

**ABSTRACTS OF PAPERS**  
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**Aeronautical and Aerospace Sciences**

F-18 HIGH-ALPHA RESEARCH VEHICLE MULTIAXIS THRUST VECTORING CHARACTERISTICS. Scott C. Ashbury, Aerospace Engineer, NASA-Langley Research Center, Hampton, Va. 23681-0001. An investigation was conducted in the Langley 16-Foot Transonic Tunnel to determine the multiaxis thrust vectoring characteristics of the F-18 High-Alpha Research Vehicle (HARV). Thrust vectoring provides the HARV with unprecedented levels of agility at angles of attack up to  $70^\circ$ . NASA is conducting flight experiments with the HARV to study potential benefits of thrust vectoring for the next generation of high-performance aircraft. A wing-tip supported, partially metric, 0.10-scale, jet-effects model of an F-18 prototype aircraft was modified with hardware to simulate the thrust vectoring control system of the HARV. Testing was conducted at free-stream Mach numbers ranging from 0.30 to 0.70, at angles of attack from  $0^\circ$  to as high as  $70^\circ$ , and at nozzle pressure ratios from 1.0 to approximately 5.0. Results indicate that the thrust vectoring control system of the HARV can successfully generate multiaxis thrust vectoring forces and moments. During vectoring, resultant thrust vector angles were always less than the corresponding geometric vane deflection angle and were accompanied by large thrust losses. Significant external flow effects that were dependent on Mach number and angle of attack were noted during vectoring operation. Comparisons of the aerodynamic and propulsive control capabilities of the HARV configuration indicate that substantial gains in controllability are provided by the multiaxis thrust vectoring control system.

AERONAUTICS CONTENT PRESENTED THROUGH PROBLEM-BASED LEARNING PROMOTES THE INTEGRATION OF MATHEMATICS AND SCIENCE WITH OTHER DISCIPLINES IN ELEMENTARY AND MIDDLE SCHOOL. Bobbye Hoffman Bartels, Dept. of Math., Christopher Newport Univ., Newport News, Va. 23606. During Summer 1995, sixty elementary and middle school teachers participated in 2-week sessions as part of a Teacher Enhancement Institute. The objective of the Institute was to increase teachers' knowledge of aeronautics, problem-based learning, and technology for implementation in classrooms. NASA aeronautics researchers made presentations to teach content, tours of NASA facilities demonstrated the scientific environment of aeronautics, hands-on experiments provided classroom-useful activities, and Internet exploration of aeronautics resources incorporated technology. By the end of the Institute, teachers' knowledge of aeronautics improved significantly, in their classrooms they incorporated aeronautics through problem-based learning, and they reported a greater awareness of aeronautics in the media. Teachers observed that implementations of aeronautics through problem-based learning produced highly motivated students and an effective medium for integrating science and mathematics with the other disciplines. (Funded by NASA-Langley Res. Ctr. Office of Education)

REDUCING SEPARATION ON AIRFOILS THROUGH THE USE OF BOUNDARY LAYER CONTROL. Jeanette Farrah (Elliott), Systems Analysis Branch, NASA Langley Research Center M/S 248, Hampton, Va. 23681. Inviscid theory predicts that lift at angles of attack up to 90 degrees is possible. Viscosity, however, results in a momentum energy loss in the flow, creating a boundary layer. When there is insufficient energy in the flow to overcome the adverse pressure gradient, due to the low energy air in the boundary layer, separation occurs. By using boundary layer control (BLC), the flow can be re-energized, or the low energy air removed. This delays separation and makes the use of thick airfoils and high angles of attack practical. Early experimental results demonstrated large increases in  $CL_{max}$ , as well as reductions in drag through the use of BLC on both thin and thick airfoils. A 31.5% thick BLC suction wing attached to a glider illustrated that the glider could land safely if suction failed, and that the overall drag was equivalent to a 16% thick low drag airfoil. While the major technical problem with thick airfoils is a low critical Mach number, recent research by MIT illustrated the possibility of designing a 30% thick suction airfoil with a critical Mach number of 0.65. Research needs for the future include testing new BLC suction airfoil designs as well as integrating the boundary layer control with the propulsive system of an aircraft.

A BRIEF HISTORY OF DISTRIBUTED LOAD AND LIFTING SURFACE VEHICLES. Henri D. Fuhrmann, NASA Langley Research Center, Systems Analysis Branch, Mail Stop 248, Hampton, Va. 23681-0001. An overview of the motivation for pursuing designs such as spanloaders, flying wings, and blended-wing-body type aircraft is presented in general terms. Vehicles that have the majority of their structure providing lift fall in this category. This does not limit the classification to tailless aircraft or designs that attempt to package the payload solely in the wing. The benefits of distributed loading for structural weight reduction and distributed lifting surface for aerodynamic efficiency are discussed as well as some of the pros and cons of the various configuration options. A general classification scheme for this genre of aircraft is proposed that is composed of (i) Lifting bodies, (ii) Spanloaders, (iii) Partial spanloaders, and (iv) Minimal body configurations. Several historical designs and aircraft from the early 1930's to the present are examined and discussed in light of the underlying missions and design motivations. Finally current design challenges that had not previously been considered, such as passenger pressurization of noncircular fuselages and high transonic cruise speeds, are introduced.

JOYSTICK TRACKING EFFECTS ON AUDITORY EVENT-RELATED POTENTIALS. Timothy F. Knebel, NASA Langley Research Center, Hampton, Va. 23681. Twenty-four dextral volunteers performed a tracking task across three levels of difficulty while silently counting or ignoring tones. EEG was recorded and averaged at frontal, central, and parietal electrode sites to obtain ERP components: N1, P2, N2, and P3. The amplitude of P3 was significantly diminished in the difficult tracking level compared to the easy and medium tracking levels. For the counted stimuli, P3 amplitude was larger at the central and parietal regions and N2 amplitude was greater at the frontal region. Tracking error, measured as root-mean-square error (RMSE), increased significantly from the easy tracking level to the most difficult. N2 and P3 amplitudes were significantly and negatively correlated with RMSE and P3 amplitude was negatively correlated with counting error. The results are consistent with theories of resource allocation and relevant to the development of cockpit monitoring. (This work was performed while the author held a National Research Council-NASA LaRC Research Associateship).

ACOUSTIC ANALYSIS OF A FLAP-EDGE FLOW MODEL. James E. Martin, Dept. of Mathematics, Christopher Newport Univ., Newport News, VA 23606-2998, & Jay C. Hardin\*, NASA-Langley Research Center, Hampton, VA 23681-0001. Sound generated at the side edges of airfoil flaps is a very important, in some cases the most intense, source of airframe noise. Recently, Sen of the Boeing Company has proposed a new physical mechanism for the flap-edge noise source and a two-dimensional model to illustrate it. In this study, Sen's model of flap side-edge flow is analyzed to reveal its noise production potential. The flap is taken to be a slab of finite thickness in the presence of which there exists a potential flow as well as a vortex to represent the flap-edge vortex. For a particular range of the existing flow parameter, equilibrium positions of the vortex off the side edge of the flap are found to exist. The model assumes that the vortex will form near the equilibrium position. The vortex is then perturbed away from the equilibrium position by incoming turbulence causing it to oscillate and thus radiate sound. The noise field is calculated three-dimensionally by numerically integrating the Ffowcs Williams-Hawkins equation. Spectra and directivity of the farfield sound are presented. In addition, the effect of retarded time differences is evaluated.

THREE-DIMENSIONAL BOUNDARY-LAYER STATE MEASUREMENTS FROM THE 737 HIGH-LIFT WING IN FLIGHT. V. Eric Roback, NASA-Langley Research Center, Hampton, VA 23681. Flight experiments were conducted on an instrumented NASA-Langley 737-100 aircraft (TSRV) to investigate high-lift flow physics and for correlation and validation of computational and wind tunnel measurements. The possible reversion of turbulent attachment-line flow to a laminar state (relaminarization) under the action of strong favorable pressure gradients at flight Reynolds numbers has a potentially significant impact on the prediction of high-lift system performance from wind-tunnel tests and computational analyses. A combination of hot-film and pressure data, obtained from the most recent phase of the flight experiments, are reduced and analyzed for attachment-line transition and relaminarization on the slat and leading edge of the main element. Correlation parameters based on empirical wind tunnel data are used in the analysis of these flight data to predict attachment-line transition and relaminarization. Flight pressure distributions were analyzed and then processed to obtain these parameters, the attachment-line Reynolds number and the relaminarization parameter. The pressure data were correlated with hot-film data, which is in both analog and digital format. The pressure and hot-film data indicated both slat and main-element relaminarization. The flow physics observed in flight correlated well with the critical values of both the attachment-line Reynolds number and the relaminarization parameter. The knowledge that relaminarization exists in flight could significantly impact the overall high-lift design considerations of future transports.

## Agriculture, Forestry and Aquaculture Science

### Environmental effects on yield and agronomic traits of bean (*Phaseolus vulgaris* L.)

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Common bean (*Phaseolus vulgaris* L.) is a major legume consumed as a principle source of protein, vitamins, and minerals for over 500 million people in Latin America, Africa, and Asia. Bean demand is increasing with an alarming rate around the world. Bean production has to be increased to satisfy the expected demand. The objectives of this experiment were : a) To determine genotypic variations for green bean yield and dry seed yield and b) To investigate the magnitude of genotype x environment interaction effects on yield and yield components of common bean. A total of thirteen common bean genotypes were planted in four-row plots arranged in RCBD design, replicated four times in 1992, 1993, 1994, and 1995. Each genotype was evaluated for plant height, number of pods plant<sup>-1</sup>, hundred pod weight, pod length and green pod yield at R7 growth stage, and number of seeds plant<sup>-1</sup>, hundred seed weight, seed weight plant<sup>-1</sup>, pod length, and dry seed yield at R9 growth stage. The genotype Eagle and Branco showed the highest green pod yield, while Pinto 111 and VB90-3 had the highest dry seed yield. Among the parameters measured number of pods plant<sup>-1</sup> showed the highest correlation (0.61\*\*) to green pod yield, while number of pods plant<sup>-1</sup> (r<sup>2</sup> = 0.51\*\*) and seed size (r<sup>2</sup> = 0.48\*\*) showed the highest correlations to dry seed yield. Seed size and number of pods plant<sup>-1</sup> can be used effectively for indirect selection of green pod and dry seed yield in common beans.

## PREDICTING NITROGEN STATUS OF CASTOR AND KENAF FROM CHLOROPHYLL READINGS.

Angela Aikens and H.L. Bhardwaj, Agricultural Research Station, Virginia State University, Petersburg, Va 23806. Nitrogen (N) status in leaves of castor (*Ricinus communis* L.) and kenaf (*Hibiscus cannabinus* L.), two potentially new crops for Virginia, were determined by using SPAD-502, a portable chlorophyll meter. Leaves from plots of these two crops receiving 0, 50, 100, 150, and 200 kg N/ha were used for chlorophyll recording with SPAD-502 from June 29 until July 27, 1995 at 24 hour interval. Samples of leaves from these plots were also analyzed for nitrate content. Significant variation existed among 5 N levels for nitrate content in both castor and kenaf but only in castor for chlorophyll reading. The correlation between nitrate content of castor leaves and SPAD readings was highly significant (+0.66\*\*). In kenaf, the correlation between nitrate content and SPAD reading was +0.57\*\*. Regression analysis indicated that nitrate content of castor and kenaf leaves can be predicted from SPAD readings. These results indicate that N status of castor and kenaf can be predicted from chlorophyll readings obtained using SPAD-502. Use of SPAD-502, which costs about \$750, could be beneficial for farmers for using only the needed amount of N and may also help protect the environment from over-fertilization.

## REMEDICATION OF CANINE HIP DYSPLASIA WITH VITAMIN C: ANTIDOTE AND ANECDOTE:

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ABSTRACT: Vitamin C (Ascorbic Acid) has been widely reputed to be beneficial in the prevention and treatment of many illnesses in vertebrates. For canines, Mueller 1996 writer and editor of Hunting Dog column in OUTDOOR LIFE magazine has documented improvement of mobility in severely disabled dogs that have been treated with Vitamin C. This is congruent with the fact that Vitamin C helps build collagen and lubricate the joints needed for mobility. Prevention and management of Canine Hip Dysplasia (CHD) has been addressed previously in terms of Genetics, Nutrition, and Exercise by Berg and van Lienden at the 1994 VAS meeting. A calcium derivative of Vitamin C now marketed under the name ESTER C is found to be particularly effective probably because of the ease of absorption into the body. It is postulated also that Vitamin C can be used to prevent CHD and other joint diseases. This hypothesis has not been experimentally verified. However, it has been documented that minimal stress on puppy hips for the first year of age helps prevent CHD, regardless of Vitamin C supplementation.

NATURAL PESTICIDES FROM AGRICULTURAL CROPS. H.L. Bhardwaj, Agricultural Research Station, Virginia State University, Petersburg, VA 23806. Research conducted under a US Department of Agriculture (Office of Agricultural Materials) funded three year project has indicated that rapeseed (Brassica spp.) meal has potential for controlling *Cylindrocladium parasiticum* (Crous, Wingfield and Alfenas), casual agent of *Cylindrocladium* black rot (CBR) of peanuts and eliminating/reducing the use of Vapam, currently recommended chemical treatment. The rapeseed meal reduced the disease incidence by 7, 25, and 70% over control in 'NC6', a susceptible cultivar during 1994, when it was used as soil amendment at the rates of 1, 2, or 3 tons/ha. Similar results were also obtained from 'NC10C', a resistant cultivar. The results of experiments with soybean cyst nematode (*Heterodera glycines* Ichinohe) during 1994 and 1995 have been inconclusive. Both peanut and soybean experiments are being repeated during 1996. Detailed results of these experiments will be presented and discussed. The new crops program of Virginia State University is also evaluating castor (*Ricinus communis* L.) and lupin (*Lupinus* spp.) that contain compounds with potential pesticidal properties (ricin and alkaloids, respectively).

