareness of the problems and solutions associated with natural resources, and motivated to work toward a solution to those problems. The semantic differential was the instrument measuring the perceptions subjects have toward nine concepts pertaining to water resources.

GEOLOGY AND GEOPHYSICS

Bain, B.A. Division of Physical Sciences, Emporia State University. KARST DEVELOPMENT IN CENTRAL BUTLER COUNTRY, KANSAS. Research was conducted to study the geology and hydrology of sinkholes, springs, and caves formed in Lower Permian, Fort Riley Limestone, located in central Butler County, Kansas. Research was accomplished in seven phases: literature search, locating karst features, measuring bedrock fracture joint trends, surveying major caves, estimating discharge of springs, dye tracing, and water chemistry analysis. The karst terrain found within the study area is clearly a system of interrelated features and processes. Long-term solution of the bedrock allows joints and bedding planes to enlarge, thus creating an efficient network of subsurface drainage. Factors controlling karst development in the study area are lithology, thickness, and dip of the bedrock; presence of well defined joints and bedding planes; relatively level topography; nearby entrenched river valleys; lack of thick, surficial cover; and climate.

Boltz, William H. (deceased), **Wakefield Dort Jr.,** Department of Geology, University of Kansas, and **Curtis J. Sorenson,** Department of Geography, University of Kansas. INTERPRETATION OF THE "TOPEKA TERMINAL MORAINE". A narrow, elongate ridge in the southwestern part of Topeka clearly marks the limit of an advance of Pleistocene continental ice. Till and erratics are present on the crest of this ridge and to the east, but none have been found directly to the west. Deep excavations for water mains, sewer lines, and an Interstate Bypass provided excellent exposures through the ridge. Intense weathering of the till to the maximum depth exposed created high coloration by iron oxides; in places the result is similar to a bog-iron deposit. The upper part of the original soil profile is missing; the flat ridgecrest is, therefore, a product of postglacial erosion. The present ridge of till is underlain by a bedrock high. It is not a true moraine preserved since mid-Pleistocene time. Far-travelled erratics are randomly grouped, there being local concentrations of quartzite or of granitic cobbles and boulders, as well as roughly even distributions in other places.

Emerson, J.W. Earth Science, Central Missouri State University. GEOMORPHIC FIELD WORK-A USEFUL TOOL. Any hypothesis dealing with the earth should always be backed up by field work whenever possible. The cyclic erosion concept of W.M. Davis has influenced studies of the geomorphology of the Missouri Ozarks for 100 years. J. Harlan Bretz, in his book, *Geomorphic History of the Ozarks*, 1965, stated his intent to defend the validity of the Davis concept against the new ideas emanating from Quinn, Hack, King, and Penck. Bretz identified and correlated several peneplains with the use of topographic maps. His evidence was that these flat "erosion" surfaces truncated Paleozoic rocks of diverse lithologies and age as indicated on the bedrock Geologic Map of Missouri. He identified a large area, which includes Knob Noster, Lamonte, Sedalia, Green Ridge, and Tipton, as part of thte Ozark Peneplain. Study of numerous outcrops and excavations, and of coring and sample logs show that this flat area is depositional, not erosional. Pleistocene pro-glacial lake clays and silts containing spruce pollen overlie a well dissected Cenozoic landscape.

Everhart, M.J., P.A. Everhart. NOTES ON THE BIOSTRATIGRAPHY OF THE PLETHODID *MARTINICHTHYS* IN THE SMOKY HILL CHALK (UPPER CRETACEOUS) OF WESTERN KANSAS. *Martinichthys* is an obscure genus of plethodid fish whose remains have been found only in the Smoky Hill Member, Niobrara Chalk, of Western Kansas. The genus was originally described by C.E. McClung (1926) and was named by him in honor of H.T. Martin who had collected one of the most complete specimens in 1909. Earlier workers, including Cope (1877) and Hay (1903), had assigned the fragmentary and enigmatic remains to the genus *Protosphyraena*. While several of the specimens of *Martinichthys* collected by McClung and others do include locality data, there has been no information published on the stratigraphic interval in which these rare fossils were found. Field work by the authors between 1988 and 1992, and examination of more recent and better documented specimens in the Kansas University and Fort Hays University collections have shown that *Martinichthys* occurs only in the lower one third of the Smoky Hill Chalk, and more precisely, in the stratigraphic interval

between Hattin's (1982) Marker Units 3 and 5. The approximate five meter interval correponds to the upper portion of the biostratigraphic Zone of *Protospnhraena pernicosa* proposed by Stewart (1990) and is of the late Coniacian age.

Hagni, Ann M., Richard D. Hagni, Department of Geology and Geophysics, **Mark E. Schlesinger, Y.-D. Chung,** Department of Metallurgical Engineering, University of Missouri-Rolla. MINERALOGY AND CHARACTERIZATION OF IRON-OXIDE SLAG ATTACK OF MAGNESIA STABLIZED ZIRCONIA REFRACTORY. Zirconia, ZrO_2,, has a high melting point, chemical stability, and resistance to corrosion that renders it useful in the refractory industry. When mixed with 10% lime, the zirconia remains stable over a broad temperature range, and is used in the steel industry for nozzles and ladle slag-lines, and in glass melting furnaces. This study examined the effects on stabaility of 3-1/2% and 8% MgO. Magnesia stabillized zirconia (MSZ) at 1550°C for 40 minutes and exposed to FeO-CaO-SiO_2 slags were studied by mineralogical techniques to determine the extent of slag penetration, slag reaction with MSZ, and the mineralogy of the reaction products. High iron slag (29% FeO) had a greater slag penetration, 2.4 mm, into the MSZ than the low iron slags (7% FeO, average of 525 uγm). Reaction products identified were CF_4S, $C_3F_2S_4$, rankinite (C_3S_2) and $CaZrO_3$. The red cathodoluminescence of C_3S_2 shows its relationship to the slag and MSZ. $CaZrO_3$ formed by corrosion of MSZ and ZrO_2 formed by dissolution of the MSZ. Extensive penetration of the zirconia refractory by the high-FeO slag indicates that FeO is a more corrosive slag constituent that SiO_2 or CaO.

Li, Bin, J.T. Lee and O.K. Manuel. Department of Chemistry, University of Missouri-Rolla. ANOMALOUS ^{131}XE IN BARITES FROM NEUTRON-INDUCED RACTION ON ^{130}BA. The excess of ^{131}Xe in lunar samples was considered as from the reaction $^{130}Ba(n,\gamma)^{131}Xe$. The measurement of ^{131}Xe in samples high in barium content can provide a test for the postulation. Five barite samples from the United States were analyzed for their xenon and krypton abundance and isotopic composition. Anomalous ^{131}Xe was detected in two of the samples, T118 from Pea Ridge Mine, Sullivan, Missouri and T119 from Franklin New Jersey. The ^{84}Kr and ^{132}Xe abundances are 7.78×10^{-11} ccSTP/g and 5.17×10^{-12} ccSTP/g for T118, and 2.7×10^{-11} ccSTP/g and 2.86×10^{-12} ccSTP/g for T119, respectively. The ^{131}Xe relative to atmosphere is 1883 for sample T118 and 1236 for sample T119. Previously, excess ^{131}Xe has been found in lunar samples and two terrestrial barites from 54South Africa and Australia. This result further confirms the postulation that the excess ^{131}Xe in the lunar samples are from the reaction $^{130}Ba(n,\gamma)^{131}Xe$. The possible sources of the neutrons needed for this reaction are the spontaneous fission of ^{238}U and perhaps the reaction $^{18}O(\alpha,n)^{21}Ne$ with the α particle provided by the decay of ^{238}U and its products.

Li, Bin and O.K. Manuel. Department of Chemistry, Universitiy of Missouri-Rolla. NOBLE GAS GEOCHEMISTRY OF THE KUROKO DEPOSITS. This work tries to use noble gas abundance and isotopic composition to identify between mantle and crustal sources and apply the technique to the Japanese Kuroko deposits. The mantle and the crust have different abundance patterns of noble gases (Ozima and Alexander, 1976). The isotopic composition of He, Ne and Xe for the mantle and the crust are also separted (Allegre et. al, 1987; Allegre and Staudacher, 1986). These propeties can be used to distinguish mantle materials from the crustal ones. Eighteen Kuroko ore samples were analyzed for their Ar, Ne, and Xe abundances and Ar and Xe isotopic composition. The results are in good agreement with other isotopic and geochemical data. Most of the samples show seawater isotopic composition of Ar and Xe which confirm the conclusion of previous studies that the seawater is the major component of the Kuroko ore fluid. The high ratios of the heavy xenon isotopes in some of the ore samples suggests the existence of fissiogenic components in the ore samples. This also implies that there might be substantial contributions from the mantle source. Further analysis of He isotopic composition of the Kuroko ores is needed to get a full picture of the genesis of the Kuroko deposits.

Merriam, D.F., A. Forster, and R.J. Sampson. Kansas Geological Survey, The University of Kansas, and GeoForschungsZentrum-Posdam. MINERAL SPRINGS AND WELL WATERS OF EASTERN KANSAS AND THEIR RELATION TO THE GEOTHERMAL FIELD. In 1902, E.H.S. Bailey

published a report on the mineral waters from springs and wells, and although limited in nature, these data are considered in the context of the known geothermal conditions of Kansas. Because of large vertical contrasts in sediment thermal conductivity, significant different temperatures occur at the same depth in different parts of the State. The local temperature-depth distribution can be explained generally as follows: the thicker the Pennsylvanian clastics (shales), the larger the thermal 'blanket' effect over the relatively high heat-conducting Mississippian and older carbonates. The surface springs show a decrease in temperature from about 20°C to 12°C from southeast to northwest. In a simplified situation a depth from which the water came can be drived from structural and heat-conducting conditions. This would imply that the waters of springs in southeastern Kansas come from deeper depth ranges than in the sedimentary basins.

Neuhauser, K.R. Department of Geosciences, Fort Hays State University. A SIMULATED ENVIRONMENTAL RESEARCH PROJECT IN GEOLOGIC FIELD METHODS CLASS AT FORT HAYS STATE UNIVERSITY. Metalliferous materials were buried in different control sites on the Fort Hays State University campus. The buried materials: 55-gallon steel drums, an electric motor, and scrap steel provided the Geologic Field Methods Class an opportunity to conduct a magnetometer survey over one of the sites in order to detect and to locate the different anomalous patterns generated by these buried metals. The applied-geophysics project involved a team effort where students were required to review basic magnetic theory and surveying principles. Students learned to operate the magnetometer; set up a survey grid; conduct the survey; utilize digitizers, generate computer graphics; interpret the data; and, prepare a report using word-processors and text analyzers. On completion, the team was encouraged to present a seminar or poster session of their results. The "hands-on" class project provides an atmosphere of critical thinking and it simulates a real-life environmental scenario facing many environmental agencies today.

Rasberry, Mark A., Richard D. Hagni, Department of Geology and Geophysics, University of Missouri-Rolla, **Wayne T. Walker,** ASARCO, Missouri Mines Division, **Andrew G. Childers,** Doe Run Company. MINERALOGY AND PARAGENETIC SEQUENCE OF POTASSIC ALTERATION ASSOCIATED WITH PB-ZN-CU ORE DEPOSITS IN THE VIBURNUM TREND, SOUTHEAST MISSOURI. Local occurrences of fine-grained material, commonly called clay pods at the Sweetwater and Viburnum 29 mines in the Viburnum Trend, Southeast Missouri have been investigated by mineralogical techniques. The pods consist mainly of fine-grained sericite and adularia. Sericite plates are 1-10 μm long, 3 times more abundant than adularia, and are particially altered to illite. Adulaia occurs as euhedral rhomb-shaped crystals, about 5 to 25 μm across, that may include the earlier formed sericite. About 60% of the adularia crystals contain cores of rounded, detrital feldspar grains present as an insoluble residue from dissolution of the host Bonneterre Formation. The potassic alteration formed relatively late, during or after east-west faulting transgressive to the dominant trends of the orebodies, and during dissolution of earlier deposited octahedral galena. It formed prior to the deposition of cubic galena, hydrothermal quartz, late chalcopyrite, late marcasite, and calcite

Ravichandren, G.R. and G.J. Cwick. Department of Geosciences, Southeast Missouri State University. USE OF MULTIDATE SPECTRAL DATA AND GIS TECHNIQUES FOR ASSESSING VEGETATION RESPONSE TO ANOMALOUS BIOGEOCHEMICAL CONDITIONS AT A MINERALIZED SITE IN S.E. MISSOURI. A previous biogeochemical investigation found anomalous concentrations of copper and zinc in the soil and vegetation at the Zell mine. These concentrations have the potential to influence the spectral response of the vegetation and be detectable in remotely sensed imagery. In an effort to detect this, multitemporal Lansat-TM data were digitally analyzed using change detection analysis procedures to ascertain if any unique temporal differences existed in the spectral character of the vegetation. Results were then merged in a GIS with geochemical and geological base maps to find the relationship between these spectral attributes and sites having high biogeochemical concentrations. Preliminary results indicate that there is some correlation between anomalous vegetation spectal responses and biogeochemical conditions.

Shimade, K. Department of Geosciences, Fort Hays State University. UPPER CRETACEOUS ELASMOBRANCHS FROM THE BLUE HILL SHALE MEMBER OF THE CARLILE SHALE, WESTERN KANSAS. The occurrence of selachian fossils from the Blue Hill Shale Member (Upper Cretaceous: Middle Turonian) of the Carlile Shale in western Kansas has been known, but they have never been described. The confirmed taxa incudes: *Ptychodus anonymus, P. polygyrus, P. whipplei, Scapanorhynchus cf. S. rhaphiodon, Cretodus crassidens, C. semiplicatus, Cretolamna appendiculata,* and *Squallicorax falcatus*. These taxa represent typical Middle to Late Turonian species known from other Turonian elasmobranch faunas of the United States. Because vertebrate fossils from the unit are poorly documented, the fauna is important as glimpse of the pre-Niobrara paleoecology of the Late Cretaceous Western Interior Sea of North America. The neoselachian taxa are thought to be active carnivores, and, therefore, suggset the possibility of other vertebrates being found in the unit.

Shimada, K. and D.J. Martin. Department of Geosciences, Fort Hays State University. UPPER CRETACEOUS SELALCHIANS FROM THE BASAL GREEHNORN LIMESTONE IN RUSSELL COUNTY, KANSAS. More than 100 selachian specimens were collected from the basal unit of the Lincoln Limestone Member of the Upper Cretaceous Greenhorn Limestone in Russell County, Kansas. The fossils are mostly isolated oral and rostral teeth and include the following taxa: *Ptychodus decurrens, P. cf. P. anonymus, Odontaspis amonensis, O. cf. O. saskatchewanensis, ?O. subulata, Cretodus semiplicatus, Cretolamna appendiculata, Cretoxyrhina mantelli, Squalicorax falcatus, S.* sp., *Onchopristis dunklei,* and *Cretomanta canadensis*. The tooth of *Cretomanta canadensis* represents the second documentation and the oldest fossil record of the species. The comparison with known Middle to Late Cenomanian elasmobranch faunas of the United States indicates that the basal Lincoln is early Late Cenomanian.