NEW CROP DEVELOPMENT IN VIRGINIA-A PROGRESS REPORT. H.L. Bhardwaj. Agricultural Research Station, Virginia State University, Petersburg, VA 23806. A diverse array of crop plants, including canola (*Brassica* spp.), castor (*Ricinus communis* L.), chickpea (*Cicer arietinum* L.), kenaf (*Hibiscus cannabinus* L.), lesquerella (*Lesquerella fendleri* Gray), mungbean (*Vigna radiata* L.), pigeonpea (*Cajanus cajan* L.), and vernonia (*Vernonia galamensis* Cass.), have been evaluated for production potential under Virginia conditions, under the New Crops Program of Virginia State University, established in 1991. Research during last four years has identified canola, mungbean, and kenaf as potential crops for production in Virginia. Use of canola oil is increasing steadily among health-conscious consumers due to its lowest content of saturated fatty acids. The average state canola yields during last three years yields have ranged from 1.8 to 2.1 tons/ha with highest yielding varieties yielding upto 2.7 tons/ha. Yields of kenaf, a source of pulp for paper manufacturing have been 10 to 12 tons/ha (dry matter) at about 90 to 100 days after planting. Considerable progress has been made in developing kenaf as a summer forage. Mungbean yields have averaged about 1475 to 2706 kg/ha, indicating that it can be easily produced in Virginia to eliminate annual import of about 5-7 million kg of mungbean.

FISH HEALTH STATUS OF THE AQUACULTURE INDUSTRY IN VIRGINIA. David Crosby, Cooperative Extension, Virginia State University, Petersburg, Va. 23806. The analysis of casework submitted to Va. State Univ. Aquaculture Disease Laboratory from 1993 to 1995 is reported. The laboratory processed over 150 cases during this period. The most frequently found problem were parasites. Nearly 43% of all cases (1993-1995) involved some type of fish parasite as part of the diagnosis. Trichodina, a gill and skin protozoan of fish, was the most frequently identified parasite. However, in 1993 Ichthyophthirius multifiliis, white spot disease (Ich), comprised nearly one quarter of the caseload. Overall, bacteria problems were involved in 27.6% of the fish health problems. The temporal grouping of casework fell into the classic fish health binomial distribution with the first peak occurring in the spring (April, May, and June) and the second peak occurring in the early fall (September and October). Catfish and hybrid striped bass were the most frequently submitted fish to the laboratory.

ASEASONAL REPRODUCTIVE PERFORMANCE OF VIRGINIA BRUSH GOATS. Michael O. Ezekwe and J. Lovin, Ag. Res. Station, Va. State Univ., Petersburg, Va 23806. Ability to reproduce all year round in goats used for meat production will increase productivity and income for producers. A two-year study was carried out to access the potential for aseasonal reproduction in three breeds/types of goats. A total of 62 Virginia Brush (VB), 44 Nubian (N) and 46 Spanish (S) 2-3 year old does were exposed to 47-day breeding season beginning on May 20th of each year. Animals were grazed on permanent as well as summer pastures. There was significant differences ( $P < .05$ ) for all reproductive performance characteristics studied between years, among breeds, and year x breed interactions. Spanish does did not breed during the two year trial period. Kidding rate, weaning rate, and prolificacy were 56.4, 43.6 and 85% for N, and 129.5, 118.0 and 182.5% for VB, respectively, which were significantly higher ( $P < .05$ ) than those of the N. Litter weight at birth and at weaning did not differ ( $P > .05$ ). Progeny ADG and weight gain between birth and weaning were unaltered. Nubian female progeny body weight was higher ( $P < .05$ ) than those of VB counterparts at post weaning but these differences disappeared by 6 months of age. Similar trends were noted for castrates and intact males. Results indicate that VB has a potential for greater aseasonal productivity than S and N breeds. Differences in body size seem to disappear between N and VB goats raised solely on pasture for meat production.

PECTORAL SPINE LOCKING AND SOUND PRODUCTION IN THE CHANNEL CATFISH. Michael L. Fine, David McElroy, John Rafi, Charles B. King, Kathryn E. Loesser and Scott H. Newton., Virginia Commonwealth Univ., Mary Washington College, and Virginia State University. We examined the anatomical basis for sound production and locking of the pectoral spine in the pectoral girdle of the channel catfish *Ictalurus punctatus*. The locked spine is stabilized vertically by the glenoid process laterally and the dorsal and ventral processes medially. Anterior motion is halted by contact between the dorsal process and the locking foramen of the pectoral girdle, and posterior motion is prevented by the locking tubercle of the dorsal process sitting in a narrow depression at the base of the locking foramen. Pulsatile sounds, which vary in frequency, amplitude, duration and patterning, are produced when ridges on the lateroventral surface of the glenoid process contact the ventral plate of the glenoid fossa during fin abduction. We suggest that individual pulses are generated by successive contacts of a single ridge on the ventral plate of the glenoid fossa. Pulse frequency appears to be determined by the pectoral girdle, and the swimbladder does not play an active role in sound production.

A HISTOMORPHOMETRIC EVALUATION OF THE TESTIS AND EPIDIDYMIIS IN THE POSTPUBERTAL SPANISH BUCK. O. M. Gaines and S. Wildeus, Agricultural Res. Station, Va. State Univ., Petersburg, Va. 23806. The present study evaluated age-related changes in histomorphometric testicular and epididymal characteristics of postpubertal Spanish bucks. Fifteen male goats, managed for moderate growth, were randomly allocated (n=5) to three treatment groups to be castrated at 8, 11 or 14 mo. Following castration, a portion of the testis and epididymal segments were histologically processed for histomorphometric analysis. Diameter and epithelial height from approximately 20 to 25 essentially circular cross sections of the seminiferous tubule (ST) and tubules in the ductule efferentes (DE), caput, (CA), corpus (CO) and cauda (CD) were measured. Volumetric proportions of these segments were determined from 200 test line intercepts per section. Data were analyzed for age group effects and by correlation analysis. ST diameter and epithelial height were similar between age groups and ranged from 175.4 to 179.2  $\mu\text{m}$  and 50.2 to 52.0  $\mu\text{m}$ , respectively. Epididymal tubular diameter was reduced ( $P < .05$ ) in CA and CO at 11 mo (269 and 283  $\mu\text{m}$ , respectively), compared to 8 mo (320 and 318  $\mu\text{m}$ ) and 14 mo (328 and 339  $\mu\text{m}$ ). Diameter of DE (343 to 392  $\mu\text{m}$ ) and CD (428 to 443  $\mu\text{m}$ ) were not affected by age. Epididymal tubular height was also not affected by age and ranged from 21  $\mu\text{m}$  in the CD to 94  $\mu\text{m}$  in DE. Testicular volumetric proportions were similar between age groups (tubular lumen: 11-18%; seminiferous epithelium: 63-70%; interstitial tissue: 19%). Epididymal volumetric proportions were also similar between age groups, except for a decline ( $P < .05$ ) in extra tubular tissue in CA of 14 mo old bucks. Histomorphometric measurements were generally not significantly correlated with body and organ weights. Few age-related changes in testicular and epididymal histomorphology appear to occur in postpubertal bucks.

EFFECT OF AGE ON PARASITE BURDEN IN MEAT GOATS. T.A. Gipson, S.M. Lacey & J.C. Lovin, Agric. Res. Station, Va. State Univ., Petersburg, VA 23806. Effective control of internal parasites requires knowledge of the host-parasite interaction. In sheep, the detrimental effect of internal parasites is partially mitigated by an acquired immunity related to age. Thus, older animals are more resistant than younger animals. It has not known if goats have a corresponding age-related immunity to internal parasites. The objective of this study was to determine the relationship between age and parasite burden as determined by fecal egg counts in goats. Age of the animal was determined by dentition (0, 2, 4, 6 and 8 teeth) and ten females of each of the five age groups were randomly assigned to the sampling group. Animals used in this study were maintained as a single group on common pasture. Measurements included body weight, packed cell volume, total protein, trichostrongyle eggs per gram (epg) and coccidia oocysts per gram (opg) of feces. Fecal egg counts were determined by the Modified McMaster technique and normalized using a  $\log(\text{count}+1)$  transformation. Fecal samples were cultured to identify nematode species. Data were analyzed using analysis of variance. A significant ( $p < .05$ ) linear effect of age on bodyweight was found. Bodyweight increased linearly from 18.2 kg for 0 teeth to 53.4 kg for 8 teeth. Significant linear and quadratic effects of age on coccidial opg were also found. Coccidial opg decreased rapidly from 3764 opg for 0 teeth to 878 opg for 2 teeth and remained stable to 8 teeth (711 opg). Trichostrongyle egg counts ranged from 399 epg for 0 teeth to 775 epg for 6 teeth; however this difference was not significant. Packed cell volume ranged from 31.9% for 4 teeth to 28.4 for 2 teeth and total protein ranged from 7.0 g/dl for 2 teeth to 7.6 g/dl for 8 teeth ( $p > .10$ ). *Haemonchus contortus* was the predominate nematode species for all age groups. This study indicates that young goats (0 teeth, which is one year of age or less) are more susceptible to coccidia than older goats. However, there does not appear to be an acquired immunity to trichostrongyle nematodes in goats.

MULTIPLE ANTHELMINTIC RESISTANCE IN GOATS RAISED FOR MEAT PRODUCTION IN VIRGINIA. T.A. Gipson, Agric. Res. Station, Va. State Univ., Petersburg, VA 23806, A.M. Zajac\*, Va. Polytechnic Inst. & State Univ., Blacksburg VA 24061 & J.C. Lovin, Agric. Res. Station, Va. State Univ., Petersburg, VA 23806. Worldwide, sheep and goat producers rely heavily on anthelmintics for parasite control. Because of this heavy use, anthelmintic resistance is developing rapidly in many countries. Recent interest in meat goat production has prompted an increased movement of breeding stock around the country, thereby increasing the risk of spreading anthelmintic resistance. Limit information on the extent of anthelmintic resistance is available in the US, especially in goats. The objective of this study was to determine if anthelmintic resistance existed in a research goat herd that had been assembled from several geographic locations. A fecal egg count reduction test was conducted using different anthelmintic popularly used by goat producers. At the start of the test, fecal samples were taken from every individual in the buck herd and half of the buck herd was dewormed with the anthelmintic being tested. The anthelmintics tested were fenbendazole, ivermectin and levamisole. The number of bucks involved in the fecal egg count reduction tests were 47 for fenbendazole, 74 for ivermectin and 34 for levamisole. Ten days post-treatment fecal samples were taken from every individual in the untreated (control) and treated groups. Fecal egg counts were determined by the Modified McMaster technique. If an anthelmintic fails to yield a 95% reduction in fecal egg counts as compared to the control group then anthelmintic resistance is concluded. Fenbendazole gave a 59.4% reduction, ivermectin a 54.0% reduction and levamisole a -4.3% reduction. Fecal egg counts actually rose after levamisole treatment. Resistance to all three of the anthelmintics tested was found in this research goat herd. Therefore, alternative methods of internal parasite control will need to be pursued in this herd of goats.

CHEMICAL COMPOSITION OF RAPESEED GREENS. A.A. Hamama and H.L. Bhardwaj, Agricultural Research Station, Virginia State University, Petersburg, VA 23806. Pre-flowering foliage from four canola and high erucic acid rapeseed (HEAR) was evaluated for chemical composition and compared to that of raw mustard and turnip greens. Canola had the highest protein content followed by mustard, HEAR and turnip. Canola, HEAR and turnip were similar in lipid content but had higher lipids than mustard. HEAR and turnip were characterized by a relatively high amount of carbohydrates and calcium as compared to canola and mustard. All four species were similar in K, Mg, P and Zn contents. Canola and HEAR had better concentration of Fe than turnip and mustard. Turnip, canola/HEAR, and mustard had the highest, intermediate, and lowest total saturated fat, respectively. For monounsaturated fatty acids, the four species can be arranged in the following descending order: mustard >HEAR>canola >turnip. Canola, HEAR and turnip were similar in total polyunsaturated fatty acid but higher than mustard. Canola and HEAR were similar in omega-3-fatty acid (18:3) content (43.0%) followed by turnip (37.2) and mustard (13.1). The results suggest that foliage of canola and HEAR (*Brassica* sp.) has potential as food/feed.

SEED AND FOLIAGE INSECT RESISTANCE IN VEGETABLE SOYBEANS. Mark E. Kraemer, Vaidra Hodges\*, and Carmen Sudderth\*. Virginia State University, Petersburg, VA 23806. We evaluated 12 large-seeded (green vegetable) and 10 tofu genotypes for resistance to corn earworm (CEW) defoliation and pod damage, and hemipteran seed damage. Hemipterans appeared to be responsible for much more damage than CEW and other pod feeders at our Chesterfield Co. Site. Hemipterans affect seed quality by causing aborted, discolored, or shriveled seeds, often with secondary microbial infections. Estimates of hemipteran damage ranged from 2% (*Shangraowan gingsi*) to 92% (*Kanrich*) of seeds moderately or severely damaged. Seed resistance was not correlated with foliar resistance to CEW (petri dish assays) but was positively correlated with maturity group ( $P=0.0001$ ,  $R^2=0.33$ ). This is probably related to hemipteran population levels during critical periods of seed development.

FETAL AGING VIA REAL TIME ULTRASONOGRAPHY IN GOAT BREEDS OF DIFFERING MATURE SIZE. S.M. Lacey and S. Wildeus, Agricultural Res. Station, Va. State Univ., Petersburg, Va. 23806. The use of veterinary ultrasonography finds an increasing application in livestock management. This experiment evaluated the application of transrectal and transabdominal ultrasonography in does (n=169), representing five breeds of varying mature size, at the end of a 40-d fall breeding season and 4 weeks thereafter. The accuracy of diagnosis was evaluated based on kidding outcome, and the indicator for diagnosis (uterine fluid, fetus or cotyledon) was recorded. Fetal dimensions were recorded as crown-rump length, and cranial length and width, wherever possible. Correlation coefficients of dimensions with fetal age were calculated. The accuracy of transrectally diagnosing open does correctly ranged from 62% at <25 d to 77% between 26-68 d of gestation, whereas the correct diagnosis of pregnant does ranged from 63% at <25 d to 96% between 26-68 d. The accuracy of transabdominal scanning of pregnant does ranged from 52% at 36-50 d and 91% at 51-68 d of gestation. The fetus was the most commonly identified structure for both transrectal (74%) and transabdominal (67%) diagnosis. Cotyledons became indicators of pregnancy after 50 d of gestation in 31% of all diagnosis. Crown-rump length increased from 1.65 cm at 21-30 d to 3.58 cm at 51-60 d and could not be measured after 61 d. Cranial width and length increased from 1.42 and 1.23 cm at 21-30 d to 2.20 and 3.63 cm at 61-70 d of gestation, respectively. Differences in fetal dimensions between breeds were not consistent. Crown-rump length ( $r=.55$ ), cranial width ( $r=.64$ ) and cranial length ( $r=.78$ ) all had significant ( $P<.001$ ) correlations with fetal age. These data indicate detection limits of 25 d for transrectal and 50 d of gestation for transabdominal modes of scanning. The findings further indicate that breed differences in fetal size appear to be limited at this early stage of gestation.