Shimada, K. Department of Geosciences, Fort Hays State University. UPPER CRETACEOUS SELACHIANS FROM THE FORT HAYS LIMESTONE MEMBER OF NIOBRARA FORMATION IN ELLIS COUNTY, KANSAS. Unlike the overlying Smoky Hill Chalk Member, the vertebrates from the Fort Hays Limestone Member (Coniacian) of the Niobrara Formation (Upper Cretaceous) in Kansas are poorly known. One elasmosauir fossil, in fact, has been the only vertebrate formally described from the member. In addition to this record, three selachian taxa are recognized at the present time: *Ptyhchodus mortoni, Paranomotodaon* sp., and *Squalicorax falcatus*. The specimens were found in Ellis County, Kansas. *Ptychodus* and *Paranomotodon* are the first records for the member. The occurrence of *S. falcatus* in the Fort Hays off-shore deposits suggest that this shark had the capability of living in various environments. The presence of *P. mortoni* and *S. falcatus* are also known from the Smoky Hill Chalk suggesting the possibility of other vertebrates being found in the Fort Hays.

Underwood, James R., Jr. Department of Geology, Kansas State University. SEISMICITY IN THE MANHATTAN, KANSAS, AREA. The Manhattan area lies within an arcuate belt of moderate seismic risk. The history of seismic activity with epicenters in adjacent counties, beginning in 1867, shows six events ranging in Modified Mercalli Intensity (MMI) from V to VIII that probably were associated with movement along the Humboldt fault that flanks the east side of the Nemaha uplift. Not only are such events likely in the future, Manhattan also can expect to be affected by earthquakes centered elsewhere in Kansas and adjacent states and especially by major events along the New Madrid seismic zone eastward in the Mississiippi valley. Estimates by Algermissen and Hopper (1985) are that an earthquake of 8.6 Richter magnitude along the New Madrid zone would result in MMI effects of VI to VII in the Manhattan area. Residents should be informed about possible seismic activity and urged to take whatever precautions they think are reasonable to mitigate the kinds of damage to be expected. The potential danger is not trivial.

Vann, B.W. Department of Geology, Oklahoma State University. CONODONT BIOFACIES AND EUSTATIC EVENTS OF THE ADMIRE GROUP OF KANSAS. Conodont biofacies analysis across the traditional Carbonifererous-Permian boundary strata of the North American Midcontinent was utilized to demonstrate maximum water depths attained by each glacial-eustatically controlled maximum

transgressive episode. Determing the percentages of the conodonts *Adetognathus* vs. *Streptognathodus* was used as the primary method of distinguishing biofacies. *Adetognathus* dominated conodont assemblages have been consistently equated with near shore conditions, whereas Streptognathodus occurs in more offshore open marine environments. The Brownville Limestone, Five Point Limestone, and Americus Limestone each represent relatively major transgressions (+/- 40-50 meters of water depth) and are characterized by a predominance of *Streptognathodus*. The Falls City Limestone represents an intermediate transgression (+/- 20 meters of water depth) characterized by a mixture of *Adetognathus* and *Streptognathodus*. The Aspinwall Limestone, unnamed limestone in the West Branch Shale, and the Houchen Creek Limestone represent minor transgressions (+/- 5 meters of water depth) characterized by predominance of either *Adetognathus*, or by no conodonts at all. The results of this study confirms Elias's 1937 sea-level fluctuation curve, which was based on fusulinids and distribution of other invertebrates.

Welch, D.K. Department of Biology, Kansas State University. SIZE-FREQUENCY ANALYSIS AND PRESERVATION POTENTIAL OF EXTANT MYTILUS ASSEMBLAGES. Study of the preservation potential of living macrobenthic assemblages is important in interepreting the significance of fossil assemblages. Analysis of a (1) life assemblage and a (2) taphonomically altered death assemblage of the common mussel *Mytilus edulis* is an example of such a study. Biotic components of the life assemblage were sized, and articulation, degree of breakage, and evidence of predation recorded. A sieve analysis indicated that on average 74% of the particles smaller than 2mm in size were abiotic. The altered death assemblage was separated into biotic and abiotic comonents, similar analyses performed, and the results compared to the life assemblage. Those results indicate that small to medium-sized individuals (2-20 mm) have a very low preservation potential. As might be expected, species diversity in the death assemblage is different from that of the life asemblage. Application of these results to fossil occurrences of byssally attached epifaunal bivalves, such as *Mytilus edulis*, indicates that care must be taken in inferring population size and community structure of such fossil assemblagles.

Whittemore, D.O. Kansas Geological Survey, University of Kansas. GEOLOGIC SOURCE OF STRONTIUM UNDERLYING A HAZARDOUS WASTE DISPOSAL SITE. Ground-water quality is being monitored at a site formerly used for the land disposal of hazardous wastes in Sedgwick County, Kansas. One of the constituents that has bern monitored is strontium. An Alternative Concentration Level (alternate to background or contaminant limit) for strontium was set as 1.0 mg/L without prior examination of background levels. During monitoring, strontium concentrations were found to be as high as 16.3 mg/L in the site ground waters. I determined that the source of the high strontium concentrtions is natrural solution of minerals observed and expected in the bedrock. The main mineral providing strontium is celesite, although dissolution of gypsum containing strontium contributes to the total-dissolved strontium concentration. The celesite probably formed during the hydration of subsurface anhydrite to gypsum. Any increases in concentrations of major inorganic constituents introduced by waste leaching are too small to significantly affect the solubility of strontium-containing minerals in the natural ground waters. Strontium concentrations in samples from the background wells located in the upgradient direction of ground-water flow are as great as in samples downgradient of the past waste-disposal area. Supported by the U.S. Environmental Protection Agency.

Young, G.J. Department of Geosciences, Southeast Missouri State University. PETROLOGY OF MAFIC HYBRID ENCLAVES IN SILVERMINE GRANITE, TIEMANN SHUT-IN, ST. FRANCOIS MOUNTAINS, MISSOURI. Recent field studies revealed a 1.5 km zone of mafic hybrid enclaves within the Silvermine granite at Tiemann Shut-in. This study was conducted to determine under what conditions these hybrid enclaves formed. Thin sections of the hybrid enclaves were prepared and examined unter the polarizing microscope. Analsis revealed the presence of a bimodal quartz and feldspar population, mantled feldspars, zoning in plagioclase, quartz ocelli, and acicular apatite crystals with axial ratios as high as 32:1. Collectively, these features indicate mixing/mingling of granitic and basaltic magmas. The hybrid zone indicates interaction between partially crystallized Silvermine Granite magma and a basaltic magma. Supported by Southeast Missouri State University Graduate Research Assistantship.

ONCOLOGY

Case, C., N. Ercal, R. Matthews, and R. Winters. Department of Chemistry, University of Missouri-Rolla. PLASMA FREE AMINO ACID LEVELS IN CANCER PATIENTS. The plasma free amino acid profile (PFAA) is different in a malignant disease state as compared to a normal healthy state. This difference in amino acid levels is believed to be associated with altered protein metabolism and the wasting of body tissue observed in cancer patients. There appear to be discrepancies among previous studies. A recent study reports a decrease in glutamine level in cancer patients compared with healthy controls, while an earlier study reports an increase in glutamine plus glutamic acid level in patients with cancer as compared to healthy controls. We have measured the levels of the amino acids glutamine, glutamic acid, alanine, asparagine, and glycine in patients with cancer of the colon, endometrium, and prostate. The amino acids were measured using a reverse phase High Performance Liquid Chromatography (HPLC) method. Deproteinized plasma samples were derivatized with 9-Fluorenylmethylchloroformate FMOC), and then injected onto a C18 column. The amino acids were eluted using an acetonitrile:water (26%:74%) mobile phase containing 2 mL/L acetic acid and 3 mL/L triethylamine. Detection was performed with a fluorescence detector operating at an excitation wavelength of 266 nm and an emission wavelength of 315 nm. Our results show no significant difference in amino acid levels in cancer patients and healthy control subjects.

Ercal, N. and Matthews, R.H. Department of Chemistry, University of Missouri-Rolla. RESPONSE PATTERNS IN PROSTATE SPECIFIC ANTIGEN (PSA) FOLLOWING DEFINITIVE IRRADIATION OF STAGE D1 PROSTATE CANCER. PSA is a glycoprotein first identified in semen in 1971, and found to have a specific origin in prostate tissue in 1979. It has been used to detect diseased states of the prostate, including prostate cancer, and the response to treatment in recent years. Stage D1 prostate cancer represents spread of the cancer to lymph nodes in the pelvis, and has been frequently regarded as being incurable disease. We have studied the progression of PSA values in 5 men treated for stage D1 prostate cancer at Phelps County Medical center by aggresive radiation therapy techniques. PSA has been measured in clinical laboratories by polyclonal or monoclonal antibody techniques; values greater than 4.0 being regarded as abnormal. Four of the 5 men had abnormal elevated levels of PSA prior to radiation treatment. In all cases the PSA values fell progressively into the normal range. In one case there was a transitory rise from not measurable to 0.6, but the value then fell back to not measurable on a subsequent assay. The only 1 of the 5 patients demonstrating clinical progression of a cancer had 2 cancers of a glandular type, adenocarcinoma of the prostate and adenocarcinoma of the colon; it is not certain which cancer metastasized. The results in our small series are somewhat encouraging for the responsiveness of local-regionally advanced prostate cancer to definitive radiation treatment.

Krishnan, K, R. Winters, N. Ercal and R. Matthews. Department of Chemistry, University of Missouri-Rolla. IN VITRO STUDIES OF THE ROLE OF GLUTAMINE IN RADIATION STRESS. Glutamine has traditionally been regarded as a nonessential amino acid. However, it has been shown that glutamine may become an essential amino acid following major surgery, during infection, and in immunodeficient states. Glutamine also appears to become an essential amino acid following X-Ray Therapy (XRT). After XRT, plasma levels of glutamine drop, presumably due to an increased need by an organ system. One of the organ systems known to be sensitive to irradiation is the gut. Glutamine supplementation following XRT has been shown to alleviate some of the gastrointestinal-associated side effects of radiatioin, such as nausea, diarrhea, and bacterial translocation. We have attempted to show that glutamine has a radioprotective effect in an *in vitro* system. Cell survival curves for Chinese Hamster Ovary (CHO) cells were constructed by irradiating a known number of cells, incubating for ten days, and then staining the resulting colonies with methylene blue. The surviving fraction of cells at each radiation dose was calculated by dividing the number of colonies formed by the number of cells

intially plated times the plating efficiency. Cell survival curves were obtained by plotting surviving fraction on a log scale vesus radiation dose on a linear scale. There was a slight increase in the mean lethal dose (D_0) with an increase in the glutamine concentration in the media. To verify this, cells were irradiated at 10 Gy with varying amounts of glutamine contained in the media. A linear response (R^2=0.967) was obtained by plotting surviving fraction versus glutamine concentration in the media.

Winters, R., J. Zukowski, N. Ercal and R. Matthews. Department of Chemistry, University of Missouri-Rolla. AN INCREASE IN WHOLE BLOOD GLUTATHIONE LEVEL IN RODENTS AFTER IONIZING RADIATION: AN APPLICATION OF A RAPID AND SENSITIVE ASSAY FOR REDUCED GLUTATHIONE. Glutathione (g-Glutmylcysteinylglycine) is the most abundant non-protein thiol in whole blood. The reduced form of glutathione (GSH) is generally considered to prevent damage due to ionizing radiation by acting as a free radical scavenger. We have developed a sensitive and rapid reverse phase High Performance Liquid Chromatography (HPLC) method for GSH analysis. The assay depends on the reaction of sulfhydryls and N-(1-Pyrenyl)-Maleimide (NPM) to form stable fluorescent derivatives. Following derivatization with NPM, samples are injected onto a 3 μm C18 column and eluted with an acetonitrile:water (59%:41%) mobile phase containing 2 mL/L acetic acid and 2 mL/L phosphoric acid. Detection was performed using a fluorescent detector operating at an excitation wavelength 330 nm and an emission wavelength of 380 nm. *In vivo* studies of GSH levels before and after radiation were performed using C57Bl mice. Eight mice were irradiated at 15 Gy whole abdomen using 9 MeV electrons. Blood samples from the tail were taken prior to irradiation, three days post-irradiation, and four days post-irradiation. Each mouse's GSH level after irradiation was compared to his own GSH level prior to irradiation. A 43.8 ± 19.3% increase in GSH level between three days post-irradiation and prior to irradiation was observed.

PHYSICS

Adawi, I. Department of Physics, University of Missouri-Rolla. THE QUEST TO UNDERSTAND LIGHT: FROM AETHER TO QUANTUM ELECTRODYNAMICS. Efforts to understand the nature of light during the last nearly four centuries will be sketched to explain how our ideas on light evolved and indirectly to the development of electromagnetic theory, special relativitiy, quantum mechanics, and electrodynamics.

Ferguson, D.E. Departments of Computer Science and Physics, Southwest Baptist University. TRADITONAL PHYSICS LABS VERSUS MICROCOMPUTER-BASED LABS UTILIZING CONSTRUCTIVIST STRATEGIES. Previous studies by Thornton at Tufts and Sokoloff at the University of Oregon reported significant conceptual change in students participating in microcomputer-based labs (MBL) versus students who did not participate in labs. This study was conducted to ascertain the relative effectiveness in facilitating conceptual change between MBL and traditional lab activities. 77 students in a non-calculus General Physics class were randomly assigned either to sections using traditional physics labs or the MBL lab sections. The experimental treatment consisted of seven, two-hour labs dealing with motion and forces. All students attended the same lecture and had the same problem sets. The force and motion concept inventory test developed at Tufts was used as a pretest and post-test. Analysis of variance using repeated groups revealed the MBL group had a gain in mean scoere on the test that was 2.2 times that of the traitional group ($p<0.001$). Correlation analysis was used to study relations between students' backgrounds and their performance in General Physics. Supported by NSF matching grant for equipment.

McDavitt, K.I., J. Manweiler and J.P. Davidson. Department of Physics and Astronomy, University of Kansas. SEARCH FOR GOLD AND OTHER HEAVY ELEMENTS IN THE ULTRAVIOLET SPECTRA OF A-TYPE STARS. Using the DEC-VAX program VIRIS, a KU-developed interactive

computer program, we have searched the specta of the International Ultraviolet Explorer (IUE) satellite for the presence of gold and other nearby heavy elements in several chemically peculiar (CP) stars. The presence of AuII has been observed in several sets of images from the short wavelength primary (SWP) camera aboard the IUE satellite. We have found a very strong AuII line at 1800.58 A in Kappa Cancri (HD 78 316) in order 77 of SWP images 1352, 3021, 3086 and 3960. Results of searches in other CP stars will be discussed.

Samiullan, M. and P. Rolnick. Science Division, Northeast Missouri State University. ANGULAR DEPENDENCE OF THE PROFILE FUNCTION OF THE SKYRMION. It has been shown that the Skyrme model has a soliton-like solution which, for isospin 1/2 has properties similar to those of the nucleon.[1] Radial symmetry of the profile function in this solution is suitable for the description of a single-nucleon system. In this study we investigate the solutions of the Skyrme model which have angular dependence in the profile function, with the anticipation that these solutions may model multi-nucleon systems. We derive the expressions for energy, and the Euler-Lagrange equation obeyed by the profile function corresponding to the minimum energy soliton.

[1]T.H.R. Skykrme, *Proc. Roy. Soc. London Ser.*, **A260**, 127 (1961)l; *Nucl. Phys.* **31** 556 (1962); Witten, *Nucl. Phys.*, **B223**, 422 (1983); G.S. Adkins, C.R. Nappi, E. Witten, *Nucl. Phys.* B228, 552 (1983), and references therein.

Stacey, L.M., and S. Tellez-Minor. Department of Physics, St. Louis University and the Department of Physics, Escuela Superior de Ingenieria Mecanica y Electrica (ESIME). JOINT PROGRAMS IN PHYSICS BETWEEN MEXICAN AND U.S. UNIVERSITIES AND LABORATORIES. St. Louis University and ESIME have created a six-week summer institute held in St. Louis for students and faculty from the ESIME campus in Mexico City. The institute, which will be held for the second time in the summer of 1993, features computers in undergraduate laboratories and experiments in superconductivity. This program shares a student selection process with the Lederman Award at Fermilab. These efforts have been very successful and represent a growing number of joint ventures between Mexican and U.S. institutions.

Venezian, Giulio V. Department of Physics, Southeast Missouri State University. NON-LINEAR EQUILIBRIUM CONFIGURATIONS OF A CHAIN ROTATING ABOUT A VERTICAL AXIS. The large-amplitude equilibrium configurations of a heavy chain rotating about an axis parallel to a gravitational field are described. Two Lagrangian descriptions of the problem are obtained. The mathematical problem reduces to a second-order non-linear differential equation. An infinite number of modes exists, and the energy and angular momentum of the chain is examined for the different modes.

Venezian, Giulio V. Department of Physics, Southeast Missouri State University. WAVE TRAPPING IN A VIBRATING STRING. The behavior of waves in a semi-infinite string which has a linear spring attached to it is analyzed in the frequency and time domain. In the case of forced oscillations, it is found that waves are trapped between the spring and the end of the string and that the amplitude of the oscillations between the spring and the wall can be much larger than the amplitude of the incident waves. The solutions are compared to those previously found for waves trapped beween a mass and a wall.

SCIENCE EDUCATION

Babrakzai, N. and T. Archibald. Department of Biology and the Directorate of Information Services, Central Missouri State University. APPLICATION OF FLUORESCENCE MICROSCOPY AND 24 BIT COLOR DIGITAL IMAGERY IN THE CURRICULUM OF TWO UNDERGRADUATE BIOLOGY COURSES. The goal of this project was to develop a functional research/teaching/demonstration unit of fluorescence microscopy, interfaced with video, 24 bit color digital, and photomicrographic recording systems, for the two upper division biology courses Cytogenetics and Parasitology. The following steps were taken to accomplish this goal. 1. Sixteen student research stations were equipped, for the safe handling of fluorescence staining procedures, with appropriate apparatus, reagents, and solvents. 2. Protocols for making microscope slides of human chromosomes and parasites from frogs (*Rana blairi*), were developed and communicated to the students. 3. The techniques for staining chromosomes/parasites with the fluorochromes Quinacrine & Acridine Orange were applied by the students in laboratory exercises, such that each student used an epifluorescence microscope for 1-2 hrs during the semester. 4. The students hard copied their results either photomicrographically, or electronically by interfacing the fluorescence microscope with a Macintosh IICX microcomputer, through a video camera and the Color Snap TM digitizer installed in a NuBus slot. The 24 bit color digitized images were manipulated with the help of a graphics software program and printed on Laser/Video Printers. They were required to write research reports and include their hard copied images in support of their conclusions. 5. The digitized images were stored on 88 Mb cartridges. "Thumb Nail" pictorial data bases were created for interaction by the participapnts.

Berkland, T.R. Earth Science Department, Central Missouri State University. CONDUCTING AN ACTIVITY-ORIENTED SCIENCE DAY FOR SECOND GRADERS EMPLOYING PROSPECTIVE TEACHERS AS GROUP LEADERS. A program for elementary school students in second grade in the Warrensburg R-VI School District was started Spring, 1992, as an annual event which utilizes prospective teachers at Central Missouri State University. Eight science concepts were introduced to 200 second graders in eight mini-groups. Topics included fossil types, properties of minerals, food web, energy, magnets, matter, air pressure, and simple machines (levers). The program allowed prospective teachers to work in small groups with elementary children and created interest in science topics that would be continued later in the elementary classroom.

Mills, S.H. and S.K. Mills. Department of Biology, Central Missouri State University. USING "ON-HAND" TRANSDUCERS WITH THE MACSCOPE ANALOG-TO-DIGITAL MICROCOMPUTER INTERFACE FOR PHYSIOLOGICAL EXERCISES. Chart recorders are rapidly becoming obsolete in the physiology laboratory due to the limited graphical and analysis possibilities with chart recorder output. A multi-channel analog-to-digital converter used with a microcomputer permits data to be transferred directly to the computer. The "MacScope system" goes beyond "fancy chart recording," to provide curve reviewing, curve averaging, or Fourier Analysis. Although a number of A/D devices and software are available for a variety of microcomputers, the MacScope system was chosen due to the ease of setup and use by undergraduates. The "MacScope system" was used with transducers by Harvard Apparatus or Narco-Biosystems for comparison with the typical "physiograph" recording systems. The "MacScope system" was found to be easier to use, more percise for measurements, able to review specific portions of the waveform, able to print out sections of the waveform, better able to eliminate noise in signals, and able to transfer data to graphical and analysis software. These comparisons were made by undergraduates during physiological exercises such as influences on human heart rate and breathing, regulation of the frog heart, intestinal motility, and skeletal muscle contraction. Equipment was provided by a grant from the CMSU Center for Technology.

Nold, John L. Department of Earth Science, Central Missouri State University. ON THE IMORTANCE OF DISCUSSING PSEUDOSCIENCE TOPICS IN INTRODUCTORY SCIENCE COURSES. Most introductory science courses are very content-oriented. Students, having completed the course, are probably fairly knowledgeable about what that particular science consists of. However, most students probably have only a very vague idea of what topics are considered, by scientists, to be science and what are considered to be "pseudoscience". Today, considering the exploitation of pseudoscience topics by the tabloid television shows and tabloid newspapers, education of students on

what is science and what is not has become more important. Skepticism does not come naturally to people; it must be learned. Pseudoscience topics discussed in a one hour lecture in Introduction to Geology at Central include creation science, astrology, mysteries, witching, and crystal power. The lecture always spawns the largest discussion of the semester and some of the students are willing to challenge my skepticism about some of the topics. I would rate the learning experience as one of the more valuable of the semester.

Oshima, E.A. Department of Curriculum and Instruction; **J.L. Nold,** Department of Earth Science, Central Missouri State University. CENTRAL'S TEACHING PARTNERS PROGRAM. In recent years, more time and effort have been devoted to ways of improving the act of teaching/learning in the sciences in higher education. In 1988, the New Jersey Master Faculty Program was instituted with 30 New Jersey colleges and universities participating in a three-year project. CENTRAL's Teaching Partners Program is patterned after the New Jersey project. The unique feature is the collaborative efforts of a teacher, a colleague who observes, and students who provide input. To teach well--if we define teaching well as the capacity to enable students to learn, to develop the desire to learn, and to develop the skills to learn--requires all three components. CENTRAL's program is very informal and strictly voluntary. Results from one and a half years of the program merit its continuance.

Owen, Lawton. Department of Biology, Kansas Wesleyan University. USING CITY PARKS TO TEACH BIOLOGY. A major obstacle to field instruction in biology is the distance from the school to rural areas. The purpose of this study was to explore the use of different types of city parks for field experiences. Various investigations have been conducted in these parks for many years by students in a college general biology course. These investigations can be modified to provide experiences at different levels from elementary grades through college.

Salt, S.D. Division of Science, Northeast Missouri State University. NATURAL PHILOSOPHY: REDISCOVERING THE SCIENTIFIC METHOD IN COLLEGIATE INTRODUCTORY BIOLOGY COURSES. Textbook presentations and prepared laboratory exercises often fail to effectively transmit to science students the human dimensions and real world uncertainties and practical constraints of applying the scientific method to observed phenomena. In this study, students in undergraduate introductory biology courses both for general education non-majors and for science majors were assigned to design *de novo*, execute, analyze and report upon a semester-long investigation of a phenomenon of personal interest observable in their everyday environment. Requirements for topic choice were only that the investigation were safe, legal, practicable and of some relevance to biology, broadly defined. Extremely diverse topics were chosen, e.g., effects of exposure to types of music upon standardized test performance, effect of socioeconomic "halo" upon ice cream taste perception, correlation of climatological data with tree ring data, etc. Students commonly encountered problems with testable hypotbesis formation, legal/regulatory/economic obstacles to project execution, selection and recruitment of subjects, identification and design of appropriate controls, data collection, uncooperative subjects and mechanical failures, statistical analysis, etc. The resultant intensely interactive teaching/learning experience is descirbed in this presentation.

Twining, L. and G. Sells. Science Department, Northeast Missouri State University. MEASURING RESPIRATION BY USING A MODIFIED SCHOLANDER RESPIROMETER (MSR). For several years students in both majors and non-majors courses have successfully used a MSR to measure oxygen uptake of organisms ranging from germinating seeds to mice of various sizes. The design and procedures for using the MSR will be presented. Examples of problems posed to students are: 1) At what stage following imbibition do germinating seeds begin to rapidly use oxygen? and, 2) How does a cool environment affect the rate of respiration in warm-blooded animals such as mice? As students collect data they are actively involved in problem-solving and analysis of data. The overall goal of the unit on respiration is to assist students to understand the basic principles of cell respiration and then help them to gain a broader understanding of respiration as it applies to different types and sizes of organisms.

Wood, D.M. and J.P. Davidson. Department of Physics and Astronomy, University of Kansas. DEVELOPMENT OF A BREWSTER'S ANGLE APPARATUS. The purpose of the project was to design and construct a prototype apparatus to measure Brewster's angle or the polarizing angle, θ_p. Brewster's angle is the angle at which incident, unpolarized light is completely plane polarized uon reflection. This property relates Brewster's angle to the index of refraction of the reflecting dielectric through the relation tan $\theta_p = n$. Our Department has had for a long time a senior laboratory experiment to measure Brewster's angle consisting of many pieces of equipment which are difficult to set up and align. We have designed and constructed a much simpler apparatus consisting of a 99+% polarized He-Ne laser beam incident on a dielectric reflector followed by a light sensitive diode. The arrangement is such that at θ_p the reflected light is extinguished. That is, the system has been designed to be a null experiment. The apparatus is sufficiently easy to use to be sutable for elementary physics laboratories. We will show drawings and pictures of the equipment and discuss test results of our prototype.

SCIENCE, TECHNOLOGY AND SOCIETY

Bainum, D. E. Academic Computer Center, Washburn University, **Jerry Niebaum,** University of Kansas, **Rick Summerhill,** Kansas State University. THE STATUS OF THE KANSAS RESEARCH AND EDUCATION NETWORK (KANREN). KANREN is a computer network which will connect 38 Community Colleges, Colleges, and Universities throughout Kansas. A proposal to fund the formation and first two yesrs of operation of KANREN has been submitted to the National Science Foundation. The status of that proposal will be discussed as well as the administrative structure and the objectives of KANREN.

Bryant, D.L. Department of Safety, Science, and Technology, Central Missouri State University. ENVIRONMENTAL LEAD (Pb) CONTAMINATION POSES RISK TO CHILDREN AND CHALLENGE TO INDUSTRY. Recent warnings from the public health community are intended to marshall public and private forces to protect children from toxic exposure to Pb. The sources of available Pb are as myriad as the pathological responses. As the EPA and U.S. Public Health Service continues to reduce the level of Pb in blood considered to be toxic in children, industry mobilizes to address strict regulations with improved remediation technology. This massive environmental cleanup will not repeat the same mistakes of the asbestos abatement efforts, most notable: increasing childhood exposures, fueling litigation, and escalating government expenditures.

Bryant, D.L. Department of Safety, Science, and Technology, Central Missouri State University. REPRODUCTIVE RISK ASSESSMENT INITIATIVES TARGET MALE EXPOSURES AND HISTORICALLY FEMALE OCCUPATIONS. Higher numbers of women in the workplace and increasing employment in traditionally male, high hazard jobs have produced heightened concern over reproductive toxicology. The greatest concern has focused on occupations historically prohibited to women, based on the medical communities asessment that women were particularly vulnerable because of their reproductive responsibility. This narrow approach to assessing reproductive risk, fostered by limited research on traditionally female occupations, has ignored the broader issues relevant to reproductive protection. Contemporary investigations address male reproductive viability and assess risk for historically female occupations.

Gaseor, R.A. Department of Safety Science and Technology, Central Missouri State University. SPACE SYSTEM PREVENTS EARTH TRAGEDY-SEARCH AND RESCUE SATELLITE AIDED TRACKING (SARSAT) A LOW COST SUCCESS. Automatically activated emergency beacons called emergency locataor transmitters (ELT) have been mandated on most aircraft since the early 1970's. These transmitters utilize very high frequency (VHF) and ultra high frequency (UHF) aircraft bands and

reception is limited to line-of-sight. A similar emergency beacon is used in the marine environment and is called an emergency position indicating radio beacon (EPIRB). In the late 1970's the suggestion to use existing low earth orbit satellites to enhance reception was proposed, and operational testing began in June 1982. The program was validated in July 1988 and to date has been directly credited with saving 3148 lives.

Keller, L.E. Department of Biology. Pittsburg State Universitiy. MAGNETOELECTRIC CURE-ALLS. Throughout the history of electrotherapy three types of electricity were used: Static or Faradic; Galvanism or Voltaic and Magnetoelectric. This paper traces the development, design, construction and operation of mid-19th century magnetoelectric generators and how they were used to treat human diseases with induced electrical charges or shocks. The most common and economical therapeutic device was the Davis and Kidder Machine patented in 1854. The booklet of instructions which acompanied the machine listed fifty different diseases and disorders which could be cured with the shock from the machine. A few examples of how to apply the electrical charges are presented. This paper is the thirteenth in a series of projected illustrations and demonstration of part of the author's vast collection of antique medical quack devices.