EVIDENCE OF A PERIPARTURIENT RISE OF FECAL EGG COUNTS IN A HERD OF VIRGINIA BRUSH GOATS MANAGED FOR MEAT PRODUCTION. J.C. Lovin & T.A. Gipson, Agric. Res. Station, Va. State Univ., Petersburg, VA 23806. The rise in nematode egg output around the event of parturition is well documented in sheep and is a critical control point for strategic deworming. However, it is unclear whether the periparturient rise in nematode egg output occurs in goats. Therefore, pregnant and open goats were evaluated to determine if a periparturient rise in fecal egg output occurs. Thirty-three mature female goats (19 pregnant, 14 open) made up the experimental group. A composite fecal sample (five (5) goats from each of the pregnant and open groups) was taken at two week intervals over a 20-week period that began with first doe kidding and examined for the presence of trichostrongyle eggs. Fecal egg counts were determined by Modified McMaster technique and counts were normalized by a  $\log(\text{count}+1)$  transformation. Data were analyzed using analysis of variance. Fecal worm egg count means were significantly different ( $P<.05$ ) for the pregnant and open does (1018 and 491 epg, respectively). Pregnant does were dewormed four (4) times with an average interval between dewormings of thirty-six (36) days; whereas, the open does received only two (2) dewormings with an average interval of sixty-eight (68) days. This evidence suggests that a periparturient rise in fecal trichostrongyle egg counts does exist and therefore should be an important factor in deworming strategies.

RESISTANCE TO INTERNAL PARASITES AS DETERMINED BY FECAL EGG COUNTS IN THREE "BREEDS" OF MEAT-TYPE GOATS. J.C. Lovin & T.A. Gipson, Agric. Res. Station, Va. State Univ., Petersburg, VA 23806. Control of internal parasites is the second greatest cost of goat production and therefore it is advantageous to select breeds which have a resistance to parasitism. Three breeds (Nubian, Spanish and Virginia Brush) of meat-type goats were evaluated for their resistance to internal parasites as determined by fecal worm egg counts. Sixty mature does (20 Nubian, 26 Spanish and 14 VA Brush) were managed similarly for a period of one year. A composite fecal sample (five (5) does from each breed) was taken every two weeks and examined for the presence of trichostrongyle eggs. Fecal egg counts were determined by Modified McMaster technique and counts were normalized by a  $\log(\text{count}+1)$  transformation. Data were analyzed using analysis of variance. Fecal egg count means for the VA Brush does were significantly ( $P<.01$ ) lower (390 epg) than the Spanish (785 epg) or Nubian (900 epg) does. Number of dewormings for the Nubian, Spanish and VA Brush does was 12, 9 and 6, respectively, translating into a significant difference ( $P<.05$ ) in the average interval between dewormings of 33.7 and 67.8 days for the Nubian and VA Brush does, respectively. From these findings, estimated annual deworming costs for this herd were \$13.08, \$7.29 and \$5.16 per head, respectively, for the Nubian, Spanish and VA Brush does. This evidence suggests that VA Brush does are more resistant to internal parasites than Spanish or Nubian and that deworming costs can be reduced by selecting for resistant breed types.



DOMESTICATION AND NUTRITIONAL EVALUATION OF PURSLANE. Tadesse Mebrahtu, Michael Ezkewe\*, Thomas Omara-Alwala\*, Abdulkadir Elmi\*, Agric. Res. Stat. Va State Univ. Petersburg 23806. A total of eleven purslane accessions received from different geographical locations were planted for agronomic and nutritional characterizations. Each accession was planted at two planting dates arranged in a split-plot design during three growing seasons. Significant differences ( $P < 0.05$ ) for Protein, total lipid, carbohydrate, linolenic (18:3)/linoleic (18:2) fatty acid ratio, and fresh yield were observed among accessions tested. Similarly, significant accession x planting date interactions were observed for all traits measured. Among the accessions tested, *Portulaca oleracea* and Garden Dutch showed consistently the highest fresh yield throughout the growing seasons. Linolenic acid was the most abundant fatty acid in purslane leaf tissue. This resulted in, an overall average of 18:3/18:2 a fatty acid ratio of 7.1% which is more superior nutritively than that of many essential oil crops such as perilla (*Perilla trutescens*) and soybean (*Glycine max* L.). The average total protein content of purslane crop was 24 % which is higher than alfalfa. Wide range of variability existed among the accessions tested for selection and genetic improvement through hybridization.

EFFECTS OF MICROWAVE HEATING ON THE QUALITY OF VERNONIA OIL. A. I. Mohamed, C. Paul\*, Agricultural Research Station, Virginia State University, Petersburg, VA 23806 & R.L. Grayson\*, Depart. of Plant Pathology, Virginia Tech., Blacksburg, VA 2406. Epoxy fatty acids and epoxy oil are useful raw materials for manufacturing paints, coatings with low or no volatile organic compounds, and many other products. Currently, no oilseed crop has been commercialized as a source of natural epoxidized oils. Vernonia galamensis is an ideal candidate to be domesticated to meet the need for epoxy oil. This study was conducted to determine the effects of microwave heating on the physical and chemical characteristics of vernonia oil. Whole vernonia seeds were microwave heated at 1000 watts for 0, 10, 20, 40, 60, 80, 100, 120, 140, and 160 Sec./5g seed at 8 and 15% moisture. In another experiment vernonia seeds were microwave heated for 80 Sec. at 0, 20, 40, 60, 80, and 100 watts. No significant change ( $P > 0.1$ ) was found in oil content, vernolic acid, epoxy content, oxirane  $\text{O}_2$  %, and weight per epoxy equivalent at 8% moisture. However, increasing moisture to 15% caused a small but significant ( $P > 0.05$ ) reduction in vernolic acid and epoxy content and a significant increase ( $P > 0.05$ ) in the amount of extracted oil. Microwave heating of pure vernonia oil caused a small increase in the total free fatty acid. Increasing microwave heating time was associated with an increase in vernolic acid % in the free fatty acid pool. As a conclusion, microwave heating can be used as an economical method for inactivating lipase in vernonia seeds with minimum or no deteriorating effect of the oil.

EVALUATION OF SOYBEAN GENOTYPES FOR TOFU QUALITY AND QUANTITY. A.I. Mohamed, Paul, Agricultural Research Station, Virginia State University, Petersburg, VA 23806 & V.T. Spara\*, Alabama A&M University, Normal, AL 35762. Most soyfood processors recognized that to make a high quality tofu, a high quality soybean must be used. At this point, producers and breeders have failed to identify these ideal soybean varieties. The objective of this study was to determine the influence of variety and environmental factors on yield and chemical composition of tofu. A total of 12 Soybean genotypes were used. Proximate analysis were carried out using standard AOAC methods. Soymilk and tofu were manufactured using the traditional method. There were significant differences between cultivars for all tested parameters. Soybean genotypes with high oil were lower in protein content as reported in our earlier studies. Tofu yield ranged from 75 for Barc-8 to 52 g/100 g seed for V71-370. A positive and significant correlation was found between seed protein content and tofu yield. Genotypes Ernei and V71-370 had significantly lower yield than the other genotypes. Barc-8 and Barc-9 had the highest resistance pressure with Shear Force of 44 and 33 lb., respectively indicating least tender tofu, while V71-370 was most tender (18.9). Fiber content ranged from 4.1 to 5.1%. Data also indicated that genotypes with lower fiber content had a higher swell ratio. (this research is a group efforts and is a part of RR7 regional Project funded by CSREES/USDA).

PRELIMINARY EVALUATION OF CAGE CULTURE OF BROOK TROUT IN VIRGINIA. Scott H. Newton, Cooperative Extension, Virginia State University, Petersburg, Va. 23806. Brook trout (*Salvelinus fontinalis*) was designated as the State Fish by the 1993 Virginia General Assembly. Brook trout is the only species of freshwater trout native to the Commonwealth. They are raised primarily for stream stocking and fee-fishing operations. Because they command a higher price than rainbow trout, both as juvenile and adult fish, they may have aquaculture potential for cage operations located in the Piedmont Region. Three cages were each stocked with 250 brook trout averaging 3.5 ounces on November 2, 1995 and harvested April 23, 1996. Fish survival was 93% overall and the trout averaged over 9 ounces at harvest. Although growth was less than expected, most of the first year culture difficulties were associated with a colder than normal winter production season. Based upon first season observations, brook trout appears to be a good candidate for commercial cage production during the winter season; however, further research is warranted before specific recommendations can be provided to producers.

THE VIRGINIA AQUACULTURE PLAN - A SYNOPSIS. Scott H. Newton, Cooperative Extension, Virginia State University, Petersburg, Va. 23806. The Virginia Aquaculture Plan consists of two documents. ***The Executive Summary and Recommendations*** outlines principal industry concerns and gives recommendations for changes. This document also provides industry overviews, production status for marine and freshwater operations, business opportunities and related information. ***A Guide to Aquaculture Development and Industry Information*** provides material on industry opportunities, resource contacts, economics, marketing and financial aspects, production potentials, and regulatory requirements for commercial aquaculture. The Virginia Aquaculture Plan was compiled and written over a two year period, (1993 - 1995) and involved industry, government, support organizations, and the scientific community. The Plan was supported and printed by the Virginia Department of Agriculture and Consumer Services. Distribution began during early 1996 and copies of The Plan are available free to those interested in commercial aquaculture ventures from the Virginia Department of Agriculture and Consumer Services, Richmond, Virginia.

EVALUATION OF MINT GERmplasm UNDER VIRGINIA CONDITIONS. M. RANGAPPA, H.L. Bhardwaj, and M. Showhda. Agricultural Research Station, Virginia State University, Petersburg, Va 23806. A collection of 35 mint (*Mentha* spp.) lines, received from US Department of Agriculture in 1992, was evaluated for chemical composition during summer of 1993 to study suitability for culinary use or oil extraction. These lines were categorized based on geographic origin (domestic vs. Foreign), ploidy level (diploid vs. Polypldoid), mint type (peppermint vs. spearmint), and genetic makeup (pure lines vs. hybrids). Leaf moisture was affected by the genetic makeup, pure lines had lower moisture content (71%) as compared to hybrids (73%). The ash content was affected by the geographic origin, the ploidy level, type of mint, and genetic makeup of mint lines. The ash content of domestic lines was lower (10%) than that of foreign lines (10.7%), diploid lines had higher ash content (10.8%) as compared to polypldoids (10.0%), peppermint types had lower ash content (10.0%) than spearmint lines (10.6%), and pure lines had higher ash content (10.4%) than hybrids (10.0%). The content of essential oils was higher in diploid lines (2.1%) as compared to polypldoid lines (1.6%) indicating that diploid lines may be more suitable for oil extraction.

CHINESE WATER CHESTNUTS, A POTENTIAL NEW CROP FOR VIRGINIA. David Wainwright\* and A.J. Provenzano. Dept. of Ocean., Old Dominion Univ., Norfolk, Va. 23529. Currently no Chinese water chestnuts (*Eleocharis dulcis*) are grown commercially within the United States. Available supplies are grown in Asian countries and imported. Methods for growing Chinese water chestnuts in the United States have been established through a limited number of experiments conducted throughout the past 50 years. Using these established methods, a preliminary crop of Chinese water chestnuts was grown in a shallow lined pond in Surry County, Va. The purpose of this study was to determine the feasibility of possibly establishing a new alternative crop for Virginia's Eastern Shore, as well as in other places along the southern portion of the eastern seaboard. Results showed an average of more than 15,000 kg/ha and an average corm size of 10.8 g. Furthermore, 75% of the yield is considered marketable. Our study also included a salinity tolerance experiment. Results from this experiment showed that Chinese water chestnuts are restricted to fresh water.

TESTICULAR AND EPIDIDYMAL SPERM RESERVES AND HISTOMORPHOLOGY IN MATURE SPANISH GOATS. O. M. Gaines and S. Wildeus, Agricultural Res. Station, Va. State Univ., Petersburg, Va. 23806. This study determined sperm reserves and quantitative histomorphology of testis and epididymis in mature, sexually rested, Spanish bucks (n=6) castrated during the breeding season. The right testis and epididymis were processed for the determination of sperm numbers by tissue homogenization and hemocytometer count, whereas the left testis and epididymis were fixed, sectioned and stained (H&E) for quantitative histology. Means and standard errors, and correlation coefficients of live animal measurements (body weight and scrotal circumference) with reproductive tract characteristics were determined. Body weight, scrotal circumference and paired testicular weight were  $46 \pm 4.6$  kg,  $26 \pm 0.3$  cm and  $227 \pm 11$  g, respectively. Paired epididymal weight was  $42 \pm 0.8$  g, with caput, corpus and cauda representing 50, 9 and 41% of the total weight, respectively. Sperm production (elongated spermatids and spermatozoa)/g testicular parenchyma was  $92 \pm 5.5 \times 10^9$  and total testicular reserve  $20.1 \pm 1.7 \times 10^9$ . Epididymal sperm reserves were  $54 \pm 2 \times 10^9$ , with cauda reserves, the site of sperm storage, representing 67% of this reserve. Semiferous tubule diameter and epithelial height were  $212 \pm 2.7$   $\mu$ m and  $62 \pm 2.3$   $\mu$ m, respectively. Epididymal tubule diameter and epithelial height ranged from  $339 \pm 18$  (corpus) to  $470 \pm 16$   $\mu$ m (d. efferentes) and  $27 \pm 3$  (cauda) to  $124 \pm 6$   $\mu$ m (d. efferentes), respectively. Body weight was correlated with sperm production rate ( $r = .84$ ;  $P < .05$ ) and seminiferous tubule diameter ( $r = .89$ ;  $P < .01$ ), whereas scrotal circumference was correlated with testis weight ( $r = .90$ ;  $P < .01$ ) and testicular reserve ( $r = .79$ ;  $P < .05$ ). These data demonstrate similar reproductive characteristics in meat-type bucks to those reported for fiber bucks.