Min, S.E. Department of Systematics and Ecology, University of Kansas. A MORE HOLISTIC SCIENCE. Many of the works of existential philosophers are pervaded by evolutionary biological concepts. These concepts are apparent in discussions of knowledge, the human "drive-for-truth", ethics and morality, and consciousness. In realizing that scientists actively construct their questions, methods, and interpretations based upon their worldview, one is compelled to ponder the role of anthropocentrism in science and the fundamental assumptions of causality. The present paper examines current scientific worldviews and inquires into the basis for the exclusion of morality, and conseqeuntly meaningfulness, from scientific inquiry. Philosophy needs empirical data to give it pragmaticism and significance (to the scientific community), whereas science needs morality to give it meaningfulness (to the non-scientific community). Together, the arts and the sciences can aid us in the existential challenge of assessing the human position in nature. A heuristic rather than metaphysical solution is offered to the existential problem so familiar to philsophers yet neglected by scientists.

Terry, D.E. and R.L. Tabor. Department of Agriculture, Central Missouri State University. AN EVALUATION OF THE CONSISTENCY AMONG MEASURMENTS OBTAINED FROM MULTIPLE FIRMS' RADON 222 CHARCOAL TEST CANISTERS. A preliminary non-statistical evaluation of various charcoal radon test canisters was conducted. Measuring devices, from several different companies and identical canisters from the same firm, were exposed to the same level of radon gas. The results indicated relatively high levels of variability and results from within sites sometimes ranged over different radon action levels; thus, a more intensive investigation followed. The consistency of radon measurements of eight different companies were evaluated at four different locations in west-central Missouri. The radon levels of these four sites had been previously tested and were generally known. At each site, eight of each company's identical canisters were randomly placed side-by-side and exposed for equal periods of time. Each of the company's canisters carried different addresses and exposure time and location records were maintained. After exposure, each canister was sealed and returned to the appropriate laboratory for analysis. An 8 x 8 Latin square design for each site (conisters of eight firms replicated eight times) was utilized to determine if differences exist among measurments recorded by the eight companies' radon canisters. Tukey's test was employed to make all possible mean comparisons at $\alpha = .05$. Differences among recorded measurements of each company, over all locations were evaluated using analysis of variance. Supported by Central's Center for Technology and Small Business Development.

SOCIAL/BEHAVIORAL SCIENCES

Bramblett, D.A. Department of Psychology, Westminster College, **D. Kipnis,** Department of Psychology, Temple University. EVIDENCE FOR REDUCED JOB SATISFACTION AMONG "HIGH TECH" PROFESISONALS. The research linking industrial technology and psychological outcomes consistently finds greater job satisfaction among workers doing skilled rather than unskilled work. Behavioral technologies such as psychotherapy can also be described in terms of their skill demands. Cognitive-behavior therapy, a relatively recent development in the technology of psychotherapy, represents a more advanced level of behavioral technology than psychodynamic therapy. The purpose of the present sudy was to examine the relationship between professional psychologists' attitudes toward their work and the level of behavioral technology they employ. 251 practicing psychotherapists were surveyed by mail regarding their satisfaction and involvement with their work. Psychodynamic therapists were more satisfied ($p<.01$) and more involved ($P<.01$) with their work than were cognitive-behavior therapists. Behavioral technology thus affects professionals as industrial technology affects managed workers.

Jelavich, M.S. Department of Economics, Northwest Missouri State University. ESTIMATION OF STRUCTURAL DIFFERENCES BETWEEN RURAL NORTH AND SOUTH MISOSURI. This study examines the differences between rural nothern Missouri and rural southern Missouri, using the Missouri River as a division line and excluding metropolitan statistical areas. County personal income in each half of the state is specified as a function of net farm earnings, manufacturing earnings, transfer payments, and Federal government earnings. OLS regresions using 1986-87 data reveal that (a) net farm income and Federal earnings have greater impacts in northern rather than southern Missouri; (b) manufacturing earnings and transfer payments have similar impacts in both halves of the state; and (c) rural south Missouri counties adjacent to metropolitan areas have higher personal incomes than similar northern countis.

Keller, A. Craig. Department of Economics, Southwest Missouri State University. AN EXAMINATION OF THE DEVELOPMENT OF GREENE COUNTY, MISSOURI, AS A REGIONAL MEDICAL CENTER. Springfield, Missouri has long served southwest Missouri as a regional medical center. The purpose of this paper is to take a statistical glance at the continued growth of this regional center as the demographic characteristics of the community, and the region, change. Specifically on the surface it appers that the role of Greene county's medical community may change as the population ages, both through aging of the indigenous population and through immigration as Southwest Missouri has become a retirement destination. To examine these issues regression analysis will be employed using data from the Bureau of Census, the Census of Manufacturers and other sources. Results are expected to show an increase in the medical industry data at an increasing rate as the population ages and as rural medical practitioners become rarer.

Sheets, D.F. Department of Economics, Southwest Missouri State University. INDUSTRIAL CONCENTRATION IN U.S. MANUFACTURING INDUSTRIES: RECENT LEVELS AND TRENDS. Published studies show average industrial concentration remained constant or declined during the period 1947-80. The purpose of this study is to investigate whether this trend has continued during the past decade. Two recent developments have prompted this investigation. A change in antitrust enforcement beginning in the early 1980's is believed to have relaxed the legal barriers to mergers, including horizontal mergers. Also, beginning in 1982 published statistics have included the Herfindahl index, generally considered a more comprehensive measure of market structure than the value-of-shipments concentration ratio. Data on industry sales, concentration ratios, and (where available) Herfindahl indices were obtained for 352 matched four-digit SIC industries for 1977, 1982, and 1987 from the Census of Manufactures. Simple t-tests were used to compare differences in mean levels of concentration and mean differences in concentration. Although calculated rates declined slightly between 1977 and 1982 and increased slightly between 1982 and 1987, no statistically significant trend was determinend. Substantial increases in concentration were found in specific industries, however.

Telatar, E. Department of Economics, University of Missouri. THE CREATION OF A EUROPEAN CENTRAL BANK. This paper analyzes how the creation of a European Central Bank would affect the political economy of monetary policy in the European Community. The Delors plan proposes a very high level of independence of the future Central Bank as a precondition for monetary stability. In this paper we discuss the probable consequences of the Delors option and evaluate the cost and benefits the relevant countries would incur as a result of their participation in this monetary and economic union.

Topping, E.E. and D. F. Sheets. Department of Economics, Southwest Missouri State University. QUANTITATIVE AND QUALITATIVE COMPONENTS IN UNIVERSITY MERIT PAY. Many universities base a large portion of faculty members' salary increments on annual evaluations of productivity. However, little is known about how faculty respond to the economic incentives present in such schemes. Since merit pay is added to base salary rather than paid as a bonus, there is less incentive for older faculty to perform meritorious activities. Married women may have less time to engage in their careers as their family responsibilities are greater. The authors gathered data on merit awards at a single Midwestern university for 1988 and obtained copies of the merit pay applications of about one-half the faculty. Detailed information on additional variables was obtained from the university's administration. Analysis of these data by multiple regression indicated support for the hypotheses that marital status and age affect merit awards, even after differences in productivity were taken into account. Several measures of faculty output were also found to be significant, as expected, in explaining merit pay.

COLLEGIATE DIVISION

BIOLOGY

Bourdon, D.M. and G.D. Sells. Division of Science, Northeast Missouri State University. MEASUREMENT OF PROLINE ACCUMULATION IN LEAVES OF *CUCUMIS SATIVUS* DURING DIFFERENT RATES OF DROUGHT. The purpose of this study was to determine how the rate and degree of drought affect proline concentrations in cucumber (*Cucumis sativus*). Proline is oxidized in the mitochondria by proline oxidase and two subsequent pathway enzymes in a stepwise manner to form α-ketoglutarate which can enter the TCA cycle. The projected roles of proline in plants include serving as an osmoticum as well as a reserve nitrogen source. Previous studies on agricultural plants have indicated that proline accumulates in high concentrations during late stages of drought. Other experiments have shown that proline oxidation by mitochondria is inhibited at the very onset of drought. Cucumber plants were ideal for this investigation because of their extreme tolerance to drought conditions. This tolerence enabled experiments to continue well into stages of drought where most plants would have died. The rate of drought was varied by raising equal numbers of plants in two different size pots. Plants in smaller pots dried faster than plants in larger pots. Water potentials were32 determined in reference to leaf position using a dew point microvoltmeter. Proline assays followed the protocol by Troll and Lindsley. The following hypotheses were tested. 1) *plants exposed to rapid drought will accumulate proline more quickly*, and 2) *leaves near the apical meristem will be less affected by drought than older leaves on the plant.* Experimental data indicated a four-fold increase in proline accumulation rates of *C. sativus* exposed to a faster rate than that of the control group. Proline accumulation rates were proportional to increasing age of the leaves on a plant. Partial support from the Missouri Academy of Science.

Deck, M.E., and H.G. Spratt, Jr. Department of Biology, Southeast Missouri State University. SULFATE REDUCTION IN SEDIMENTS FROM TWO SOUTHEAST MISSOURI PONDS: THE EFFECT OF LACTATE AND ACETATE ADDITIONS. Rates of sulfate reduction (SR), as influenced by addition of acetate and lactate, were compared in two ponds located at the Kelso Wildlife Sanctuary. Earlier studies had indicated that sediments from the older (OP) of the two ponds had much greater rates of SR than sediments from the younger pond (YP). Total organic carbon was also greater in OP than YP sediments. These findings suggested that organic substrate limitations might be responsible for the lower rates of SR in sediments from YP. To test this hypothesis, YP sediment slurries were prepared, using anaerobic sample processing techniques, to which acetate or lactate were added (final concentrations, 5.25 μM). Rates of SR were determined using trace additions of $^{35}SO_4^{2-}$, followed by incubation at field temperature for 36 h. Chromium reduction was used to quantify SR. When the slurries were analyzed immediately after addition of the organic substrates SR rates were lower. However, if the slurries were allowed to incubate with the organic substrates for 10 days prior to $^{35}SO_4^{2-}$ addition, at which time an additiional 3μM of the substrates were also added, then SR rates were significantly greater when acetate was used (3.6 fold higher compared with control, 5.8 vs. 20.7 pmol/g/da). Lactate addition did not stimulate SR rates. These data suggest that the bacteria responsible for SR in YP sediments are Group II sulfate reducers (acetate oxidizers), and that they may be acetate limited in situ.

Farrar, V. Department of Biology, Southeast Missouri State University. ATTACHMENT, PROLIFERATION, AND VIABILITY OF THE BOR II AMPHIBIAN CELL LINE AFTER LOW-TEMPERATURE STORAGE Storage of cultured amphibian cells in a low-temperature incubator will

slow cellular metabolism, reducing the time and materials required for long-term maintenance of stock cultures. This study was conducted in order to measure the effects of low-temperature storage on characterized properties of the fibroblast-like Bor II amphibian cell line. Cultures were stored for two weeks in temperatures of 25°C (control), 15°C, and 10°C, after which the low-temperature cultures were returned to the 25°C incubator. Attachment efficiencies were determined by plating 1 x 10^5 or 2 x 10^5 cells per well into a 24-well plate. After 24 hours, unattached cells were washed from the wells and an MTT assay performed on each well. This assay showed that cells stored at lower teperatures exhibited 1.5- to 2-fold increases in attachment efficiencies. Proliferation was measured by plating cells into 24-well plates and performing an MTT assay on four wells every three days, for a total of 15 days. Proliferation curves were similar for all three treatment groups. Percent viability, measured by Trypan blue exclusion staining, was also similar for all three groups. Low-temperature storage appears to have selected for improved attachment efficiencies, but trhe viabilities and rates of proliferation appear relatively unchanged. Therefore, low-temperature storage should have little effect on Bor II cells, or on the outcomes of subsequent experiments using these cells.

Fiegel, C.A. and P.W. Gabrielson. Department of Biology, William Jewell College. EFFECTS OF A WASTEWATER TREATMENT FACILITY ON WATER QUALITY OF THE FISHING RIVER. The purpose of this study was to monitor monthly fluctuations in the water quality of the Fishing River upstream and downstream of the Excelsior Springs Wastewater Treatment Facility. The water quality previously had been assessed only twice, once in September, 1984 by the Missouri Department of Natural Resources (DNR) and again in September, 1988 by the U.S. Environmental Protection Agency (EPA), the latter following the addition of an overland flow system to the wastewater treatment facility. Many of the same physical and chemical parameters of the river, such as temperature, flow, pH, dissolved oxygen (DO), phosphates, nitrates and Biological Oxygen Demand (BOD) were assessed at the same six sites that had been sampled by the DNR and the EPA. BOD levels showed a tendency to decrease during the fall and winter. At one site upstream of the treatment facility, phosphate levels showed a dramatic increase in late fall and winter compared to earlier months. Because of the month to month fluctuations observed in some parameters, monitoring a stream only once a year may not accurately assess the water quality.

Henderson, J. (Faculty Sponsor G. Sells). Department of Biology, Northeast Missouri State University. TESTING A HYPOTHESIS ON THE ORIGIN OF ALZHEIMER'S DISEASE: INJECTION OF MICE WITH A MODULATED ANTIGEN AND MEASURING SUBSEQUENT LEVELS OF CHOLINE IN THE BRAIN. The etiology of Alzheimer's disease, a progressive neurodegenerative disorder, is unknown. Among the phenomena observed in patients with the disease are a decrease in the concentration of choline and abnormal phospholipid turnover. Excessive turnover of cell membranes may deplete the organism's supply of choline due to a diversion of choline to the synthesis of phosphatidylcholine. Therefore an experiment was designed to test whether an antigen could trigger an immue response which could lead to a decrease in choline levels in the brain. In this experiment, mice were injected with a modulated antigen, which creates an immune response, which leads to cell membrane turnover. If such a series of events outside the CNS can lead to a depletion of choline levels in the CNS, mice injected with the antigen should exhibit lower levels of choline in the brain than the control mice. Choline levels in the brain were assayed using gas chomatography. Partial funding for this project was provided by an MAS grant.

Miers, J.I. and N.B. Babrakzai. Department of Biology, Central Missouri State University. MUTAGENIC EFFECTS OF PODOPHYLLOTOXIN ON ONION ROOT TIPS. Previous research has suggested some cytopathic effects on dividing eukaryotic cells after treatment with *Podophyllum peltatum* L. extract. This study was done to establish a dose dependent effect on the Mitotic Index (MI) on onion root tips (ORT's). ORT's were grown for 24-hours in doses of 0 (control), 0.01, 0.1, 1, 2, 5, and 10% *P. peltatum* extract. The ORT's were fixed and observed using the chromosome squash technique. The following chromosomal aberrations were observed in the treated mitotically dividing cells: C-metaphase, polyploidy, aneuploidy, fuzzy chromosomes, chromosome lag, etc. The MI decreaased with increased does of the extract. Supported by MAS Undergraduate Research Grant.