KIDDING PERFORMANCE OF PYGMY GOATS IN A VIRGINIA HERD. S. Wildeus<sup>1</sup>, S. Waters\*<sup>2</sup> and M. Waters\*<sup>2</sup>, <sup>1</sup>Agricultural Res. Station, Va. State Univ., Petersburg, Va. 23806 and <sup>2</sup>Daisy Hill Pygmy Goats, Callaway, VA 24067. Pygmy goats have been widely used as pets or show animals in the U.S., but their potential for meat goat production has not been well defined, though their origin and conformation is that of a meat type animal. This study summarizes records collected in a commercial herd over a 14 year period (1980-1993), and included 130 doe and 224 kid records, representing 37 dams and 18 sires. Animals were managed on a forage base (pasture or high quality hay), with concentrate supplied according to stage of production. Standard herd health practices (deworming, vaccination) were performed on routine basis. Does were hand-mated to kid in spring. Observations recorded included dam and sire identification, litter size, kid birth weight and time of birth. Doe data were analyzed for effects of dam, sire, parity and litter size; kid data were analyzed for effects of dam, sire, birth type and sex of kid effects. Overall litter size and litter weight were 1.75 kids and 2.25 kg/doe kidding, respectively, and both increased ( $P < 0.05$ ) from first to third parturition. Single litters were lighter (1.63 kg) than twin (2.69 kg) and triplet (2.40 kg) litters ( $P < 0.05$ ), whereas quadruplet litters (4.54 kg) were heaviest ( $P < 0.005$ ). Dam had a significant effect on litter size ( $P < 0.01$ ), but not litter weight, while sire had no effect. Single born kids were heavier ( $P < 0.001$ ) than multiple born kids (1.35 kg), but there was no effect of sex on kid birth weight. Both dam and sire had an effect ( $P < 0.01$ ) on kid birth weight. Kidding occurred predominantly between 10 AM and 5 PM (60% of potential kiddings). These data confirm the Pygmy as a prolific breed under temperate production conditions, but additional data are needed on the growth performance of the breed in relation to mature size.

BLOOD METABOLITE CONCENTRATIONS IN MEAT-TYPE GOAT BREEDS AT THREE STAGES OF LACTATION. M. A. Wright and S. Wildeus, Agricultural Res. Station, Va. State Univ., Petersburg, Va. 23806. Limited information is available on the comparative performance of meat-type goat breeds and the underlying physiological differences. This experiment evaluated the blood metabolite concentrations of Myotonic (n=12), Pygmy (n=10) and Spanish (n=22) does at parturition, peak lactation (21 d) and weaning (63 d). All does were managed as one group and fed a medium quality, high forage diet. Plasma urea nitrogen, total protein and glucose, and hematocrit were determined in jugular vein samples. Data were analyzed by repeated measures analysis and correlation analysis. Doe body weight was higher ( $P < .01$ ) in Spanish (34.3 kg) than in Pygmy does (17.4 kg), with Myotonic does (30.0 kg) being intermediate, but body weight was not affected by stage of lactation. Plasma urea nitrogen concentrations were higher ( $P < .001$ ) at weaning (19.3 mg/dl) than at the earlier stages of lactation (8.5 - 11.9 mg/dl), and showed a breed x stage of lactation interaction ( $P < .01$ ), with Pygmy does having lower concentrations at parturition and peak lactation, but higher values at weaning, than the other two breeds. Plasma total protein increased ( $P < .001$ ) from 5.54 g/dl at parturition to 11.1 g/dl at weaning, but was not affected by breed. It was positively correlated with doe lactation weight change ( $r = .511$ ;  $P < .01$ ) and negatively with litter pre-weaning average daily gain ( $r = .588$ ;  $P < .001$ ). Plasma glucose was lower ( $P < .05$ ) in Spanish (3.42 mg/dl) than in Myotonic (3.99 mg/dl) and Pygmy does (4.12 mg/dl), but not affected by stage of lactation. In contrast, hematocrit was similar between breeds, but declined from 21.1% at parturition to 17.6% at weaning. These data suggest that nutritional status, expressed as plasma total protein and urea nitrogen, is more affected by stage of lactation than breed in meat-type goats.

## Archaeology

MANDIBULAR TOOTH WEAR AND PIG MANDIBLES: FINDING THE HUSBANDRY IN THE FITH. Eihel Wu, Dept. of Archaeological Res., Colonial Williamsburg Fndn., Williamsburg, Va. 23187-8795. Tooth wear analysis may determine the approximate age of death of a certain animal with more accuracy and precision than the more commonly used method of long bone analysis. The accuracy of long bone analysis depends heavily upon the extent of dog chewing in an assemblage. For this reason, it is believed that the youngest age group in the total population will be underestimated. To test the extent of error of the ages based on fusion, two methods of tooth wear analysis are employed to determine the ages of pig mandibles from two colonial sites in the Chesapeake. The Annie Grant method allows for a detailed relative ages, while on the other hand, the Gail Bull & Sebastian Payne method provides the approximate real ages needed for the comparison of the long bone data. Together, these methods will not only test the validity of long bone analysis, but because they provide different perspectives on the data, they combine to make the data more accurate.

THE RISE AND FALL OF GLOUCESTER TOWN: AN HISTORICAL AND ARCHAEOLOGICAL PERSPECTIVE. Kenneth E. Stuck, Center for Archaeological Research, College of William and Mary, Williamsburg, Va. 23187. Gloucester Town, located on Gloucester Point, is among the earliest towns in Virginia. It was archaeologically investigated in the late 1970s and early 1980s by the Virginia Research Center for Archaeology. These emergency salvage excavations identified structures and recovered artifacts from Gloucester Town's three-hundred-year history, resulting in the placement of the Gloucester Point Archaeological District on the National Register of Historic Places in 1985. Since 1988, the William and Mary Center for Archaeological Research has conducted 20 projects on Gloucester Point that have recovered extensive evidence of the town's development. This paper presents a comprehensive look at Gloucester Town. Using the archaeological evidence to support the historic documents, the paper discusses the formation of the town, its growth and decline, and its eventual disappearance.

WATSONS, WIIIS, AND DEDAKERS: THE EVOIUTION OF A NINETEENTH CENTURY FARMSTEAD IN PIEDMONT VIRGINIA. Stevan C. Pullins, Ctr. for Archaeological Res., Dept. of Anthropology, Col. of William and Mary, P.O. Box 8795, Williamsburg, Va. 23187-8795. The physical evolution of an Amherst County farm over 130 years reflects the lives of two families in the nineteenth century and changing socio-economic and settlement patterns before and after the Civil War.

HIGH-TECH ARCHAEOLOGY ON A SHOESTRING BUDGET: EVALUATION OF SOIL RESISTIVITY TESTING AT MONTPELIER. Scott K. Parker, Montpelier Archaeologist, National Trust for Historic Preservation, Montpelier, P.O. Box 67, Montpelier Station, VA 22957. Soil resistivity survey, while not a new technique, has proven to be an inexpensive and efficient means of discerning sub-surface patterns with a minimum of site impact. Testing by National Trust for Historic Preservation archaeologists began in the spring of 1992, and has been accomplished using a "home made" soil resistivity meter, developed by a Montpelier volunteer. This paper will discuss the results of ongoing soil resistivity testing at Montpelier, home of President James Madison. The paper will explore soil resistivity in general, aspects and specifics of Montpelier's meter, and the results from several sites tested including an early 18th-century cemetery, 18th - 19th century domestic sites, and an 18th-century industrial ironworks site.

THE SAUGUS IRON WORKS RESTORATION: A COLD WAR LEGACY. Donald W. Linebaugh, Center for Archaeological Research, College of William and Mary, Williamsburg, Va. 23187. Following his discovery of Thoreau's cabin at Walden Pond in 1946, Roland Robbins performed pioneering work at a series of important sites, the Saugus Iron Works in Saugus, Massachusetts, the Jefferson birthplace in Virginia, and the Philipsburg Manor Upper Mills in Tarrytown, New York. Robbins worked for preservation organizations that were engaged in developing and enhancing their properties through historical restoration, reconstruction, or monument building. The postwar period was an age of anxiety, "a time when concerns about national security, swift social change, and a profound sense of historical discontinuity troubled people deeply." Historical museums and sites around the country reacted to this growing angst and began to market themselves as sources of patriotic inspiration, national pride, and as keepers of the legends of early America. The Saugus Iron Works restoration, for example, was underwritten by the American Iron and Steel Institute as a symbol of the industry's important contribution to the past and present growth of the country. In this context, the Saugus project was wedged between the tradition-oriented, antimodern values of the early preservation movement and a burgeoning commercial utilization of the past. This so called "Corporate Roots movement" had its own agenda that was frequently at odds with the goals and desires of preservation professionals. This paper examines the Saugus Iron Works project and Robbins's developing career within this broader historical context.

FINGERPRINT ANALYSIS OF POTTERY SHERDS AS A POTENTIAL SOURCE OF INFORMATION FOR THE HISTORICAL ARCHAEOLOGIST. Emily D. Johnson, Mark A. Fashing\*, Dept. of Archaeology, Colonial Williamsburg Foundation, Williamsburg, Va. 23185. Fingerprints are common to all mankind, yet unique to each individual. Fingerprints left by a colonial potter during production can yield data concerning trade distribution, and information relating to seventeenth-century pottery production. In order to successfully use the information provided by these impressions, it is necessary to find a suitable method of comparing fingerprints. Ideally this method would meet three criteria. It must be cost-efficient, nondestructive, and yield an accurate reproduction of the impressed print suitable for analysis. In view of these criteria, several methods were tested using the pottery sherds found at the Challis site on the banks of the James River. Three methods have proved acceptable and may provide future studies with the key to more extensive analysis.

"THOSE ABOMINATIONS, THOSE BREEDER'S OF DISEASE": THE ARCHAEOLOGY OF CIVIL WAR SIBLEY TENTS AT GLOUCESTER POINT, VIRGINIA. Thomas F. Higgins III, Center for Archaeological Research, College of William and Mary, Williamsburg, Va. 23187. The Civil War soldiers' ability to adapt to a range of conditions, as expressed in the types of shelters in which they lived has resulted in a diverse archaeological record. The excavation of portions of Site 44GL358 for the Coleman Bridge Project in Gloucester County, Virginia, provided the WMCAR the opportunity to document Civil War structures associated with a Federal army camp at Gloucester Point. The camp site, dating to the period 1862-1865, was probably occupied by either Massachusetts or upstate New York troops. Site 44GL358 revealed the remains of palisade-walled Sibley tents or "Bell Tents" as they were also called. Although soldiers' generally disliked Sibley tents due to cramped conditions, the archaeology suggests that attempts were made to make the tents at Gloucester Point more comfortable. The Sibley tents found at Site 44GL358 contain the remains of unique heating systems known as "California Furnaces." These furnaces consisted of an underground air hole, i.e., flue, that extended from a stove to the exterior of the tent. The California furnace has been attributed to some Massachusetts troops, but was probably used by other troops as well early in the war.

A KAOLIN PIPE STEM SERIATION OF THE CLAY BARROW PIT AT RICH NECK PLANTATION. Richard Grant Gilmore, III, The College of William & Mary in Virginia, Williamsburg, VA 23185-4044. Imported English kaolin pipe stems are used to seriate a clay barrow pit at a seventeenth century plantation established by the Ludwell family in James City County, Virginia. Using this dating technique it can be determined that the pit was filled over a lengthy period of time. Seriation can be used to determine a relative sequence for context deposition. Contexts not in physical proximity to each other are shown to be related temporally. Bi-modal deposition is observed in early layers. Adequate sample size is indicated through "battle ship curves" in data plotting. Pipe stem seriation of this barrow pit is able to address each of these questions where alternate artifacts are not able to provide the desired information. (Research data generously provided by the Colonial Williamsburg Foundation, Department of Archaeological Research.)

THE  $E^3$  FORMULA FOR THE PRESENCE AND ABSENCE OF DOMESTIC FAUNA IN ARCHAEOLOGICAL SITES. Jeremiah R. Dandoy, Norfolk, VA 23517. I believe there are only three factors which account for the presence or the absence of non-pet domesticates in any archaeological site. These are the Ecology of the area, the Economics of any associated hominid population, and the Ethos of any associated hominid population. When these three are incorporated into a binary equation with a presence or absence outcome, and then correlated with a locus type, a focus is provided for a more far reaching analysis of faunal richness and diversity as they relate to hominid preference and activity patterns. Taphonomic and recovery biases, of course, enter into the analysis but are a given for this paper. The equations number 16 with 8 being equalities and 8 being inequalities. Seven of the equalities result in an absence marker. Seven of the inequalities result in a presence marker. The equations force us to think more about how and why fauna were used and the role of competing species. I have found this approach useful to better understand why goats are virtually non-existent in early 17<sup>th</sup> Century Chesapeake sites, seemingly disputing the extant documentation for that time. Greater cultural understanding may unfold by incorporating this methodology into our faunal interpretation

## Astronomy, Mathematics and Physics

ON THE SECULAR ACCELERATIONS OF THE ORBITS OF IO, EUROPA, GANYMEDE, AND CALLISTO. Kenneth C. Jacobs, Dept. of Physics, Hollins Col., Roanoke, Va. 24020. In collaboration with Samuel J. Goldstein, Jr. (Dept. of Astronomy, Univ. of Va.), we seek the effects of tidal torques on the secular accelerations of the orbits of the four large Jovian moons. We consider the fully-coupled satellite system, and set up five linear equations – conservation of energy and angular momentum, the Laplace law, and data from Sampson (1910) and Lieske (1980) – to determine the time derivatives of the mean motions of the four moons. In units of  $10^{-10} \text{ yr}^{-1}$ , the results are:  $\dot{n}_1/n_1 = 3.54 \pm 0.56$ ,  $\dot{n}_2/n_2 = 2.78 \pm 0.11$ ,  $\dot{n}_3/n_3 = 1.23 \pm 0.91$ , and  $\dot{n}_4/n_4 = -3.12 \pm 0.85$ . The effective torque on Io is:  $(-5.1 \pm 4.6) \times 10^{24}$  dyne-cm; this torque opposing Io's orbital motion is consistent with zero! This talk will clarify our results, and will exhibit the algebraic sensitivity of our five linear equations. (Supported in part by a Faculty Travel Grant from Hollins College.)

THE USE OF AN INTERACTIVE CLASSROOM AS AN EARLY WARNING SYSTEM FOR STUDENTS WITH DIFFICULTIES. Frederick F. Hartline, Dept. of Physics & Computer Science & George R. Webb, College of Science & Commerce, Christopher Newport University, Newport News, Va. 23606. Student motivation and participation in class is greatly increased by the use of a classroom communication system (CCS) consisting of a network, numerous palm-top computers that students share in small groups, and an instructor's desktop computer with projection capability. This system allows students to electronically answer questions from their seats, and stores, categorizes, and displays analyses of these answers on cue for the instructor and class to share. The daily use of such a CCS provides a detailed electronic record of student attendance, participation, and overall success in answering questions that are directly related to the course objectives. We have correlated CCS acquired student performance data with customary indicators of performance (mid-semester tests, exam and course grades) over four semesters in a 90 to 140 student introductory physics course for non-majors at Christopher Newport University. Our analyses suggest that CCS acquired data readily identifies students who are experiencing difficulty in the course. Since these indicators are gathered automatically and are continuously updated, it may be appropriate to use them to trigger interventions designed to increase student retention and success in the course.

TESTING OF PHOTOMULTIPLIER TUBES FOR THE CEBAF LARGE ACCEPTANCE SPECTROMETER. Robert Atkins and Dr. Kevin Giovanetti, Department of Physics, James Madison University, Harrisonburg, Va. 22807. Photomultiplier tubes are being tested at James Madison University for future use in the Electromagnetic Calorimeter of CEBAF's large acceptance spectrometer. These tubes are being characterized by dark current and linearity. Methods and results will be presented.

COMPRESSION OF ELECTROCARDIOGRAM DATA: AN IMPROVED WAVELET BASED SCHEME. Brian Bradie, Dept. of Mathematics, Christopher Newport Univ., Newport News, VA 23606-2998. Several modifications have been made to a wavelet packet based compression scheme for single lead electrocardiogram (ECG) data. First, digital filters were implemented to remove powerline interference and to attenuate high-frequency muscle noise prior to compression. By localizing signal variance around the structural components of the ECG, noise filtering produced better than a 9% reduction in data rate, together with a 13.5% reduction in root mean-square (rms) error in the reconstructed signals. Next, linear prediction and an adaptive arithmetic coder were used to improve the coding of compressor output. The improved coding strategies produced an additional 17% reduction in average data rate; since all techniques were lossless, there was no effect on rms error. Finally, separate average vectors were maintained for the dominant and non-dominant beat types occurring in a given signal to account for morphological changes in the QRS complex. A significant reduction in coefficient data rate was anticipated; however, for the test cases used in this study, a slight increase in coefficient data rate was produced.

Development of a Calibration System for CEBAF's Large Acceptance Spectrometer. Darren Ellis, Dr. Kevin Giovanetti, Department of Physics, James Madison University, Harrisonburg, Va. 22807. The forward EMC of the CLAS detector will require routine calibration. Development and installation of a photomultiplier tube calibration system to perform this operation is currently being performed by our group at JMU. An overview of the design and implementation of our calibration system will be presented.

THE DESIGN AND DEVELOPMENT OF A PROCESSOR FARM FOR ANALYZING A LARGE VOLUME OF EXPERIMENTAL DATA. David L. Hibler, Department of Physics & Computer Science, Christopher Newport Univ., 50 Shoe Lane, Newport News, VA 23606. The Continuous Electron Beam Accelerator Facility (CEBAF) will generate experimental data at a rate of roughly one terabyte per day. This corresponds to a sustained rate of about ten megabytes per second and is approximately ten times the data collection rate at other national accelerator laboratories. Basic data analysis must keep up with the accumulation of raw data. In order to do this, a processor farm is being built. Raw data files will be stored in a tape silo. The data will then be sent to a collection of approximately forty workstations for processing. These workstations will be connected to an ATM network. The software which manages the processor farm is being designed in an object oriented fashion although the implementation will not be in an object oriented language. The farm will operate in a coarse-grained parallel mode (CPM) instead of a fine-grained mode. This talk discusses both the hardware and the software design for the CEBAF processor farm.

GUI INTERFACES USING TCL/TK TO CONTROL A PHOTOMULTIPLIER TUBE CALIBRATION SYSTEM FOR CEBAF'S CLAS DETECTOR. Walter Opaska and Dr. K.L. Giovanetti, Dept. of Physics, James Madison University, Harrisonburg VA 22807. A graphical interface is being designed as an input and status display for control of a calibration system. This interface will be built using TCL/TK a script language developed to facilitate the development of windows with nice graphical features. This system must have the added capability that it can be run over a network. An overview of the control problems and their solution using TCL/TK will be given.

OPTICAL PROPERTIES OF LITHOGRAPHICALLY FABRICATED SEMICONDUCTOR NANOSTRUCTURES. Peter A. Knipp, Dept. of Physics and Comp. Sci., Christopher Newport Univ., Newport News, VA 23606, & T. L. Reinecke, Naval Research Lab., Washington, DC 20375. Experimentalists at the University of Würzburg (Germany) have the ability to fabricate quantum wires and dots of lateral dimensions 25 nm - 200 nm by patterning 5 nm thick semiconductor quantum wells. In subsequent experiments, photoexcited carriers are confined laterally in quasi-one-dimensional or quasi-zero-dimensional states by the modified potential barrier. We have made detailed numerical calculations of the laterally quantized electron and hole states and of the optical transitions for these systems, including also the presence of a uniform magnetic field. Blueshifts seen in recent photoluminescence experiments agree quite well with our calculated results, which are free of any tunable parameters and which use the nanostructure sizes obtained directly from scanning electron microscopy images. This agreement indicates that there are effectively no optically inactive dead layers in these structures. (Supported in part by the U. S. Office of Naval Research and by the Office of International Studies at Christopher Newport University.)



Developing Instructional Scanning Tunneling Microscopy for Surface and Biological Studies in Undergraduate Research. K. Daniel Phillips and Gerald R. Taylor, Jr., Physics Department, James Madison University, Harrisonburg, VA 22807.

The Scanning Tunneling Microscope (STM) is a powerful tool for visualizing molecules and surfaces at the atomic level. It has been used by others to examine metals, semiconductors, and organic molecules. In this paper, we describe methods of vibration isolation using a stacked-plate elastomer system and review STM techniques. Atomic resolution of highly oriented pyrolytic graphite is employed as an excellent surface material for instructional scanning tunneling microscopy. Finally, we show that uncoated *E. coli* DNA adsorbed onto highly oriented pyrolytic graphite can be imaged to show the helical nature of DNA, including elucidation of the major and minor grooves. This work illustrates the wide array of applications of scanning tunneling microscopy for surface sampling and molecular biological research.

PHOTOMULTIPLIER TUBES AND THEIR APPLICATIONS TO A CALIBRATION SYSTEM FOR THE CLAS DETECTOR AT CEBAF. Justin Voshell and Dr. Kevin Giovanetti, Department of Physics, James Madison University, Harrisonburg, Va. 22807. Photomultiplier tubes are key to the operation of the CLAS detector in Hall B at CEBAF. The operation of these tubes will be discussed as well as their role in the detector.

Exploring the Atomic Structure of Graphite With X-ray Diffraction and Scanning Tunneling Microscopy. Michael D. Purdy and Gerald R. Taylor, Jr., Physics Department, James Madison University, Harrisonburg, VA 22807.

Application of STM (scanning tunneling microscopy) and x-ray diffraction were used to reveal the atomic configuration and spacing of pyrolytic graphite in an undergraduate laboratory project. The configuration and spacing of atoms in the crystal structure of pyrolytic graphite were measured using an instructional STM. The sample was then mounted in a TEL-X-Ometer X-ray diffraction apparatus to determine the distance between the weakly bonded planes. Graphite data and problems associated with set-ups, vibration, and humidity will be presented.

## Biolog

EFFECTS OF DEPLETION OF MACROPHAGES BY DESULFATED IOTA CARRAGEENAN INJECTION ON INDUCTION OF RESORPTION BY LIPOPOLYSACCHARIDE INJECTION IN CD-1 MICE. C. A. Aurentz and A. F. Conway, Dept. of Biol., Randolph-Macon Col., Ashland, Va., 23005, and C. M. Conway, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284-2012. Pregnant CD-1 mice were injected intraperitoneally with 3 mg of desulfated iota-carrageenan in phosphate-buffered saline on days 4, 6, and 8 of gestation in order to deplete active macrophages. Control mice were injected intraperitoneally with 0.5 ml of phosphate-buffered saline on days 4, 6, and 8 of gestation. Resorptions were induced by intravenous or intraperitoneal injection of 5  $\mu$ g of lipopolysaccharide in sterile phosphate-buffered saline on day 9 of gestation. Females were euthanized on day 12 of gestation and evaluated. Injections of desulfated iota-carrageenan had no significant effect on the frequency of resorptions induced by intravenous or intraperitoneal injections of lipopolysaccharide. If the desulfated iota-carrageenan injections did effectively eliminate macrophages, then active macrophages were not essential to the lipopolysaccharide-induced resorption process.

EFFECTS OF ESTRADIOL 17-BETA ON PHENYLETHANOLAMINE N-METHYLTRANSFERASE AS MEASURED BY WESTERN BLOTTING. Laura M. Kim & Jennifer K. Stewart, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284. The goal of this research project was to determine the effect of estradiol 17-beta, a potent estrogen, on the electrophoretic pattern of phenylethanolamine N-methyltransferase (PNMT) protein extracted from the adrenal glands of male rats. Total tissue protein was determined with the Lowry assay. Proteins were separated by molecular weight with SDS-polyacrylamide gel electrophoresis (SDS-PAGE) and by both molecular weight and charge with native polyacrylamide gel electrophoresis. Western blotting, in which an antibody is used to detect a specific protein, was used to visualize the electrophoretic pattern of PNMT protein. No changes were observed in the electrophoretic pattern of PNMT protein separated by SDS-PAGE. However, after separation of proteins on native gels, a different charge form of PNMT was observed in adrenals of rats treated with estradiol 17-beta. This change in charge was associated with low PNMT activity. These findings suggest a new mechanism for modulating PNMT.

COMPARISON OF RESORPTION FREQUENCIES INDUCED IN CD-1 MICE BY INTRAVENOUS INJECTIONS OF INTACT LIPOPOLYSACCHARIDE, DETOXIFIED LIPOPOLYSACCHARIDE, AND LIPID A FROM *ESCHERICHIA COLI* O55:B5 AND *SALMONELLA TYPHIMURIUM*. J. T. Kohler, J. M. Lively, and A. F. Conway, Dept. of Biol., Randolph-Macon Col., Ashland, Va. 23005 and C. M. Conway, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284-2012. The effects of injection of lipopolysaccharide (LPS) from *Escherichia coli* O55:B5 and from *Salmonella typhimurium* were studied in pregnant CD-1 mice. Intravascular injection of 5 µg of LPS from either bacterium on day 9 of gestation increased resorption significantly (from 10% to 100% for *E. coli* LPS and from 10% to 85% for *S. typhimurium* LPS), but intravascular injection of 1 µg of either LPS had no significant effect on frequency of resorption. Injection of 1 µg or 5 µg of either LPS reduced female body weight in a dose-dependent fashion. *S. typhimurium* significantly increased maternal spleen weight and increased maternal dorsal lymph node weight, but *E. coli* LPS had no significant effect on those organs. Neither detoxified LPS (lipid A removed) or purified lipid A from the LPS of either bacterial strain caused any significant increase in frequency of resorption or decrease in maternal body weight. These results indicate that intact LPS from *E. coli* was slightly more effective than intact LPS from *S. typhimurium* in causing resorption, but LPS from *S. typhimurium* caused stronger immune stimulation (as indicated by spleen and dorsal lymph node enlargement). The lack of effectiveness of either detoxified LPS or purified lipid A in causing resorptions indicates that the complete LPS molecule is required to induce resorption.

EMERGENCE STUDY OF THE PERIODICAL CICADA IN BOTETOURT COUNTY, VA, 1995  
Philip C. Lee, Jr., Department of Biology, 221 College Lane, Roanoke College, Salem, VA, 24153. Counts were made of emerging nymphs of *Magicicada septendecim* (L.) during May and June, 1995. This was part of the seventeen year brood predicted for Botetourt County. A twenty-five meter wide and one-hundred twenty meter long area of lawn on the Lee farm was used as the study site. Trees and shrubs on the site included: ginkgos (2), white pines (2), red cedars (2), sugar maples (2), silver maples (3), pin oaks (3), willow oak, sweet gums (2), pears (3), golden rain tree, apples (2), redbud, dogwoods (3), catalpa, green ash, Pfitzer junipers (12), Japanese yews (7), Korean boxwoods (4), American boxwoods (5), leather leaf viburnums (8), doublefile viburnums (2), spirea, weigelas (3), beautybush, lilacs (4), hardy-orange, Japanese quinces (2), deutzia. Crawling nymphs were captured by hand, counted and placed in collection bags. Largest counts were on May 21: 1,378; May 22: 1,534; May 23: 1,626. Total nymphs counted for the study: 8,028.

**PREGNANCY BLOCK IN WHITE-FOOTED MICE (*PEROMYSCUS LEUCOPUS NOVEBORACENSIS*): THE ROLE OF LACTATION.** Kelcey M. Becker, Elizabeth L. Spruill and C. Richard Terman, Lab. of Endo. & Pop. Ecol., Col. of William and Mary, Williamsburg, VA 23185. Uterine implantation of fertilized eggs (blastocysts) is prevented in several species of small mammals if the recently inseminated female is exposed to a stranger male or his urine. Some species of deer mice (*Peromyscus*) are susceptible to pregnancy blocking. Reproduction in wild white-footed mice has been shown to be suppressed in May and June each year even when food is supplied in surplus. This study examined the pregnancy block phenomenon in white-footed mice and demonstrated that: (1) Nulliparous females are very sensitive to multiple factors blocking their pregnancies, (2) Current lactation or recent lactation (within two or three days of the birth of young) protects the female against pregnancy block, and (3) Parity *per se* does not protect against pregnancy block (7 days after birth when not lactating, protection is gone).