Mills, J.D., and H.G. Spratt, Jr. Department of Biology, Southeast Missouri State Uni-versity THE EFFECT OF THE ADDITION OF SULFATE ON RATES OF SULFATE REDUCTION IN SEDIMENTS OF A SOUTHEAST MISSOURI POND. The effect of increasing SO_4^{2-} concentrations in porewater of sediments from a pond located in the Kelso Wildlife Sanctuary, on rates of sulfate reduction (SR) was determined. Previous studies had indicated porewater SO_4^{2-} concentrations averaged 129 μM in sediments from this pond. To determine whether SO_4^{2-} was limiting to the sulfate reducing bacteria in the sediments, SO_4^{2-} was added to sediment slurries, prepared using anaerobic sample handling techniques, to yield final slurry concentrations of 680, 3400, and 8500 uM. Trace additions of $^{35}SO_4^{2-}$ were made to slurry samples, followed by a 36 h incubation at field temperature. Incorporation of ^{35}S into reduced inorganic sulfur was determined using chromium reduction. When the $^{35}SO_4^{2-}$ was added immediately following addition of the unlabeled SO_4^{2-} , rates of SR increased, compared with controls, nearly 1.9, 1.5, and 1.4 times for the three elevated SO_4^{2-} concentrations noted above, respectively. However, if the $^{35}SO_4^{2-}$ was not added until after 10 days incubation at field temperature and elevated unlabeled SO_4^{2-} concentrations, rates of SR increased by 324.2, 72.9, and 151.3 times, compared with the controls, for the three elevated SO_4^{2-} concentrations noted above, respectively. These findings suggest that the sulfate reducing bacteria populations in these sediments may be limited by SO_4^{2-} concentrations found in the porewater.

Nalley, T.J., K.M. Riskowski, Faculty Sponsor: Dr. Donald Kangas. Department of Biology, Northeast Missouri State University. MORPHOOGY AND BEHAVIOR OF THE CARNIVOROUS LARVAE OF THE FROG, *CERATOPHRYS CRANWELLI.* The genus *Ceratophrys* contains six recognized species all from South America (Lynch, 1982). The larval forms of *C. cranwelli* (Barrio) and *C. Stolzmanni* (Steindachner) still remain undescribed. Adult *C. cranwelli* were purchased from a dealer in Michigan. Breeding was hormonally induced and eggs were fertilized resulting in approximately 3,600 eggs being laid and 89 of those hatched into the larval form. The eggs contained a black animal hemisphere with a distinctive pearl white vegetal hemisphere. The fastest developing larvae reached state 25 (Gosner, 1960) with a completed operculum in 43 hrs at 30 C. At this time the larvae readily preyed upon other larvae and living or dead flesh. The larvae are obligate carnivores with an abdomen twice the size of its sharply beaded head. The larvae are voracious, preying on food items many times larger than their body. The animals raised in lab were separated into individual cups for observation purposes as well as to prevent larval loss due to cannibalism. Observations of larvae have indicated that the rate of developemnt can be variable according to environmental conditons.

Pearson, T.M., C.E. Good, K.M. Vogel, L.N. Roy, and R.N. Roy. Walter H. Hoffman Department of Chemistry, Drury College. LIQUID JUNCTION POTENTIAL AND pH STANDARDS FOR DETERMINATION OF THE BIOCHEMICAL BUFFER MOPS AT 25°C AND 37°C AT I = 0.16. The liquid junction potential for the physiological buffer MOPS {3-(N-Morpholino)-propanesulfonic acid} has been estimated at 25°C and 37°C from electromotive force measurements for the following electrochemical cells:

I $Pt;H_2(g, 1\ atm) \mid MOPS(m_1), NaMopsate\ m_2), NaCl(m_3) \mid AgCl;Ag$

II $Pt,H_2(g,1atm) \mid MOPS(m_1), NaMopsate\ (m_2), NaCl\ (m_3)$ II
$KCl(sat'd) \mid Hg_2Cl_2, Hg$

Cell (II) represents a flowing junction cell which was connected to the Harned cell (I). The experimental details will be described fully.

Riskowski, K.M., T.J. Nalley, Faculty Sponsor: Dr. Donald Kangas. Department of Biology, Northeast Missouri Sate University. RESPIRATORY RATES IN SEVERAL DEVELOPMENTAL STAGES OF THE FROG, *CERATOPHRYS CRANWELLI.* The *C. cranwelli* is native to the Chacoan Region of South America. Although the region does not have great temperature ranges, there are ditinct wet and dry seasons resulting in temperature fluctuations. Strubing (1954) indicated that there were

dramatic peaks of oxygen consumption at various temperatures in the adult *C. cranwelli*.. Respiration during larval development of this species has not been studied. Therefore, the objective of this study is to monitor changes in respiration of the larvae as well as document changes in larval development at various temperatures. In order to determine changes in respiration, adult *C. cranwelli* were induced to breed and larvae were hatched and reared at temperatures ranging in two degree increments from 26 C to 34 C. Oxygen consumption was measured at rearing temperatures and at varying stages of larval development.

Roberts, D.K., D.J. Robbins, B. Fulton, and R. Bell. Department of Biology, Missouri Western State College. A 5 YEAR SUMMARY OF WHITE-TAILED DEER REPRODUCTIVE DATA FROM PRIMITIVE WEAPONS HUNTS AT SQUAW CREEK NATIONAL WILDLIFE REFUGE. One hundred and seventeen pregnant uteri were collected in January primitive weapons hunts held at Squaw Creek Wildlife Refuge for the years 1988 through 1992. An aging procedure utilizing forehead-rump length, weight and physical characteristics allowed calculations of the approximate conception and birth dates of each fetus. Sex ratios and productivity rates were also calculated. Data from 1993 primitive hunt will also be included.

Rogers, P.R., R.H. Alper and G.E. Scottgale. Department of Biology, William Jewell College; Department of Pharmacology, Toxicology and Therapeutics, University of Kansas Medical Center. ROLE OF SEROTONIN IN ANGIOTENSIN II-INDUCED HEMODYNAMIC RESPONSES. The purpose of this study was to evaluate the role of serotonin in the angiotensin II (A-II) induced pressor response by examining the ability of the serotonin antagonist, LY53857, to alter the response. Prior to the experiments, male Sprague-Dawley rats were anesthetized; the lateral cerebral ventricle was cannulated and the femoral artery and vein were catheterized. On the day of the experiment, an LY53857 pretreatment was injected intravenously followed by an intracerebroventricular (i.c.v.) infusion of A-II. Blood pressure and haart rate weree recorcded before and for ten minutes after A-II infusion. The data were analyzed by two-way analysis of variance ($p<0.05$). In these experiments, the antagonist LY53857 did not significantly alter the blood pressure response elicited by the i.c.v. administration of A-II. This suggests that A-II increases blood pressure independent of serotonergic pathways.

Smith[1], C.J., J.M. Osborn[1], and R.A. Stockey[2]. [1]Division of Science, Northeast Missouri State University and [2]Department of Botany, The University of Alberta, Canada. MIDDLE EOCENE *PINUS* REMAINS FROM THE PRINCETON CHERT OF BRITISH COLUMBIA, CANADA: POLLEN CONES. The Princeton chert locality in southern British Columbia, Canada, represents one of the most diverse petrified Middle Eocene floras known. The genus *Pinus* is one that occurs extensively throughout the chert; four species have been described based on disarticulated leaves *(P. andersonii, P. similkameenensis),* ovulate cones *(P. arnolodii, P. princetonensis*), and woody twigs (*P. similkameenensis*). In this paper, pine cones assoicated with the aforementioned organs are described. The pollen cones are preserved in various developmental stages, both singly and in clusters. Cones are ellipsoidal, ranging from 1.7-2.8 mm in length and 1.0-1.7 mm in diameter. Resin canals are present both in the cone axes and in their helically arranged microsporophylls. Pollen sacs occur in pairs on the abaxial surface of each microsporophyll. The wall of each pollen sac is multilayered, with distinct cell wall thickens in the outer layer. Many cones contain in situ bisaccate pollen, averaging 55 um in length. The pollen grains show rugulate surface ornamentation of the corpus, faintly scabrate surface sculpturing of the sacci, and an alveolate exine ultrastructure. These specimens represnt the best anatomically preserved pollen cones of the genus discovered to date, and will afford a more complete reconstruction of the Princeton chert pines.

Stammeyer, M.M., T.R. Chaudhuri, and K.R. Zinn. Research Reactor, University of Missouri-Columbia. A NOVEL CU-64 RADIOISOTOPE FOR STUDYING CU-BINDING PROTEINS. Many important enzymes are known to be Cu dependent, but less is known about proteins involved in Cu transport or gene regulation. The purpose of the present investigation was to develop a model system to study copper binding to known purified proteins *in vitro*. Purified proteins were applied to nitrocellulose

blots using a slot-blot apparatus. These blots were subjected to varied conditions of pH, temperature, buffers, reducing agents and other trace elements; probed with high specific activity Cu-64 (250 Ci/mg Cu) followed by autoradiography. Significant differences were noted among the proteins for Cu affinity. The Cu-binding was most specific for Cu-proteins at pH 6.5 (37° C), using a buffer with 0.9% saline, 10 mM Tris, and 10 mM $Mg(NO_3)_2$. This system successfully identified Cu-binding proteins in Western blots, and will be useful for studying proteins involved in Cu transport or gene regulation. Supported by NSF REU grant, PHY 9200479.

Thompson, J., J. Fieberg, M. Amspoker. Department of Biology, Westminster College. PHYSICAL FACTORS INFLUENCING DISTRIBUTION OF EPIPHYTIC BRYOPHYTES. This study was conducted to determine what physical factors influence the distribution of bryophytes growing epiphytically on tree trunks. Approximately 35 trees representing 4 different tree species were sampled in a 50mX50m plot, located near the Devil's Backbone, Mark Twain National Forest outside of Guthrie, MO. A transparent flexible quadrat was used to estimate percent coverage of each epiphyte at eye level on the tree trunks. Percent coverage of each bryophyte species was correlated with several physical factors including: host species, bark texture, ability of the bark to absorb and retain water, prevailing winds and availability of moisture. The results suggest that the liverwort *Frullania* sp. may inhibit the growth of other bryophytes.

Wesson, J. Department of Biology, Southwest Missouri State University. USE OF A MODIFIED MTT PROLIFERATION ASSAY FOR COMPARING GROWTH OF THE C4 AND R6 CLONES OF THE BOR II AMPHIBIAN CELL LINE. The MTT proliferation assay consists of incubating cells in medium containing the tetrazolium salt, MTT, which is converted into blue formazan dye by mitochondrial dehydrogenases. The amount of blue formazan dye present is determined by measuring absorbance at 570 nm wavelength. Absorbance at 690 nm is subtracted from the absorbance at 570 nm in order to account for nonspecific asorbance due to cellular debris. Because our microplate reader lacks a 690 nm filter, we developed a modified MTT assay in which the formazan dye solution is centrifuged to eliminate background absorbance. The lower mean absorbance and standard errors of the means obtained using our modified assay indicate that the procedure effectively eliminates background absorbance. Use of this assay to compare proliferation of two cell lines is based on the assumption that differences in amounts of blue formazan dye are directly proportional to differences in cell numbers. If two cell lines matabolize MTT at different rates, then different amounts of blue formazan dye cannot be used to compare cell numbers. In order to test this assumption, proliferation rates of C4 and R6 clones of the Bor II amphibian cell line were charged using our modified MTT assay and by directly counting cells using a hemacytometer. Parallel growth curves obtrained by these two methods indicate that differences in MTT assay results directly reflect differences in cell numbers.

Willard, D., K.M. Vogel, C.E. Good, L.N. Roy, and R.N. Roy. Walter H Hoffmann Department of Chemistry, Drury College. THERMODYNAMICS OF THE DISSOCIATION OF THE BIOCHEMICAL BUFFER TAPSO FROM 5 TO 55°C. The pK_2 values for the physiological buffers TAPSO, 3-[N-tris (hydroxymethyl) methyl amino]-2-hydroxypropanesulfonic acid] have been determined at 5°C to 55°C from electromotive force measurements for the following electrochemical cells without liquid junction:

$$Pt,H_2(g, 1\ atm) \mid TAPSO\ (m_1), Na\ Tapsoate\ (m_2), NaCl\ (m_3) \mid AgCl, Ag$$

The Gibbs energy, enthalpy, and entropy values for the dissociatioin process were derived from the temperature coefficient of pK_2 of TAPSO. The results will be compared with those of other zwitterionic buffers and the choice of a pH scale in the physiological range will be recommended.

Zimmerman, D.M.[1], S.E. Seematter[2], P.W. Gabrielson[1], and M.G. Tannenbaum[2]. [1]Department of Biology, William Jewell College; [2]Division of Science, Northeast Missouri State University. EFFECTS OF SEED DIET VERSUS CHOW DIET ON REPRODUCITON IN *PEROMYSCUS LELUCOPUS*.

The purpose of this study was to determine the effects of a seed diet versus a chow diet on reproductio in *P. leucopus*. Two randomly selected groups of breeding pairs were fed either chow or fescue *(Festtuca arundinacea)* seed. Breeding mice were weighed every eight days, and the cages were checked daily for litters. Litters were weighed on days 1, 5, 15 and 25. On day 25 the young were weaned. The study was run for 12 weeks. T-tests showed significant differences ($p<0.05$) between the groups for number of young per litter and for the decrease in weight of female mice over the course of the experiment. Although not statistically significant, the number of litters produced and the total young produced were higher for the chow eaters than for the seed eaters. These results show that a diet of fescue seeds decreases reproduction in *Peromyscus leucopus*. Supported by NSF #DIR9200423.

CHEMISTRY

Beasley, T.M., R.N. Roy, L.N. Roy, and K.M. Vogel. Walter H. Hoffman Department of Chemistry, Drury College. THE STANDARD POTENTIAL FOR THE HYDROGEN-SILVER, SILVER-CHLORIDE ELECTRODE IN SYNTHETIC SEAWATER. The dissociation constants for carbonic acid are the thermodynamic link between the carbonate parameters being measured (pH, TA,T_{CO2}) at sea. These constants are related through equations that require the pH of the solution. The calculation of the pH of these buffers and the dissociation constants of acids in seawater requries the standard potential for seawater with added HCl. In this study we present measurements of the standard potential for the silver-silver chloride electrodes in synthetic seawater from 0 to 55°C and salinities from 5 to 45.