THE EFFECTS OF SEX RATIOS ON PROLONGED COPULATION IN COTTON STAINER INSECTS (*DYSDERCUS ANDREAE*). A. Scott Bellows and Harold J. Grau, Dept. of BCES, Christopher Newport University, Newport News, Va. 23606. *Dysdercus andreae*, one of the cotton stainer species, as in many other bugs of the family Pyrrhocoridae, exhibits prolonged copulation. Prolonged copulation may be a successful mating strategy in situations where a male-biased sex ratio would likely increase competition among males for females. To test this hypothesis in *D. andreae*, a study was conducted in which the sex ratios of adult cotton stainers were manipulated and various parameters related to mating behavior were monitored. Over a five-month period, a total of 54 trials that included 291 individual insects were used to generate over 13,000 observations. There was a significantly higher probability of partner switching per observation among males in female-biased test populations than among those in both male-biased and non-biased test populations. There was a significantly higher probability of partner switching per observation among females in male-biased test populations than among those in both female-biased and non-biased test populations. Mean copulation duration was significantly longer in male-biased test populations than in female-biased test populations. The lack of an increase in copulation duration in female-biased populations, even though there is a decrease in partner switching by females, suggests that prolonged copulation among *D. andreae* is a strategy employed by males as a result of male-male competition.

THE FUNCTIONAL SIGNIFICANCE OF A MEDIALY DIVIDED CRIBELLA IN THE SPIDER GENUS *MALLOS* (ARANEAE, DICTYNIDAE). Jason E. Bond & Brent D. Opell, Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The cribellum is a synapomorphy of the Infraorder Araneomorphae, where it first appeared as an oval plate (Platnick, 1976). However, in some araneomorphs the cribellum is divided medially. A transformational analysis that includes four species of the dictynid genus *Mallos* with entire cribella and two species with medially divided cribella shows that cribellum width, surface area, and spigot number scale to carapace width. There is no evidence that these relationships differ between species with entire and divided cribella. Thus, in *Mallos*, a median cribellar division does not appear to be associated with changes in cribellum features that are known to increase the stickiness of cribellar threads. (Supported by grants to JEB from: Sigma Xi, Graduate Student Association, Va. Tech, the American Museum of Natural History, and the Dept. of Biology, Va. Tech)

CHANGES IN NEURON POPULATIONS IN SPINAL GANGLIA IN THORACIC, ABDOMINAL, AND CAUDAL REGIONS OF *XENOPUS LAEVIS* DURING METAMORPHOSIS. A. C. Brooks and A. F. Conway, Dept. of Biol., Randolph-Macon Col., Ashland, Va., 23005. Sensory neuron populations in *Xenopus laevis* tadpoles were studied during metamorphosis. Numbers of neurons in spinal ganglia in forelimb region sections significantly increased (ANOVA with Tukey test) as the forelimbs grew and began to function from stage 52 through stage 61, then significantly decreased through stage 66. The area of the ganglia in sections from the forelimb region increased significantly from stage 52 to stage 58, then decreased significantly through stage 66. Numbers of neurons in spinal ganglia in trunk region sections increased during skin metamorphosis from stage 52 through stage 58, then decreased through stage 66. The area of the ganglia in sections from the trunk region increased from stage 52 to stage 58, then decreased through stage 65 with a slight increase in stage 66. None of the changes in the trunk region were statistically significant. Changes in numbers of neurons and in area of the ganglia were much smaller in the trunk than in the forelimb region. Neuron density (cell # / mm<sup>2</sup>) did not change significantly from stage 52 through stage 66 in either the forelimb or trunk regions. These patterns suggest that numbers of neurons increased in response to increases in the tissues supplied by the neurons, then declined, possibly due to loss of neurons which failed to make proper connections. In general, area of the ganglia increased one to three stages prior to the corresponding change on number of neurons suggesting that changes in non-neuronal cells and/or in neuron processes precede changes in numbers of neurons.

DISTRIBUTION OF SMALL MAMMAL SPECIES IN MANAGED PINE PLANTATIONS. James D. Dolan, Old Dominion University, Norfolk, VA 23529. Abundances were obtained using mark, recapture and removal techniques. Four 50 m grids, with 25 traps each, were set per site. Granivores were most abundant in 1 and 24 yr. pines, while insectivores were most abundant in those of 8, 13, and 18 yr. old stands. Herbivores were least abundant in 1, 8, 18, and 24 yr. old stands. Of the granivores, *Peromyscus leucopus* was the most abundant species in 1 and 24 yr. stands, while *Ochrotomys nuttalli* was the sole inhabitant of 8, 13, and 18 yr. stands. *Reithrodontomys humilis* was found in 1 and 14 yr. stands, while *Mus musculus* was found only in 1 yr. stands. Herbivore, *Sigmodon hispidus* was found in 1 and 24 yr. pines, and was most abundant in 1 yr. old pines. *Microtus pinetorum* was the sole resident in 8, 13, and 18 yr. pines. Insectivore, *Sorex longirostris* was the most abundant species in 8, 13, 18 and 24 yr. stands, and equal in abundance to *Cryptotis parva* in 1 yr. stands. *C. parva* was also found in 24 yr. old stands, but was the least abundant species. *Blarina brevicauda* was found at all sites.

THE LETHAL AND SUBLETHAL EFFECTS OF ALDICARB ON THE GRASS SHRIMP, *P. PUGIO*. Andrea L. Dvorak-Grantz, Dept. of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The grass shrimp *Palaemonetes pugio* has been shown to be sensitive to pesticide exposure, yet these animals survive in large numbers in the upper reaches of tidal marshes subject to agricultural runoff. The behavioral responses of *P. pugio* to chemical stress at sub-lethal doses is not fully understood. Previous studies have focused mainly on the lethal effects of pesticides to aquatic organisms (Baughman, 1989; Clark, 1988). The specific intent of this research is to assess the lethal and sub-lethal effects of aldicarb, a commonly used insecticide, on *P. pugio*. Exposure of grass shrimp to aldicarb indicated a 96-h LC50 of 107.5 ug/l for newly hatched larvae, 72.4 ug/l for 22-day larvae and 100.0 ug/l for adults. Ongoing studies will determine any behavioral responses to different toxicant levels of aldicarb by using a modified flow chamber which will be partitioned to allow the organism a distinct choice between the side being pulsed with aldicarb and the side being pulsed with uncontaminated seawater. If the shrimp display behavioral responses to aldicarb, then avoidance, generalized locomotory responses and directional movement will be measured. AChE activity and inhibition at different life stages will also be analyzed since the inhibition of this enzyme may indicate the potential for sublethal neurological impacts. An understanding of the lethal and sub-lethal effects of aldicarb on *P. pugio* will assist environmental managers and regulatory agencies in evaluating the lethal and sub-lethal effects of nonpoint source pesticide runoff to nontarget invertebrates. Protection of this organism is vital in maintaining the integrity of estuarine systems since this organism serves as an important prey item for various fish species and plays a dominant role in energy cycles of estuaries.

ARTHROPODS IN BLUE BIRD (SIALIA SIALIS) NEST BOXES. Ralph P. Eckerlin, Natural Sciences Div., Northern Va. Comnty. Col., Annandale, VA 22003. Twentyeight nests from blue bird nest boxes were sampled May to August, 1995 at Huntley Meadow Park in Fairfax County, VA. Twelve of the nests were those of blue birds, 11 were house wren nests, 3 from Carolina chickadees, and one each of tufted titmouse and tree swallow. Nests were placed in a Berlese funnel, subjected to heat from a 75 watt bulb for 24 hours and arthropods that emerged from the nests were collected and preserved in 70% ethanol. Mites, psocids, and beetle larvae, in descending order of occurrence, dominated the nests of both blue birds and house wrens. Some mites were parasitic mesostigmatid mites, but most arthropods were free living forms such as oribatid mites, psocids, dermestid beetles, leaf hoppers, ants, collembolans, flesh flies and their larvae. Chickadee nests also had mites, psocids, and beetles. The nest of the tufted titmouse yielded a single flea, Orchopeas howardi, a squirrel flea. It is hypothesized that the nest was visited by a southern flying squirrel, a local squirrel that could fit through the nest box hole. Mite numbers increased in nests of all species from May to August. The increase was not significant at the 5% level (Wilcoxon rank-sum test). The saw-toothed grain beetle, Oryzaephilus surinamensis was an unexpected find.

THE EFFECTS OF FOOD TYPE ON DEVELOPMENT OF ST. ANDREW'S COTTON STAINER (DYSDERCUS ANDREAE). Harold I. Grau & Kevin McSweeney, Dept. of Biol., Chem., & Env. Sci., Christopher Newport Univ., Newport News, VA 23606. St. Andrew's cotton stainer is one species of a pantropical group of Pyrrhocorid bugs that feed predominantly on seeds of the plant order Malvales. On St. Thomas, USVI, Dysdercus andreae feed almost exclusively on seeds of Thespectia populnea, a non-agricultural tree found along shoreline areas. To determine if a lab population of D. andreae could be sustained on an alternative food, an experimental study was initiated in which broods were divided after the first molt into two groups and fed exclusively either Thespectia seeds or those of commercially available cotton (Gossypium). Videography was used to record development from the second instar through adult stages. Measurements of body size from these video records show that bugs reared on cotton seed grew significantly ( $P < 0.01$ ) larger (both total body length and width) and faster than their Thespectia-fed broodmates. Cotton fed individuals also reached adult emergence five days more quickly than those fed on the native seed (mean age at emergence: cotton-fed = 39.45 days, Thespectia-fed = 44.05 days,  $P < 0.001$ ).

AGGREGATION, MATING, AND OVIPOSITION BEHAVIOR OF ADULT Cuterebra fontinella Clark (DIPTERA: CUTEREBRIDAE). Michael S. Hensley, Dept of Biol., Bridgewater College, Bridgewater, VA 22812. An aggregation site for the rodent bot fly Cuterebra fontinella has been studied intensively during sixteen seasons. The site is a topographic summit at the head of a ravine on a farm woodlot in Rockingham County, VA. Adult flies engage in mating behavior at the site during a 90-100 day period from mid-June to mid-September. Behavior is generally typical for the genus with males stimulated into patrolling flights during intense light. Untypically, populations are sparse (< 8 males) and flight behavior is restricted to afternoons between 1520 and 1750 EST, even when mornings are warm and sunny. Marked, released flies located the aggregation site by moving up the ravine (into the sun). Ovipositing females range over the entire 6 ha woodlot and they seem to seek out shaded depressions in host habitat where eggs are laid in clusters of six.

GEOGRAPHIC VARIATION IN NORTH CAROLINA AND VIRGINIA POPULATIONS OF THE SOUTHEASTERN SHREW, *Sorex longirostris*, INCLUDING THE FEDERALLY THREATENED *S. l. fisheri*. Nancy D. Moncrief<sup>1</sup>, W. David Webster<sup>2\*</sup>, Becky E. Gurshaw<sup>2\*</sup> and Robert K. Rose<sup>3</sup>.  
<sup>1</sup>Virginia Mus. Nat. Hist., Martinsville, VA 24112; <sup>2</sup>Biol. Dept., Univ. North Carolina, Wilmington, NC 28403; & <sup>3</sup>Biol. Dept., Old Dominion Univ., Norfolk, VA 23529. We used multivariate morphometrics and allozymic electrophoresis to examine the geographic distribution of *S. l. fisheri*. This taxon is federally listed, in part because it was thought to occur only in extreme southeastern Virginia and northeastern North Carolina. We used eight cranial characters to examine variation in 626 shrews from 28 populations in Virginia, North Carolina, and throughout the southeastern U.S. We also analyzed 25 presumptive gene loci in 103 individuals from 25 sites in Virginia and North Carolina. Both the morphological and allozymic results indicate that *S. l. fisheri* is broadly distributed across the coastal plain of North Carolina. The range of *S. l. fisheri* is not as restricted as was presumed.

RESPONSE BY SUBTERRANEAN TERMITES (RHINOTERMITIDAE: *RETICULITERMES*) TO UREA LEACHATES IN FIELD AND LABORATORY TRIALS. Susan E. Morlino & Deborah A. Waller, Dept. of Biol., Old Dominion Univ., Norfolk, Va. 23529. Little is known about how termites locate food sources. One possibility is that they follow chemical cues from nitrogen leachates to find roots or logs. In laboratory trials, *Reticulitermes* workers recruited to 1% (w/v) urea leachates sooner than to water drenches. In field trials, termites tended to attack blocks located above urea drenches more frequently than blocks above water drenches, but more data are required to establish a preference. In a separate field experiment, termites did not discriminate among stakes soaked in urea solutions or in water.

DISTRIBUTION OF HINDGUT PROTOZOANS IN WORKERS AND SOLDIERS OF THE SUBTERRANEAN TERMITE *RETICULITERMES FLAVIPES* KOLLAR (RHINOTERMITIDAE). Marian Norris & Deborah A. Waller, Dept. of Biol., Old Dominion Univ., Norfolk, Va. 23529. The hindguts of *Reticulitermes flavipes* contain approximately fourteen species of protozoan symbionts. Distribution of different species may be affected by their oxygen sensitivity or dependence on cellulose which enters the hindgut through the enteric valve. In the present study, three major protozoan species were found in all three pouches of the hindgut. *Trichonympha* was more abundant in the first pouch near the enteric valve, while *Pyrsonympha* and *Dinenympha* were more abundant in the second pouch.

EFFECTS OF TEMPERATURE ON SURVIVORSHIP AND SYMBIOTIC PROTOZOANS IN THE SUBTERRANEAN TERMITE *RECTICULITERMES VIRGINICUS* BANKS (ISOPTERA: RHINOTERMITIDAE). Jennifer Omaster & Deborah A. Waller, Dept. of Biol., Old Dominion Univ., Norfolk, Va. 23529. Termites are exposed to a range of temperatures as they forage throughout the year. In the present study, workers from six colonies of *Reticulitermes virginicus* were confined for one week at 22°C, 26°C or 32°C. Termite survivorship decreased at 32°C, but wood consumption increased with increasing temperature. Numbers of the gut protozoans *Trichonympha* and *Pyrsonympha* were similar at all three temperatures, but populations of the gut protozoan *Dinenympha* decreased at 32°C.