Bliss, M.P., T.M. Pearson, L.N. Roy, and R.N. Roy. Walter H. Hoffman Department of Chemistry, Drury College. THE FIRST DISSOCIATION CONSTANT OF CARBONIC ACID IN SYNTHETIC SEAWATER AT A SALINITY, S=35. Electromotive force measurements were made on the following cell without liquid junction:

$$Pt\ I\ (1\text{-}x)H_2 + xCO_2 \mid NaHCO_3\ (m1),\ CO_2\ (m_2)\ \text{in seawater} \mid AgCl;\ Ag$$

as a function of temperature from 0 to 45°C. The values of pK_1 were calculated using the extrapolation method of Harned to infinite dilutions. Results are in excellent agreement with those of Mehrbach and will be discussed in terms of Henry's law constant.

Chohan, Rani, Dawood Afzal, and David Wohlers. Department of Chemistry, Northeast Missouri State University. SYNTHESIS AND CHARACTERIZATIONS: METALLOPORPHYRINS AND DEUTERATED METALLOPORPHYRINS. Our research focuses on the syntheses and chemical reactivitiy of metalloporphyrins, especially cobalt porphyrins. These complexes have been characterized by visible spectra and proton NMR. By modifying a literature method, we have synthesized meso-5, 10, 15, 20, tetra tolyl porphyrin with deuterium enrichment in the porphyrin with deuterium enrichment in the B-pyrrole position. This allows us to utilize deuterium NMR in addition to ^1H and ^{13}C NMR to characterize these compounds. This talk presents sytheses and spectroscopic data of selected metalloporphyrins.

Davis, W.B., L.N. Roy, K.M. Vogel, C.E. Good, and R.N. Roy. Walter H. Hoffman Department of Chemistry, Drury College. THE THERMODYNAMICS OF QUADRIVALENT Th^{+4} ION. The activity coefficients of HCl and $ThCl_4$ for the system $HCl\text{-}ThCl_4\text{-}H_2O$ have been calculated from electromotive force measurements of the following cell:

$$Pt;H_2\ (g,\ 1\ atm) \mid HCl\ (m_A)(aq).\ ThCl_4\ (m_B) \mid AgCl;\ Ag$$

The activity coefficient data have been analyzed using linear and nonlinear forms of Harned's equations. Also, higher order elctrostatic effects according to Pitzer's formalism have been taken into account in the calculations and will be compared and discussed.

Foster, Kimberly A. and Anne E. Moody. Science Division, Northeast Missouri State University. TACKLING THE ORGANIC LAB DILEMMA: THE ULTIMATE ORGANIC CHEMISTRY EXPERIMENT.Organic chemistry laboratory is an integral component of the education of organic chemistry students. In spite of its universality, students and faculty often state that improvements could be made in the organic chemistry laboratory curriculum. This work details an investigation of how the administration of this lab affects student learning and morale. Preliminary results of an experimental two credit hour lab offered at NMSU indicate that it may be a viable alternative to the traditional two semesters for one credit hour each. Survey results from a variety of institutional settings detailing their approaches to teaching organic chemistry labs are presented. Included in the data are the timing of organic labs relative to organic lectures, the amount of time that students spend in lab, the focuses of the lab experiments, and the extent of incorporation of microscale experiments in the curriculum.

Hinze, S., J.K. Gong. Department of Chemistry, Southeast Missouri State University. APPLICATIONS OF NMR COMPUTER SIMULATION IN THE SYNTHESIS OF NICKEL COMPLEXES. Activation of small molecules by transition metal complexes has received tremendous attention in the past two decades. Many catalysts have been developed to convert these relatively common carbon compounds into useful organic chemicals. We have, in our laboratory, developed a simple but effective route to synthesize dinuclear nickel complexes with various bridging ligands. The synthesis, characterization and structure of several nickel complexes will be presented. In the process of characterization, NMR computer simulation programs are found very useful in characterizing compounds that follow second order NMR. Detailed information and specta will also be discussed in the presentation. Supported by GRFC (1002861, 1002951) and Research Corporation C-3394.

Martin, B.R. and K.N. Carter. Division of Science, Northeast Missouri State University. FOURIER SPECTRAL ANALYSES OF SOUNDWAVES USING A SOUNDBLASTER AS AN A/D CONVERTER. Mention of active desynchronization in a film on chaos theory sparked our interest in the possibility of non-Poisson distributions of events that might naively be considered random. We began investigating the popping of microwave popcorn as a potentially tractable example, recording and then digitizing the time series of pops. The Soundblaster, primarily used as a game card, stores its sampled data as a simple array of 8-bit integers, providing an inexpensive and user friendly system of analog-to-digital conversion. The resulting time series contains much noise, and the narrow dynamic range of the 8-bit A/D converter makes identifying pops by amplitude alone impractical. However, the Fourier transform allows interchange between time and frequency domains, providing a digital method for filtering unwanted noise from the data. Comparison of power spectral density for noise and pops reveals a number of high frequency peaks with signal-to-noise ratios greater than 10 to 1. However, the specific frequencies appear to differ from pop to pop, complicating identification of pops.

Patel, S.M., C.P. Moore, L.N. Roy, and R.N. Roy, Walter H. Hoffman Department of Chemistry, Drury College. THE DISSOCIATION CONSTANT OF BORIC ACID IN SEAWATER OF SALINITY, S=35, AT TEMPERATURES FROM 273.15 TO 328.15K. The thermodynamic dissociation constant, pK*, of boric acid in synthetic seawater of a salinity, S=35, was determined at temperatures ranging from 273.15 to 328.15K using the electromotive force methods. The cell diagram without liquid junction is as follows:

$$Pt;H_2(G, 1\ atm)|\ Borax\ (m_1)\ in\ seawater|\ AgCl;Ag$$

The emf data were measured at each temperature and the apparent values of pK^{*t} were calculated using the Nernst equation. Results of pK* were obtained by extrapolation to the molality of Borax = 0. The

results will be compared with the literature data and will be recommended for use to detemine the carbonate alkalinity of seawaer.

Rotert, K.H., A.P. Toste[1], J.G. Steiert[2]. Departments of Chemistry[1] and Biology[2], Southwest Missouri State University. ANALYSIS OF FATTY ACIDS OF PSYCHROPHILIC BACTERIA. Plasma membranes require fluidity to allow chemical movement into and out of the cell. Lipids are the main components of the membrane, and the fluidity is determined by their fatty acid composition. Cells that survive at non-ambient temperatures do so by maintaining fluidity via membrane fatty acid changes. Fatty acids of psychrophilic bacteria are being analyzed for identification. The fatty acids of seventeen different strains of bacteria from Antartica have been identified by gas chromatography and gas chromatography/mass spectrometery. A wide array of fatty acids appear to be present with unsaturated fatty acids being the most common.

PHYSICS, ENGINEERING, AND COMPUTER SCIENCE

Groh, K.W., R.A. Mayanovic, Y. Wang, and R.E. Giedd. Department of Physics and Astronomy, Southwest Missouri State University. XAFS STUDIES OF ARSENIC-ION IMPLANTED POLYSULFONE. Ion implantation causes structural and compositional modifications in polymers which in turn alters their physical properties, such as the electrical conductivity. Due to a lack of long range three dimensional order, studies of the local structure surrounding the implanted ion are necessary for the understanding of any changes of the polymer's physical properties. We report on recent x-ray absorption fine structure (XAFS) studies made on As-implanted polysulfone films grown on glass slides, which were obtained from Brewer Science. The samples were implanted with 50 KeV As ions in the dose range of 10^{15} to 10^{17} ions/cm^2. The films were exposed to synchrotron x-ray radiation and XAFS spectra were obtained at the As K-edge by collecting fluorescence x-rays. Preliminary results indicate presence of local order surrounding the arsenic ions. A systematic change of the local structure surrounding the implanted As ions with implantation dose rate has been observed.

Lucas, J.W. Department of Physics and Astronomy, Southwest Missouri State University. EFFECTS OF NEGATIVE GRAVITATIONAL MASS IN N-BODY SIMULATIONS. Current theory of gravitation assumes that masses must always be positive. However, N-body simulations using only positive masses generally fail to produce large structures conforming to astronomical observations. Simulations that discard this assumption, using particles with both positive gravitational mass (PGM) and negative gravitational mass (NGM), evolve rapidly into clusters and voids resembling three-dimensional maps of galactic distribution. The simulation, programmed by J.D. Edson of SMSU, uses Newton's equation, $F=-GMm/r^2$. When the product of the masses is positive, the force is attractive. When this product is negative, the force is repulsive. A cosmological model using NGM matter provides plausible explanations for rapid evolution of large structures, and peculiar galactic velocities. If NGM matter exists, it may be non-luminous, since photons from NGM interactions may not interact with PGM matter. If this is the case, NGM matter would exist in the vast intergalactic voids. Large conglomerations of non-luminous NGM matter might be detectable by diverging gravitational lensing effects on background galaxies.

Penrod, M., and R.A. Mayanovic, Department of Physics and Astronomy, Southwest Missouri State University. EFFECTS OF COPPER IMPURITIES ON THE STRUCTURE OF OXIDIZED SILICON WAFERS. Metal atom contamination at the surface of an oxidized silcon wafer used for device manufacture can have a detrimental effect on its desired performance. In order to understand how the metal impurity affects the wafer's physical properties, we need to determine the local structure surrounding the metal atom in the silicon wafer. Several samples were prepared at IBM-Yorktown Heights Research Center by evaporating copper metal on oxidized wafers in an ultra-high vacuum

chamber. The coverage for these samples ranged from approximately 10^8 atoms/cm^2 to 10^{13} atoms/cm^2. We collected x-ray absorption fine structure (XAFS) spectra for the samples at the Cu K-edge, by exposing them to synchrotron x-ray radiation, in the shallow-incident angle mode, and detecting fluorescence x-rays eminating primarily from the surface region. We plan to discuss our findings for the local structure of copper atoms, in relation to silicon and oxygen atoms at the surface region of the wafers.

Smith, C.P., S.N. Jefferson, and E.L. Tavenner, Department of Physics, University of Missouri-Rolla. SOLAR SPECTROSCOPY: CCD CAMERA PERFORMANCE. We are studying the solar spectrum using a monochromator and a CCD for the detection device. The main area of interst of the spectrum will be the chromospheric Ca II K line (393.4 nm). The apparatus will consist of the CCD camera, a Spex 0.75 meter monochromator, a 10-inch reflecting telescope, and fiber optic cable. The 10-inch telescope is used to track the sun and a fiber optic cable is used to transfer the light from selected parts of the solar disk or from integrated sunlight to the monochromator which is located on the second floor of the Physics Building. The Ca II K line exhibits self-reversal in the core of the line and our project is to attempt to measure variations in this core over parts of the solar disk, for example in sunspots, and in integrated sunlight, for example with varying amounts of activity on the solar disk.

Thilker, D.A., J.R. Fox. Department of Physics, University of Missouri-Rolla. ASTRONOMICAL CCD IMAGING AT UMR: AN INTERIM REPORT. Progress towards the modernization and update of the UMR observatory through the implementation of astronomical CCD technology is detailed. Preliminary image data is presented, specifically: globular cluster M13 and the lunar surface. An evaluation of the Santa Barbara Instrument Group's (SBIG) ST-6 CCD camera is presented; bias frames, dark frames, and flat-fields are all examined. A custom optical assembly for instrument focusing and the housing of BVRI photometry and RGB colorimetry filters is described. The ST60PS data acquisition program, provided by SBIG, is reviewed. Finally, optical telescope collimation and polar alignment issues are discussed.

SOCIAL AND BEHAVIORAL SCIENCES

Donaldson, G.N., J.T. Tuten III, C.T. Wiltshire. Department of Social and Behavioral Sciences, Culver-Stockton College. STRENGTH OF ASSOCIATIVE LINK IN THE HIERARCHICAL NETWORK. The purpose of this study was to replicate the findings that reaction time to true/false statements increases as category increases. Subjects were instructed to respond to statements that were true/false in nature and their corresponding reaction times were measured. Collins and Quillian (1969) demonstrated that strength of association diminishes as superordinate and subordinate categories move further apart (i.e., increased category distance). The experimenter verbally presented true statements and false statements of various category distances. Subjects' reaction times to declare "true" or "false" were measured. Level of associative strength also varied. Reaction times were tabulated and collapsed across combinations of statements contining high and low word association and levels of category distance. No reliable difference in reaction time was obtained between true statements and false statements. However, as category distance increased, reaction time increased reliably, for both high association words, $t(52, 2Q) = 2.316$, ($p<0.05$), low association words, $t(46, 2Q) = 2.000$, ($p<0.05$), among true statements. For false statements, only low assoiciation words yielded reliably slower reaction times as category distance increased, $t(64\ 2Q) = 2.000$, ($p<0.05$). We are currently replicating the study using computer displays rather than verbal presentation to: 1) obtain more accurate reaction times and 2) to determine the effect of display.

Ferris, J.P. Department of Geography, Northwest Missouri State University. DEFINING SUCCESS: THE IMPACT OF DEREGULATION OF TELEVISED COLLEGE FOOTBALL. In 1984, the

Supreme Court ruled that the National Collegiate Athletic Association (NCAA) would no longer have exclusive rights over televised college football. This gave individual schools and conferences freedom to negotiate their own television contracts. Since 1951, the NCAA had controlled television coverage of college football. The purpose of the control was to "reduce, insofar as possible, the adverse effects of live television at the attendance of games" (Flygare, 1984). The purpose of this study was to determine what impact the deregulation has had on individual collegiate football program success among the NCAA Division IA members since it went into effect beginning with the 1984 season. Success was defined as a combination of win-loss records, attendance and poll rankings. It was hypothesized that the 'rich' (traditional successful) would get richer and the 'poor' (traditional also-rans) would be poorer, with regard to college football program success as a result of the 1984 Supreme Court ruling. The results of the study indicate only minor correlations with the hypothesized trend. The argument for a region known by Rooney as the 'Pigskin Cult' is supported by the increase in success of southern programs.

Few, T.L., T. Guetzkow and T. Pittman. Department of Psychology, Missouri Southern State College. COLLEGE STUDENTS' ATTITUDES TOWARD HOMOSEXUALITY. Of the many topics covered in psychology courses today, few arouse as much hostility, interest and emotion as the issue of homosexuality. The present study was to determine if gender of the couple, whether the couple was faithful or had a variety of sexual partners and the presence or absence of a photograph of the couple would have an effect on the attitudes of college students. The subjects were given a vignette which described a couple and were asked to answer questions which related to the vignette. Results indicated there was a negative bias toward lesbians, gay males, as well as couples who had a variety of sexual partners. It appears that society's stigma toward homosexuality and couples with a variety of sexual partners does linger in the attitudes and opinions of the subjects.