COMPARISON OF TISSUE DESTRUCTION, GRANULOCYTE DISTRIBUTION, AND C3 COMPLEMENT DISTRIBUTION AROUND NORMAL AND LIPOPOLYSACCHARIDE-INDUCED RESORBING EMBRYOS IN CD-1 MICE. J. E. Pulley and A. F. Conway, Dept. of Biol., Randolph-Macon Col., Ashland, Va., 23005, and C. M. Conway, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284-2012. Sections of implantation sites from control and LPS-treated pregnant mice were systematically surveyed and morphological characteristics were evaluated to determine whether LPS treatment increased inflammatory factors including tissue destruction (as evidenced by total peroxidase staining), granulocyte accumulation (as visualized by peroxidase staining resistant to inactivation by methanol + peroxide), and complement deposition (as visualized by staining with antibodies against C3). Activity of each of these factors was ranked in a set of sections from implantation sites from females sacrificed at increasing time periods after LPS or control treatment (6, 12, 18-19, 24-29 hours). Total peroxidase staining and apparent tissue destruction were significantly increased in the decidua in the placental margin region and in the maternal-embryonic interface of the central placental region of implantation sites in LPS-treated females at 6 hours after treatment. Granulocytes (stained for methanol + peroxide-resistant peroxidase) and immunostaining for complement factor C3 were not significantly increased in those or in other areas of the maternal-embryonic interface in implantation sites from LPS-treated females indicating that damage in early stages of LPS-induced resorption does not involve these components.

MATE SELECTION AND THE EVOLUTION OF SEXUAL DICHROMATISM IN THE GENUS *EULEMUR*. Douglas H. Shedd, Dept. of Biol., Randolph-Macon Woman's Col., Lynchburg, VA, 24503. All of the species and subspecies in the genus *Eulemur* are sexually dichromatic. In this study, conducted at the Duke University Primate Center, captive *E. mongoz*, *E. m. macaco*, and *E. fulvus collaris* were tested using conspecific face models to investigate the significance of sexual dichromatism. It was found that females in all three species directed more affiliative behavior to male-faced models than female-faced models, and this difference was significant in *E. f. collaris* and *E. macaco*. In contrast, males did not consistently favor models of either sex and, in general, tended to show less affiliative behavior to face models than did females. Preliminary research on *E. mongoz*, *E. m. flavifrons*, and *E. fulvus* subspp. suggest that female dominance, which is typical of most lemur species, is absent in *E. fulvus*. A general model for the evolution of sexual dichromatism, based on the high level of female choice occurring in primate species displaying natal female emigration, and forest fragmentation, is proposed.

THE ROLE OF FEMALE POSITIONAL CHOICE IN PREGNANCY BLOCK (THE BRUCE EFFECT) IN PRAIRIE DEERMICE (*PEROMYSCUS MANICULATUS BAIRDII*). Tavis W. Sipe and C. Richard Terman, Lab. of Endocrinology and Population Ecology, Dept. of Biology, Col. of William and Mary, Williamsburg, VA 23185. Female *Peromyscus* are able to behaviorally modulate pregnancy block effect through positional choice when males are unable to directly influence situation. Female tends to avoid strange male under all conditions, but there is no tendency to remain near stud male when strange male is not present. Familiar males, those present at the time of insemination but not the coital partner, are treated similarly to stud rather than strange males, indicating that cues for detecting whether a male is capable of causing block do not include insemination. Pregnancy data indicate partial ability to avoid block through avoidance of strange male under experimental conditions; in wild populations this may serve to protect the female unless the stud male is no longer present. These results are reconcilable with the predominant explanation of the adaptive significance of pregnancy block to females, the "infanticide avoidance" theory; the fact that the female is not wholly able to avoid the block (physiologically or behaviorally) indicates that the block is to some degree advantageous to her when she is unable to prevent it.

THE EFFECTS OF ATRAZINE ON NITROGEN CYCLING IN WETLANDS. Rhonda E. Wilhite, & A. L. Buikema, Dept. of Biol., Va. Tech, Blacksburg, Va. 23284. Wetlands are ecologically important zones which remove excess nitrogen and agricultural chemicals from surface and groundwater. Atrazine, the most commonly used herbicide, is rapidly accumulating in surface and groundwater. Atrazine's impact on the Nitrogen cycle in a freshwater wetland is currently unknown. It is hypothesized that the addition of Atrazine to a wetland microcosm will alter the Nitrogen cycle by inhibiting nitrifying bacterial groups. This inhibition of the inorganic cycling of Nitrogen may result in an excess of Nitrogen compounds entering waterways. Seven subsamples were collected from a wetland and established in a controlled environment in the laboratory with a continual supply of water. Three of these microcosms were treated with Atrazine at a concentration of 1.5 mg/l. Bacterial groups were enumerated by a Most Probable Number method using selective media. Inorganic Nitrogen components were quantified by spectrophotometric analyses. Results show that these Nitrifying groups were not significantly affected by the addition of Atrazine to the microcosms. Significant increases were noted in the concentrations of Nitrite ( $P=0.0061$ ) and Nitrate ( $P=0.0001$ ) present in water leaving the microcosm. This is not surprising given the fact that these anions are readily leached from the soil. Ammonium and Nitrite oxidizing bacteria were previously thought to be sensitive to Atrazine at high concentrations. Because of their affiliation with the surrounding sediments, these bacteria are not as susceptible to stress in the environment. In conclusion, the addition of Atrazine to a freshwater wetland microcosm does alter the Nitrogen cycle, producing excess Nitrite and Nitrate. Also, Nitrifying bacteria are not affected by Atrazine at this concentration.

HABITS AND MATING BEHAVIOR OF CAPTIVE ALLEGHENY WOODRATS (*Neotoma magister*). Andrew K. Zadnik & Michael T. Mengak, Dept. of Life Sciences, Ferrum College, Ferrum, VA 24088. Two woodrats were studied in captivity in order to observe their typical nocturnal habits and mating behavior. It was found that they spend most of their time resting and sleeping (68.3% of time). The next longest period of time was spent exploring (10.3% of time) and grooming (10.3% of time), followed by eating (9.6% of time) and finally defecating (1.5% of time). Their mating habits include sexual chases, boxing, and multiple matings over a short period of time. They also may be capable of mating many times without the female necessarily becoming pregnant.



## Biomedical and General Engineering

BLOOD FLOW PATTERN STUDY OF HUMAN CAROTID ARTERIES USING ANGLE INDEPENDENT DOPPLER COLOR IMAGING. Danhui D. Liu<sup>1</sup>, Ding-Yu Fei<sup>1\*</sup>, Cai-Ting Fu<sup>1\*</sup>, Raymond G. Makhoul<sup>2\*</sup>, and M. Ruth Fisher<sup>2\*</sup>, <sup>1</sup>Dept. of Biomedical Engineering and <sup>2</sup>Dept. of Surgery, Va. Commonwealth Univ., Richmond, Va 23298. The flow information obtained from commercially available ultrasonic Doppler color imaging system depends on the Doppler angle. Angle correction by duplex scanning may introduce errors for complex geometry and pathological conditions such as stenosis. Angle Independent Doppler Color Imaging (AIDCI) developed in our lab is one of the image processing methods used to solve this problem. It employed an experimental system to acquire Doppler color images using a linear transducer from an ultrasound scanner to reconstruct angle independent Doppler color images. We have tested 42 common carotid arteries (CCA) from 21 normal subjects to validate the application of AIDCI *in vivo*. Furthermore, we conducted a retrospective study on 62 internal carotid arteries (ICA) from normal subjects and patients categorized into 5 groups of different degree of stenosis. The purpose of the ICA study was to quantify the blood flow patterns by some user-defined indices in an attempt to parameterize the degree of disease. Good correlations were found between AIDCI and duplex scanning for velocity amplitude and between AIDCI and B-mode imaging for flow angle. We also observed a periodic variation of the flow angle with the cardiac phases by AIDCI, while the change in the geometric angle of the vessel was insignificant. In addition, preliminary statistical analysis showed significant difference of the indices between different groups. These results suggested that our AIDCI technique may be sensitive to the change of flow angle and therefore may be used in blood flow pattern analysis. Potential application of our AIDCI technique can be expected in hemodynamic study and diagnosis of degree of disease using the flow patterns and the indices as indicators of abnormality.

ISOLINES OR TESSELLATION LINES, WHICH WILL IT BE ? William P. Harrison, Engineering Fundamentals Div., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061-0218. In current computer-aided-design (CAD) usage, tessellation lines are defined as those lines that help us more easily visualize the features and characteristics of curved surfaces. They may be straight lines, such as the linear element lines added to cylindrical surfaces and running in the lengthwise direction; or they may be curved lines, such as circular arcs added to spherical surfaces to clarify and visually enhance their three-dimensional spatiality. However, the word tessellate dates back to early Greek and Latin origins, where it had a connotation somewhat different from its present usage within the CAD software community. This paper attempts to trace the recent transition of the word tessellation from its classical usage, as it appears currently in most traditional dictionaries, to its widely accepted "new" usage within the engineering and graphic arts fields. Also, tessellation is compared to the very recently introduced term ISOLINE, and speculation about its possible replacement is presented.

DETERMINATION OF RED BLOOD CELL VELOCITY AND SPATIAL DISTRIBUTIONS USING A VIDEO IMAGING TECHNIQUE. Shruti A. Japee and Roland N. Pittman. Departments of Biomedical Engineering and Physiology, MCV/VCU, Richmond, VA 23298.

Since oxygen is carried almost exclusively by red blood cells (RBC), a knowledge of their velocity and spatial distributions in the microcirculation is important in the study of oxygen transport. RBC velocity and spatial distributions in microvessels were determined using a fluorescent video microscopy technique that used electronic shuttering of an intensified CCD video camera to provide multiple images of cells. RBCs from anesthetized Golden hamsters were labeled using fluorescein isothiocyanate (FITC) and injected into the hamster circulation. The fraction of fluorescently labeled cells (FRBC) was set to about 1% of the total RBCs, so that each video frame had 1-2 FRBCs. Video recordings of multiple images of moving FRBCs were used to calculate their velocities and lateral positions. A theoretical model, based on a parabolic velocity profile,  $v(r) = v_0 [1 - B (r/R)^2]$ , and a step-wise red cell distribution,  $H(r) = H_0$  for  $0 \leq r \leq r_0$  and zero elsewhere, was formulated to analyze the data. The shape of the RBC velocity profiles varied as a function of distance downstream from arteriolar bifurcations. The bluntness parameter, B, ranged from 0.3 to 0.9, where B = 0 corresponds to plug flow and B = 1 to Poiseuille flow. Symmetry of an RBC spatial distribution was assessed by comparing the number of FRBCs to the left and right of the centerline. Symmetry of velocity distributions was evaluated similarly. We observed both symmetric and asymmetric distributions of RBCs near bifurcations, but contrary to our expectations, the symmetry did not seem to improve with downstream distance. The asymmetry, if any, in the velocity distributions was comparatively small. Results from these experiments will be used in combination with measurement of hemoglobin and oxygen saturation to obtain improved estimates of convective and diffusive oxygen transport in microvessels.

A u-p FINITE ELEMENT ANALYSIS TO INVESTIGATE LOAD SHARING BETWEEN SOLID AND FLUID PHASES ON AN ARTICULAR SURFACE. Nilav Mukherjee and Jennifer S. Wayne\*, Orthopaedic Research Laboratory, Va. Commonwealth Univ., Richmond, Va. 23298-0694. Articular cartilage successfully functions in the demanding environment of diarthrodial joints because of its structural makeup and lubrication mechanisms between opposing surfaces. The biphasic theory<sup>1</sup> postulates that the stress within the tissue is shared by both solid and fluid phases of the tissue. It has been suggested that an externally applied stress is also partitioned to the two phases at the surface<sup>2</sup>. Different amounts of partitioning has a dramatic effect on cartilage behavior<sup>3</sup>. This study attempts to determine the load partitioning at the surface between the two phases of cartilage under in situ loading, combining both experimental and theoretical modelling approaches. Porcine knees were subjected to a 450N compressive load while fluid pressure at the cartilage surface and cartilage deformations during the loading were monitored<sup>4</sup>. For the modelling, the u-p finite element model<sup>5</sup> was used to simulate the cartilage in the experimentally loaded knee. Experimental pressure readings provided loading information to the model and the model then predicted the deformations of the cartilage due to the loading. Deformations for the model were obtained for four cases 1)30% of the total stress was partitioned to the fluid 2)50% 3)70% 4)90%. Load partitioning was assumed to be constant across the cartilage surface and over the duration of the experiment. Experimental and predicted deformations were compared at two time points during the loading to determine which partitioning case provided deformations closest to the experimentally obtained deformations. Best correlations are obtained for the case where 70% of the load is borne by the liquid. This agrees well with earlier theoretical predictions of load partitioning<sup>2</sup>. 1)Mow et al., J. Biomech Eng., 102:73-84, 1980 2)Hou et al., J Biomech Eng, 111:78-87, 1989, 3)Wayne, Ann Biomed Eng, 23:40-47, 1995, 4)Brodrick et al., Trans ORS, 21(2):737, 1996, 5)Wayne et al., J Biomech Eng, 113:397-403, 1991. Support from Whitaker Foundation is gratefully acknowledged.