Graff, J.L. Department of Psychology, Missouri Southern State College. SELF-REPORTED DELINQUENT BEHAVIOR AND SCHOOL ACHIEVEMENT AMONG ADOLESCENTS FROM AUTHORITATIVE, AUTHORITARIAN, PRMISSIVE AND NEGLECTFUL FAMILIES. The present study examined the relationship between parenting styles and adolescents' self-reported delinquent behavior and school achievement. The subjects were 200 high school students from a small town in the Midwest. The subjects completed 2 questionnaires. The parenting questionnaire is constructed based on Baumrind's topology of parenting (Baumring, 1967, 1989; Lamborn, Mounts, Steinberg, & Dornbusch, 1991), which contains questions on parental warmth/responsiveness and parental strictness/supervision. The activity questionnaire measures a variety of delinquent behavior. In addition, students' GPA's were obtained from school officials. At the current time, data from 70 subjects has been entered and analyzed. A parent was classified into 1) authoritative style if both warmth and supervision scores were in the upper tertile (n=13), 2) neglectful if both scores were in the lower tertile (n=15), 3) authoritarian if the warmth was in the lower but supervision in the upper tertile (n=5), and 4) permissive if warmth was in the upper but supervision in the lower tertile (n=11). Final results will be discussed.

Haag, S. M., Department of Behavioral and Social Sciences, Webster University. POSTTRAUMATIC STRESS DISORDER: STUDY TO DETECT INCIDENCE AND PRECIPITATING FACTORS IN A POPULATION OF FIREFIGHTERS, PARAMEDICS, AND FIREFIGHTER/PARAMEDICS. The MMPI Keane et al. (1984) subscale (PK) for assessing combat related PTSD and questionnaires assessing years of service (TR) and degree of family psychopathology (HX) were administered to 14 professional civilian firefighters, paramedics, and firefighter/paramedics. An incidence rate for significant PTSD symptoms of 7% (approx. 50% probability) is suggested in this population using a PK score above 25 as the criteria for PTSD positive. Multiple regression analysis suggests a strong correlation among the PK, YR, and HX scores (multiple $r = 0.885$). Correlation between positive family history (HX) and PTSD (PK) was calcualted at $r = 0.536$ and supports similar results reported by Davidson et al. (1985). Increased years of service is suggested to be analogous to increased level of exposure to trauma, which has been shown to account for much of the variability in PTSD symptoms. The need for PTSD research in civilian populations and understanding by mental health professionals is recommended.

Hagerman, T.S. Department of Psychology, Missouri Southern State College. THE EFFECTIVENESS OF OPENING LINES PART II. Opening lines can expand or reduce a person's chance of getting to know someone. Research conducted on the east and west coast by Kleinke, Meeker, and Staneski (1986) developed three types of lines - innocuous, direct, and cute-filippant. The research at hand replicated Kleinke et. al. in the midwest. In this research, a preliminary survey was conducted. Subjects wrote from 2-10 opening lines for 6 specific situations including restaurants, laundromats, supermarkets, swimming pools, parties, and other situations not already mentioned. On the basis of the opening lines generated in the survey, the final survey was constructed. Subjects rated the effectiveness of nine opening lines for each situation, 3 innocuous, 3 direct, and 3 cute-flippant. Ratings were made using a Likert scale with 1 indicating definitely not effective and 5 indicating definitely effective. Results of what category of lines were rated as most effective for women were compared to those rated as most effective for men. The gender of the respondent to surveys of opening lines for men or women also was used as a quasi-independent variable. The discussion focused on the possibilities of why people thought certain categories of lines were more effective.

Hoh, L.C. and J. Ciak. Department of Human Environmental Sciences, Northwest Missouri State University. BREAST FEEDING DECISIONS OF WIC (WOMEN, INFANTS AND CHILDREN) MOTHERS IN NORTHWEST MISSOURI AREA. Attitudinal, social, and psychological variables of 62 WIC mothers were correlated to infant feeding choice, Kendall's Tau showed: breast feeding was chosen more often by married females (Tau=0.32, p=0.0065); mother's feeding choice was influenced by the father's preference (Tau=0.47, p=0.0001); and if mother was formula fed as an infant, she has a higher probability of formula feeding her infant (Tau=0.26, p=0.024). Although 85.5% agreed that an advantage of breast-feeding is closer mother-child bonding, 54.8% of the mothers chose to formula feed. Pearson's correlation showed the following were associated with choice of formula feeding: lack of understanding of breast feeding (r=0.58, p=0.0001); father's objection to breast feeding (r=0.34, p=0.0066); absence of breast feeding experience (r=0.47, p=0.0001); and the positive belief of potential bonding of father with bottle fed infants (r=0.67, p=0.0001).

Ingels, Jennifer L. Department of Geology/Geography, Northwest Missouri State University. WHAT SHOULD A GEOGRAPHER KNOW? ANALYSIS OF SELECTED UNDERGRADUATE GEOGRAPHY PROGRAMS. There are several ways to measure the success of undergraduate programs in geography at any college or university. A study by Darrell A. Norris at SUNY Genesco made a ranking of the top 20 geography programs in the nation based on a combination of several ratios that help measure success such as attracting students to courses, generating majors, and building a strong presence on campus. Another way to look at these undergraduate geography programs is to look at the courses they offer. This study will compare several geography programs on the basis of courses offered, including whether each course is required, if it is required as an elective, or offered strictly as an elective, and the level at which each couse is taught. The schools this study will look at are the top 20 schools named by Darrell E. Norris, Midwestern universities with undergraduate geography programs, and a non-scientific sample of other schools in the nation based on reputation and/or enrollment of students in their undergraduate geography programs. The results of this study show what is being taught in geography. To describe the content of successful programs is one way to start defining what a geographer should know.

Lamb, M. Psychology Depaartment, Missouri Southern State College. BEHAVIOR MANAGEMENT PROGRAMS--IMPLEMENTED. Behavior Management has its roots in basic research provided by Pavlov, Watson, Skinner, and a host of contempory practitioners. Today's implementation of a management program involves baseline data (the level of the targeted undesirable behavior before program implementation), termination data (the level of the targeted undesirable behavior at the conclusion of psychologists' intervention) and consequences (rewards for not doing undesired behaviors and withholding rewards when undesired behaviors occur). The effectiveness of any management program is contingent on the consistency of provided consequences. This study is performed to analyze the effectiveness of behavior mangement programs. Data was obtained from a specific psychologist with a reputation for implementing consequences and labeling similar target behaviors. The project is

designed to examine the effectiveness of behavior management procedues with three separate parenting types. Data were analyzed, comparing foster parents, welfare recipient parents, and non-welfare recipient parents. In addition, the role of parental marital status during the intervention of the psychologist is examined as a variable to successful outcomes. Behavior management appears to be efficient with all types of parenting situatons. Subtle differences in parenting types are discussed.

Lee, L.S. Psychology Department, Missouri Southern State College. "MISTREATMENT" AND MULTIPLE PRSONALITY DISORDER. Historically, the concept of Multiple Personality Disorder has been viewed with great skepticsm and therefore given little recognition. The diagnosis has been the subject of controversy for centuries (Dawson, 1990). Janet and Freud, from the 1800's, understood the phenomenon and proposed effective therapy styles. However, more common problems of the world such as the Holocaust took precedence and the concept received little attention. As a result, misdiagnosis was typical and therefore "any" therapy proved ineffective. This study used 8 MPD patients, ages 28 through 56. Subjects rated the effectiveness of 14 potential "Mistreatments" that they recieved before being properly diagnosed. Using an ANOVA statistic, the therapy styles, such as hypnosis and journal writing had a significant main effect on the effectivenes of the therapist, as did effectiveness of the therapy style and subject ratings of the therapist. Data presented in this paper, may encourage an analyst to be more aware of the traumatic affects that misdiagnosis can create for the MPD patient and thus render any treatment plan ineffective (Bernstein & Putnam, 1986).

Lungstrum, C.A. Department of Psychology, Missouri Southern State College. SEXUAL HARASSMENT: THE RELATIONSHIP BETWEEN CLASSIFICATION AND PERSONAL ATTRIBUTES. Sexual harassment (SH) has affected the lives of many people. However, there isn't a single prevailing definition that explicitly defines what SH is, or who defines what behaviors as acceptable or unacceptable. This study was designed to discover the relationship between subjects' surveys concerning Locus of Control and classification of SH. For example; age, gender, job status, education, and personality characteristics may contribute to the way SH is classified. Several SH surveys were condensed into one, asking if the subject believed this situation involved SH, as well as Rotter's Internal-External Locus of Control was distributed to each subject. 100 subjects volunteered to complete the surveys, with no incentives offered. Although no statistics have been performed at this time, it is believed that these factors will be of some significance in determining the way SH is classified.

McGrail, T.E., and J.R. West. Department of Geography, Northwest Missouri State University. HAVING A FOE YOU KNOW: THE GEOGRAPHY OF COLLEGE FOOTBALL ARCHRIVALRIES. "Rivalry" is derived from the Latin word rivalis meaning "one who uses the same brook as a neighbor." Thus, one could assume that "football rivalry" refers to a competitive game of football played between two teams in close proximity. Traditional rivalries have arisen as a function of distance and regional competition. They continue to generate considerable attention from the media and ardent enthusiasm from fans. Despite their significant role in regional sports culture and their association with place identity in the culture at large, little research has been conducted into the geographical aspects of this phenomena. The purpose of this study was to determine which college football rivalries are viewed as the most significant by those college football coaches and sportswriters who vote weekly for the nation's top twenty teams. Questionnaires were sent to those individuals who vote on the Associated Press Sportswriters Poll and the USA Today/CNN Coaches Poll. Results of the survey were mapped to determine the spatial distribution of the rivalries listed. The pattern of close proximity was evident, in addition, conference and regional affiliation played a significant role in the geography of rivalries.

Park, D.H. Psychology Department, Avila College. REDUCING USE OF THE REPRESENTATIVENESS HEURISTIC THROUGH TRAINING. When making decisions concerning the probability of an event, people often err through the use of the representativeness heuristic, a natural cognitive assessment, rather than principles of logic. Agnoli and Krantz (1989) have suggested that brief self-training using concepts of algebraic sets suppresses the use of this heuristic. This study replicated and extended their research using their training and testing instruments. Fifty people were

tested (14 males, 36 females), 25 with and 25 without training. An overall effect for training was shown ($p<0.0003$). Female subjects with training reduced error ($p<0.0027$). Older subjects with training reduced error ($p<0.015$). This study confirmed that formal training in logic can greatly reduce error in the objective portion of probability judgments in decision making.

Phipps, D.A. Department of Psychology, Missouri Southern State College. DEVELOPMENT OF TRADITIONAL VS. NON-TRADITIONAL COLLEGE STUDENTS. The purpose of this study was to compare the levels of ego development, cognitive development, and self-esteem of traditional and non-traditional college freshmen and seniors. This was accomplished using the Erwin Identity Scale (EIS), The Scale of Intellectual Development (SID), and the Coopersmith Self-Esteem Inventory. Past research has demonstrated significant differences in development between genders, age, and class rank. The study was based on the concept of identity as defined by Chickering and, later, Erwin. The results will be discussed.

Pryor, R. and R. Denton. Department of Psychology, Missouri Southern State College. RELATIONSHIPS BETWEEN ATTITUDES AND VOTING BEHAVIOR. This study involved an election-year survey about voting. Attitudes affect voting in several ways. This survey consisted of 48 questions related to feelings, beliefs, subjective norms and involvement related to voting behavior. This study involved 233 volunteers enrolled in general psychology classes at a small Missouri college. Results were compared to a previous 1988 voting survey sampled from the same population. Expectations were that feelings, beliefs, and involvement would affect behavior. There were significant results in both surveys. There was a strong positive relationship between beliefs and subjective norms in the 1992 survey, $r(217) = 0.51$, ($p<0.001$). There were no significant findings between subjective norms and actual voting in 1992. Involvement did increase actual voting in 1992, $t(228) = -6.14$, ($p<0.001$). In 1992, 70% of subjects reported voting compared to 34.5% in 1988. A similar survey in 1996 to compare with this study would further enhance our understanding of factors related to voting behavior.

Stephenson, T.R. Department of Psychology, Westminster College. EFFECT OF CONTEXTUAL LINES COMPLETENESS ON THE PARALLEL LINES ILLUSION. This study was conducted to evaluate the relative strengths of a cognitive and a neurophysiological account of size assimilation. Eighteen subjects viewed tachistoscopically presented parallel lines illusion figures with 30 mm long central lines flanked by contextual lines that were either 15 or 45 mm long. The completeness of the contextual lines was either 33%, 66%, or 100%. For the figure with the shorter contextual lines, it was found that the central line was underestimated to a progressively greater degree as the completeness of the contextual lines was increased [$F(2,16)=7.686$, $p<.01$]. For the figure with longer contextual lines, no significant effect of segmentation was obtained though overestimation was greatest when the contextual lines were complete [$F(2,16)=1.514$, $p<.05$]. These data support the neurophysiological account of assimilation which attributes distortions of line length to facilitory interactions among neural length detectors.

Swigart, K., D. Edwards and J.D. Ciak. Department of Human Environmental Sciences, Northwest Missouri State University. PREVALENCE OF ANOREXIA NERVOSA ON A RURAL UNIVERSITY CAMPUS. The "EAT" (Eating Attitudes) survey was distributed through classes to students on a university campus in rural Missouri. The EAT survey, developed by Garner and Garfinkel, is designed to detect anorexic behavior. Independent variables were correlated to the individual's survey score using Kendall's Tau. Of 750 respondents, 45 (6%) scored in the anorexic range. Of that 6%, 5.47% (41) were female and 0.53% (4) were male ($tau=0.17$, $p=0.0001$). Also significant in the data, was semesters of college completed ($tau=-0.69$, $p=0.033$). The highest numbers of eating disorders were found in students who had completed 2-3 semesters (43.48% of the anorexic population), followed by students who had completed 0-1 semesters (26.09%). After the fourth semester, eating disorders dropped with no eating disorders in students completing 8 semesters. Although not significant, the largest population of anorexics lived on campus in the resident halls (20) followed by apartment

dwelling students (17). Belonging to a Greek social organization was not statistically significant; however, 26.09% of the total anorexic population were affiliated with a Greek organization.

Szekeres, C.M. Department of Psychology, Missouri Southern State College. THE RELATIONSHIP BETWEEN FEMALE MENSTRUAL CYCLE AND PERFORMANCE ON SPATIAL ABILITY TESTS. The differences in female spatial abilities were examined through hormonal changes. For females, the largest hormonal change occurs over the phases of the menstrual cycle. There are four phases of the cycle: 1) menstrual, days 1-4; 2) follicular, days 6-12; 3) luteal, days 17-21; and premenstrual, days 23-27. The hypotheses for the current study were: 1) toward the end of the luteal phase and during ovulation, when estrogen, progesterone, LH, and FSH levels are increasing, preceptual-spatial ability well be impaired; and 2) spatial ability will increase during the menstrual, early follicular, and pre-menstrual phases, when estrogen, progesterone, LH, and FSH levels are relatively low. Six spontaneously cycling females served as subjects. They were divided into two groups: Ss over age 35; and Ss under age 35. Only females with regular cycles, averaging between 25 (minimum) and 35 (maximum) days in length, were selected. Three tests designed to measure spatial ability were used: the Mental Rotations Test, (MRT), the portable Rod-and-Frame test, and the NIIP Group Test 82. Ss were tested on a Monday Wednesday Friday rotation over 30 days and the testing was counter-balanced. This study was designed to further explore spatial ability differences, in the hope that a conclusive link can be established between hormone levels and female spatial ability. Final results will be discussed.

Ware, D.B. Department of Psychology, Missouri Southern State College. AESTHETICS OF LANDSCAPES. Investigations of aesthetic and affective responses to outdoor visual environments reveal a strong preference for natural scenes over urban views without natural elements. Arbor-type scenes that include visual complexity and allow visual penetration receive higher aesthetic ratings than scenes without these elements. In this research, subjects were shown slides of realistic landscape photographs (with and without these elements) and abstract drawings. Subjects noted their subjective aesthetic response to each slide on a Likert-type scale from 1, indicating "not at all pleasant to look at" to 7, indicating "very pleasant to look at". Scores for each slide were compared to others in the same category (realistic or abstract) and to the correponding slide in the other category. A rank order correlation between categories was determined. The possibility that a particular type of visual stimulus inherently elicits the most favorable aesthetic response will be discussed along with the implications for fostering pro-conservation attitudes.

White, D.C. Department of Psychology, Missouri Southern State College. SEXUAL HARASSMENT: GENDER DIFFERENCES IN DEFINITIONS AND PERCEIVED PUNISHMENTS. Undergraduate students were asked to read nine vignettes depcting women encountering episodes of either gender discrimination, sexual harassment, or neither. Subjects assigned a label to the scenario and chose one of eight punishments they felt was suitable for the offense: no action taken, written warning, verbal warning, suspension without pay, transferred to other work areas, placed on probation, demotion, or fired. Responses to the vignettes for each subject and differences between gender, age, and number of years of work experience of subjects were investigated. It is predicted that women over the age of 25 who had more than 5 years of work experience will view more incidents as gender discrimination or sexual harassment, and will want stricter punishments for the offenders than younger women or men.

Williams, L. Psychology Department, Missouri Southern State College. INSTRUCTOR STYLE, GENDER, AND STUDENT MOTIVATION. During the last sixty years (1930-1990) motivation has been researched as a need or drive of an organism, but today motivation is thought to be a reward of a competitive or social nature. Society perceives men as being competitive and women as being social; therefore, men and women use different motivational strategies to achieve their goals. This research was done to see if authoritarian teaching style and gender would have an effect on student motivation. Fifty subjects voluntarily participated from the General Psychology classes at MSSC. These subjects were given two questionnaires: Classroom Atmosphere Questionnaire, consisting of 13 questions and general information to determine the teaching style and gender of the instructor, and the Motivated Strategies

Learning Questionnaire, consisting of 81 questions to determine motivational and learning strategies. The data have not been fully analyzed, but it appears that the Classroom Atmosphere Questionnaire did effectively report a difference between authoritarian and democratic instructors. It is not clear yet what impact style had on instructor, but is is suspected that authoritarian teaching style decreases intrinsic student motivation..

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Abstracts

Ashley, D.C. Biology Department, Missouri Western College. FIELD STUDIES IN MISSOURI ON CAVE-DWELLING SNAILS OF THE GENUS *Fontigens*. Between March of 1992 and January of 1994, several populations of troglobitic snails have been studied. Using a standard sized PVC square (.5m X .5m) population densities have been estimated for *Fontigens aldrichi* from Cathedral Cave and Mossy Spring Cave, and *Fontigens antroecetes* from Berome-Moore Cave and Mystery Cave. In addition, 51 *F. Aldrichi* were measured from Cathedral Cave and 28 *F. antroecetes* were measured from Berome-Moore Cave. Sizes ranged from .4 mm to 2.4 mm (mean = 1.2, st.dev. = .67). These data will provide a baseline of information for future comparisons with field populations from other caves, and for studies on seaonality of population density and individual growth rates.

Canaday, B.D. Missouri Department of Conservation, Springfield, Missouri. OZARK CAVEFISH PUBLIC OUTREACH AND HABITAT MANAGEMENT. The Ozark cavefish (*Amblyopsis rosae*) was officially listed as threatened by the U.S. Department of the Interior on December 3, 1984. It is an obligate troglobitic fish restricted to the Springfield Plateau of central North America. Habitat destruction, disturbance, excessive collection and declining water quality are typically cited as primary factors threatening this and other cave species. An outreach program by the Missouri Department of Conservation, in cooperation with the U.S. Fish and Wildlife Service and other natural resource agencies, was developed to increase landowner awareness and enhance habitat management within the recharge areas of the Ozark cavefish caves in southwest Missouri. These efforts focus on informational and educational activities and direct landowner contacts within the known range of the Ozark cavefish. Landowners are offered advice and assistance to address existing and potential impacts on cave systems. This project is jointly supported by the U.S. Fish and Wildlife Service and the Missouri Department of Conservation.

Drew, C. and D.C. Ashley. Biology Department, Missouri Western State College. A SURVEY FOR COLIFORMS IN MISSOURI CAVES. This report deals with the quantitative and qualitative analysis

of coliforms within several cave systems in Missouri. One hundred and twenty eight (128) water samples were collected from seven caves located in four counties. A membrane filtration technique was the method used to quantify coliform presence in different aquatic microhabitats from Cathedral, Mushroom, Mystery, Hunter, Tom Moore, Onondaga and Berome Moore Caves. Replicate samples were processed from many habitats to verify the validity of our techniques. Coliform counts ranged from 0 per milliliter of cave water to 412 per milliliter of cave water. Comparisons were made between the different caves, counties, and microhabitats. Species were identified using the Vitek Identification System. Twenty different species of bacteria were identified from caves during this study.

Graham, R. W. and R.S. Toomey, III. Geology Section, Illinois State Museum. MISSOURI CAVE MAMMALIAN FAUNAS. There are at least 44 mammalian faunas from Missouri caves included in the FAUNMAPdatabase, an electronic database on late Quaternary mammalian faunas of the United States which is housed at the Illinois State Museum. Fossils from these caves document the evolution of mammalian communities and environmental changes throughout the late Quaternary. Missouri cave sites in the database range in age from over 100,000 years before present to historic times, and they contain over 100 different mammalian taxa (from bats and mice to mammoths and ground sloths). Interfaced with a Geographic Information System (GIS), the FAUNMAP database can show changes in the distribution of individual species at different times. In addition, community composition and environmental forces which shape it can be examined chronologically for different geographic regions. Finally, knowledge of environments and faunas of the past may provide insights into important processes which may shape mammalian communities of the future as a result of climate change (e.g. global warming). This projet supported by NSF/BSR 9005144.

Krejca, J.K. and B.M. Burr. Department of Zoology, Southern Illinois University at Carbondale. **M.L. Warren, Jr.,** Forest Hydrology Lab, Southern Forest Experimental Station , **R.J. Paul,** Department of Zoology, Southern Illinois University at Carbondale. CAVERNICOLOUS SCULPINS OF THE COTTUS CAROLINAE SPECIES GROUP (PISCES: COTTIDAE) FROM PERRY COUNTY, MISSOURI. Sculpins in caves, springs, and surface drainages in Perry County, Missouri, show remarkable mophological differences when compared to Cottus carilinae from other areas of southeheastern Missouri. Sculpin populations with cave adaptations such as those from Perry County have not been reported elsewhere.

Description of these sculpins is in progress, and determination of their taxonomic status awaits completion of research. Analysis of characters within Zperry Count Cottus and those from aoutheastern Missouri reveled consistent differences in several features. Cave populations are variable, but exhibit reduced pigment, reduced eye size, reduced number of pelvic rays, a gap between the dorsal fins, and a longer caudal peduncle.

Surface seining and in-cave observations continue to yield information regarding specific habitat, food sources and availability, distribution, and population estimates. The large, base level cave streams of this area provide suitable habitat. with an abumdamce of troglobitic and surface food sources. Sculpins are found in waters of four large cave systems of the county, and seem to be limited on the surface to the streams into which these caves discharge.

Schaper, J. A., Editor, **Missouri Speleology.** Missouri Speleological Survey, Inc. THE NEED FOR INTERDISCIPLINARY COMMUNICATION IN SPELEOLOGY. The science of speleology is by nature an interdisciplinary pursuit, and all persons involved in it need to recognize this important aspect. Both within the sciences, and between the sciences and the lay researcher, communication is paramount to the derivation of correct and useful data. From its historical roots in the 1800s to the fieldwork of tomorrow, the methodology and manner of research must take into consideration its multidisciplinary focus in order to best serve researcher and layman alike. A look will be taken at communication styles of the past and present, and the conflict between the standard scientific paper versus popular oversimplification with the aim of attaining a readable scientific standard.

Taylor, S.J., J.K. Kejca. Department of Zoology, Southern Illinois University at Carbondale, **D.W. Webb,** Center for Biodiversity, Illinois Natural History Survey, and **J.E. Gardner,** Missouri Highway and Transportation Department. A BIOLOGICAL INVENTORY AND WATER QUALITY ANALYSIS OF ILLINOIS CAVES AND OTHER SUBTERRANEAN ENVIRONMENTS. Throughout our two year biological inventory approximately 100 of the over 390 known caves in Illinois were examined. This project expands on earlier studies, providing valuable baseline data on Illinois cave fauna. In addition, a variety of water quality parameteres are being measured, with emphasis on pesticides and fertilizers. Creating a detailed cave database for the state is another important product of this study.

Specific identification of many invertebrates awaits determination by taxonomic specialists. Thus far the water quality analysis has not revealed any caves or springs with contaminant levels. We have detected the presence of the persistent breakdown products of DDT and Aldrin in both water samples and aquatic cavernoicolous invertebrate tissues.

Because of the increasing human impact on the karst regions of the state the main goal of this project is to serve as a management tool. The inventory will be useful for future monitoring of Illinois' cave life and karst groundwater, and will aid in understanding human impacts on karst areas. Supported by ILENR/1-5-39610.

Toomey, R.S. III, R.W. Graham. Geology Section, Illinois State Museum and **T.W. Stafford. Jr.** INSTAAR, University of Colorado. NEW DATES ON MAMMALIAN FAUNAS FROM SEVERAL MISSOURI CAVES. Recent ASM radiocarbon determinations on bone collagen and uranium series analyses on tooth enamel indicate that several important Missouri cave faunas are older than the latest Quaternary age originally ascribed to them. ASM radiocarbon dates in excess of 40,000 radiocarbon years were obtained on collagen from scutes of the extinct giant armadillo *Daspus bellus* from Cherokee Cave (St. Louis Co.), and Heinze Cave (Jefferson Co.) and from rabbit *(Sylvilagus sp.)* and pocket gopher (*Geomys bursarius)* bone from Autolite Cave (Perry Co). A preliminary uranium-series age of >200,000 years was obtained on a fragment of mastodon (*Mammut americanm*) tooth enamel from Heinze Cave. These dates are important because they provide a chronological framework for understanding Quaternary environmental changes in the central continent area and indicate times during which these caves were open and receiving sediment. The new dates cause us to quesion the ages of several other cave faunas from Missouri which have been ascribed to the Late Wisconsin. These sites include Crankshaft Cave (Jefferson Co.) and the Brynjulfson Caves (Boone Co.). In addition, if the uranium series date from Heinze Cave is correct, this site is one of the oldest dated Rancholabrean sites. This project support by NSF/EAR-9206894.

Vale, Eugene R.J. Missouri Department of Natural Resources. PATTERNS OF VISITATION AT ONONDAGA CAVE AND THEIR IMPLICATIONS FOR FUTURE PLANNING. Much show cave management has been "seat of the pants." This study looks at the last 12 years' attendance at Onondaga Cave and determines seasonal and weekly patterns of visitor use. This is used to more efficiently determine staffing needs (number of guides) and hours of operation. Past data is by day only, computerized record keeping will allow for hourly records and exploration of daily patterns to even more effectively serve our visitors.

Vale, Eugene R.J. and Ron Jones. Missouri Department of Natural Resouces and Missouri Speleological Survey. MANAGEMENT CONSIDERATIONS IN SEALING ARTIFICIAL OPENINGS INTO ONONDAGA CAVE AND THEIR BEARING ON THE METHODS CHOSEN. Onondaga Cave is located in Onondaga Cave State Park at Leasburg, Missouri. The cave has been managed by the Missouri Department of Natural Resources since 1981, but it was commercially oprated and developed for the previous 90 years. During over one hundred years of operation, numerous artificial openings have been created. These openings have increased opportunities for illegal entry and vandalism and have altered the air flow and climate of the cave, affecting wildlife and speleothems. An on going program to secure and seal these artificial entrances and restore natural conditions to the cave has utilized bat compatible gates, hermetically sealed doors, air locks, concrete walls, and sewer plugs.

Work is being accomplished using state park employees and caver volunterrs from the Missouri Speleological Survey.

Vineyard, Jerry D. Missouri Department of Natural Resources, Division of Geology and Land Survey. INTO THE PHREATIC ZONE: DIVABLE SPRINGS OF THE MISSOURI OZARKS. Exploration and mapping of Vauclusian springs in the Ozark carbonate terrane, using SCUBA technology, has been underway since the early 1960's. Maximum depths of 98 meters and linear penetration of 435 meters (at -60 meters) have been achieved. Divable springs occur primarily in the thick-bedded Eminence and Gasconade Dolomites, of Cambro-Ordovician age. Feeder conduits are water-filled equivalents of air-filled cave passages, with extensive spongework and chert ledges, but few tributary conduits. Major spring conduits appear to lie 50 to 100 meters beneath current base level. Springs occur along major rivers, but not as a result of downcutting; spring throats are steeply-sloping ramps. Large surge chambers are connected at depth with conduits. Extensive gravel transport, gravel fountains, and sand transport is common. Water-tracing using fluorescent dyes has shown potential for conduit systems as long as 65 kilometers, but current technology is limited, awaiting the arrival of deep-diving submersibles.

Weaver, H. Dwight. Missouri Department of Natural Resources. THE MISSOURI CAVES AND KARST CONSERVANCY, A MANAGEMENT TOOL FOR A THREATENED RESOURCE. Missouri has more than 5,300 recorded caves. Many of these caves are significant for their ecological, cultural, geological and recreational values. The Conservancy has been formed to own and manage caves for the Missouri Speleological Survey, to ensure that cavers and speleologists continue to have access to caves which might otherwise become closed to access because of landowner or liability concerns, to foster a sense of resource stewardship within the Missouri caving community, to encourage the preservation of all high value caves in the state, to promote good communication between public and private cave owners and the caving community, to provide individual cavers with opportunities to learn about and participate in cave management activities, to be always ready and willing to lend cave owners a helping hand in the management of their caves, and to fully support what is best for the cave resources of Missouri.