ESTIMATION OF CONDUCTION VELOCITY OF A $\delta$  FIBERS USING HEAT-PAIN RELATED SOMATOSENSORY EVOKED POTENTIALS IN HUMANS. Arup Roy<sup>1</sup> & S.W. Harkins<sup>1,2\*</sup>, Depts. of <sup>1</sup>Biomed. Engr., <sup>2</sup>Gerontology, & <sup>3</sup>Psychiatry, Va. Commonwealth Univ., Richmond, Va. 23298. Estimation of large peripheral nerve conduction velocity (CV) is a common component of determination of peripheral nerve damage in clinical studies. These cutaneous fibers have a high S/N ratio and are easily studied in response to appropriate cutaneous stimuli. Currently there are no available means for determination of CV of small cutaneous fibers which subserve pain perception. The present study was designed to evaluate the potential utility of a contact thermal stimulator in determination of CV of cutaneous fibers subserving thermal pain (nociception) sensitivity in humans. The stimulator delivers a brief duration, fast rise-time (21.7°C/s) heat pulse to the skin without contamination by other stimulus modalities. Averaged somatosensory evoked potentials (SEPs) to thermal stimuli were employed as possible markers of conduction properties of nociceptive neurons. The individual responses were digitally band-pass filtered (0.5-7.0 Hz) to remove high frequency noise and exclude gross artefacts. The single trial SEPs which had very low correlation (similarity) to the average SEP were eliminated by a selective averaging technique which used a test statistic based on the Fisher transformation. To obtain a final estimate of the waveshape representative of the highest mutual correlation among all the responses, the selected single trial SEPs were passed through an adaptive cross-correlation filter (Woody filter) for latency corrected averaging. The CV of the A $\delta$  fibers were then estimated from the difference of the peak latencies of the arm and leg cortical potentials. We have determined that EPs to the thermal stimuli are maximal in amplitude at vertex(C<sub>z</sub>). Our studies show that the CV from these SEPs is consistent with their arising from A $\delta$  fibers. These are probably the first findings suggesting that a simple, contact thermal stimulus may permit identification of small fiber conduction delays in individuals with and without painful peripheral neuropathies.

ACCELERATED CONSTRUCTION OF THREE-DIMENSIONAL ISOSURFACES FROM MEDICAL IMAGES. John E. Stewart and William C. Broadus\*, Dept. of Biomedical Engineering and Div. of Neurological Surgery, Va. Commonwealth Univ., Richmond, Va. 23298. Computer graphics applications to medical visualization have grown significantly over the last twenty years. Many medical institutions now have the ability to visualize three-dimensional (3D) models of the human anatomy on high-speed graphics workstations. These models typically require hours to generate and minutes to render to the computer screen. This severely limits the utility of these models for everyday patient care. In order to resolve these problems, we have developed a number of unique algorithms to accelerate both the creation and rendering of these models. One such algorithm, Border Case Comparison, creates coherently-oriented manifold isosurfaces from MR or CT scans at a rate of 30 K triangles/second. A typical 3D model can be created from 40 CT scans in under five seconds. The rendering of these models has also been accelerated through the use of an optimized surface simplification algorithm. The purpose of this algorithm is to reduce the overall number of triangles necessary to render the model without significantly altering the appearance of the model. A model consisting of 100 K triangles can be simplified to contain 20 K triangles in less than 10 seconds with virtually no deterioration in model quality. This simplified model will render on a Silicon Graphics Indigo2 workstation in under 0.5 seconds. A software system entitled IsoView has been developed to incorporate all of these algorithms into one package. The strides made in accelerating the process of going from medical images to 3D computer model have provided a practical means of visualizing and planning neurosurgical procedures on a daily basis.

ENGINEERING AND TECHNOLOGY IN A SUMMER SCIENCE CAMP. JoAnne P. Trimbur and Lynn Lambert. Dept. of Physics and Computer Science, Christopher Newport Univ., Newport News, VA 23606. Research has shown that a significant deterrent to women in engineering is their relative lack of prior experience with hands-on activities which develop building or design skills, particularly those activities involving the use of tools. A 3-week semi-residential summer science camp for 24 middle school girls from rural areas emphasized several areas of engineering/technology, including LEGO robot design, computers and the Internet, engineering design contests, and two building projects which involved the use of a variety of tools. The use of tools was, for the majority of the girls, the most foreign concept of any included in the curriculum. The students spent a total of 4 hours building their own table lamps and building and racing their own 1/20 scale solar cars. Tools used in these projects included wire strippers, wire cutters, needle-nose pliers, and Phillips' head and regular screwdrivers. All 24 girls produced working lamps and working solar cars. By the end of these sessions, the girls had become significantly more comfortable with the use of simple hand tools and had gained confidence in their ability to successfully complete projects requiring use of tools. At a follow-up meeting with the girls and their parents four months later, the parents related several anecdotes about their daughters' newly acquired habits of taking household items apart and putting them back together. Many of the table lamps built by the girls were still in use in their homes eight months after the summer camp. Several of the students have expressed an interest in careers in engineering. (This work supported by NSF grant number HRD-9453678)

HINT AND SYBYL: MODELING AND QSAR STUDIES OF HIV-1 PROTEASE INHIBITORS. David T. Wei\*, Dept. of Biomedical Engineering, Va. Commonwealth Univ., Richmond, VA 23298, & Glen E. Kellogg, Depts. of Medicinal Chemistry and Biomedical Engineering, Va. Commonwealth Univ., Richmond, VA 23298. Rational drug design has garnered considerable interest in recent years. A key advantage of the method is the ability to evaluate potential therapeutic agents before synthesis. Current research in AIDS therapy has centered on HIV-1 protease inhibitors. Using a training set of 33 inhibitors (Holloway, M.S.; *et al.* "A *Priori* Prediction of Activity for HIV-1 Protease Inhibitors Employing Energy Minimization in the Active Site." *J. Med. Chem.* 1995, 38, 305-317.), it has been demonstrated that a high correlation exists between the intermolecular interaction energy and the observed *in vitro* enzyme inhibition. Many computational tools have become available, but few take into account hydrophobicity and hydrophobic interactions. An empirical model has been developed, called HINT (Hydrophobic INTeractions). Using HINT and the set of 33 inhibitors, we have been able to improve upon published results. Limitations of the Holloway *et al* model, including the flexibility of the enzyme active site; the energy difference between the bound and free inhibitor; and hydrophobic interactions, were also taken into account with this new approach. In essence, our model would seem to be more accurate and representative than previous models.

## Botany

BIOMONITORING A NEW TECHNOLOGY COAL FIRED POWER PLANT- PRE-IMPACT STUDIES. Stephen W. Fuller and Susan T. Lee, Dept. of Biol., Ray B. Scott and Jim Turns, Dept. of Chem., Mary Washington Col., Fredericksburg, Va. 22401. A new coal-fired power generation plant with selective catalytic reduction of pollutants is being built next to an EPA designated non-attainment air pollution zone. Lichens on oak trees are being used as biomonitors of air pollution to determine if the plant emissions will have no measurable impact. Prior to start up, 22 free standing trees greater than 40cm diameter were selected, 11 surrounding the plant site and 11 upwind, serving as a control. A time series analysis was initiated in January 1996 with collections for metal analysis and photographs for growth determination. Initial analyses of metal concentrations in lichens collected in the impact area indicate that the concentrations are between those Lawrey (1993) reported from sites 15 and 21 km. from the center of Washington D.C. Comparison of the lichen thalli photographs from the winter and spring seasons show average growth rates of 0.51 and 0.91 mm/year in the control and impact sites, respectively. These rates are not statistically different and are similar to those reported by Showman (1976).

LICHENS AS BIOMONITORS OF AIR POLLUTION. Fuller, Stephen W. and Nicole Lemieux\*, Mary Washington College, Fredericksburg, Va. 22401. A coal-fired power generation plant with selective catalytic reduction of pollutants is under construction in King George County, which is next to Stafford County, Va., an EPA designated non-attainment air pollution zone. Lichens on oak trees are being used as biomonitors of air pollution to determine if the powder plant emissions will have a measurable impact. Prior to power plant start up, 18 free standing oak trees greater than 40cm diameter, within an 20 km radius of the site were sampled; 15 lichen species were found. An Index of Atmospheric Purity (IAP) was derived which indicated that lichen stands in rural sites were more depauperate than those along a well used highway. As opposed to the findings of Pirintsos, et.al.(1993), higher IAP values were obtained at breast height than at the base in 8 of the 13 sites were basal studies were possible. However, statistical analysis indicates that there is no significant difference between the IAP's at the two heights.

THE GENUS *TETRACOCCLUS* IN NORTH AMERICA. W. John Hayden, Dept. of Biology, Univ. of Richmond, Richmond, Va. 23173. *Tetracoccus* is a genus of xerophytic shrubs native the southwest US and Mexico. Features of leaf morphology, staminate inflorescence, the gynoeceium, and seed structure prove useful in distinguishing five species which are: *T. ilicifolius*, endemic to the mountains around Death Valley; *T. dioicus*, an element of the coastal chaparral of southern California and northern Baja; *T. capensis* from the extreme southern Baja; *T. hallii* from the Sonoran Desert; and *T. fasciculatus* from the Chihuahuan Desert. Several small range extensions are noted since the last monograph of the genus, but all species remain fully allopatric. Contrary to indications in previous literature, some species of *Tetracoccus* prove to have biseriate perianth, i.e., both sepals and petals, a feature indicative of a relatively primitive position for the genus within subfamily Oldfieldioideae.

PHYLOGENETIC CONSTRUCTION WITH THE *matK* GENE: WALKING ALONG THE GENE. Khidir W. Hilu and Hongping Liang, Dept. of Biol., Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061. The surge in the application of molecular biology information to systematic and evolutionary questions has resulted in significant contributions to systematic biology. This paper addresses the utility of sequence variation in the *matK* gene for constructing phylogenies at and above the family level, and examines the rates, patterns and types of nucleotide substitutions in the gene. The results of this analysis were also used to address basic questions in plant molecular systematics and evolution such as sample size, number of characters (informative mutations), and weighting transversion mutations. The results underscored the high rate of substitution in the gene and the presence of mutationally conserved sectors. The use of different sectors of the gene and the cumulative inclusion of informative sites showed that the 3' region was most useful in resolving the phylogeny, and that the topology and robustness of the tree reached a plateau after the inclusion of 50 informative sites from that region. The potential use of partial sequencing provides the opportunity for increasing the sample size of the group at the expense of the number of nucleotides used. The presence of a relatively conserved 3' region and the less conserved 5' region provides two sets of characters that can be used at different taxonomic levels from the tribal to the division levels.

APPLICATION OF THE *matK* GENE SEQUENCE TO PHYLOGENY OF THE GRASS FAMILY (POACEAE). Hongping Liang and Khidir W. Hilu. Dept of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. 920 base pairs of the 3' region of the *matK* gene was sequenced from 39 grass species (Poaceae) representing 26 tribes and 6 subfamilies in order to investigate the circumscription and phylogeny of grass subfamilies and tribes. With *Joinvillea* (Joinvilleaceae) and *Flagelaria* (Flagelariaceae) as outgroups, the aligned sequences were analyzed by the Wagner parsimony and Neighbor-Joining Methods using PAUP and MEGA. Out of the 920 base pair used, 32% were variable and 15.2% were informative. Both parsimonious and strict consensus tree show well resolved major clades that represent the grass subfamilies. *Pharus* was basal to all grasses, and the Bamboisideae and Oryzoideae branched off after *Pharus*. Arundinoideae was the basal to the well resolved PACC group (Panicoideae, Arundinoideae, Centothecoideae, and Chloridoideae). The monophyly of the Chloridoideae was supported by both parsimonious and Neighbor-Joining trees. More variable 5' region of the *matK* gene might be needed to address the branching pattern at the tribal level.

TOXIC PRODUCING ALGAE IN CHESAPEAKE BAY. H. G. Marshall. Dept. of Biological Sciences, Old Dominion University, Norfolk, VA 23529-0266. In Chesapeake Bay, 12 potential toxin-producing species are identified, representing approximately 1.7% of the phytoplankton in the Bay. If historical records of 3 other toxin-producing species are included, this would represent 2.1% of the total (Marshall, 1994). Species recognized as toxin producers are diatoms *Amphora coffeaeformis*, *Pseudo-nitzschia seriata*, and *P. pseudodelicatissima*; dinoflagellates *Cochlodinium heterolobatum*, *Dinophysis acuminata*, *D. acuta*, *D. caudata*, *D. fortii*, *D. norvegica*, *Gyrodinium aureolum*, *Pfiesteria piscicida*, and *Prorocentrum minimum*. No major toxic blooms and fish kills have been produced in the Bay to date. The above species may represent non-toxin producing strains, or may lack the required environmental conditions for major bloom and toxin production. Early historical records of toxin producers also include *Alexandrium catenella*, *Gonyaulax polyedra*, and *P. multiseriis*. Supported in part by the Virginia Dept. of Environmental Quality and the EPA.

THE DISTRIBUTION AND ECOLOGY OF HARPER'S FIMBRISTYLIS (*Fimbristylis perpusilla*) IN VIRGINIA. Thomas J. Rawinski, Va. Dept. of Conservation and Recreation, Div. of Natural Heritage, Main Street Station, 1500 E. Main St., Suite 312, Richmond, Va. 23219. Harper's fimbriatylis (*Fimbristylis perpusilla*) is a globally rare annual sedge. The 10 Virginia populations of the species occur in seasonal ponds near Grafton in York County. Population size in 1995 ranged from a single plant to more than 10,000 individuals. Germination began with the onset of draw-down conditions, which occurred on or about 28 June at most of the ponds. Spikelet-bearing culms were evident on 6 July at the first pond to draw down, and on 27 August at one of the last ponds to draw down. Soils were mucky and strongly acidic, with an average pH of 3.7. *F. perpusilla* occurred within a community classified as the *Lindernia dubia-Eragrostis hypnoides-Panicum dichotomiflorum* Association. *Panicum verrucosum*, *Fimbristylis autumnalis*, and *Juncus repens* were the most frequent associates of *F. perpusilla*. At several ponds, most of the *F. perpusilla* plants were out-competed by larger annuals. Water returned to the ponds during late January, 1996, and presently water levels are much higher than during similar dates in 1995. Monitoring of the *F. perpusilla* populations will continue through 1996.

AFRICAN VIOLET ARTIFICIAL SEEDS. Michael H. Renfro, Dept. of Biology, James Madison University, Harrisonburg, VA 22807. Artificial seeds provide a means for mechanized field planting of clonally propagated plants. In addition, artificial seeds facilitate distribution and storage of select germplasm. Somatic embryos or shoot tips can be encapsulated in an alginate matrix to form an artificial seed. Shoot primordia were excised from African violet (*Saintpaulia ionantha*) and were encapsulated in alginate. The alginate drops containing shoot primordia were complexed for various times to determine the effect on shoot growth and emergence. Artificial seeds were planted on several media including two tissue culture media, vermiculite, and a peat-based potting medium. Complexing time had no effect on emergence within the times tested, which ranged from 30 to 75 min. Best growth was obtained from seeds planted on tissue culture media. The size, condition and ontogenetic stage of the embedded shoot tip had an effect on the subsequent growth. Results indicate that encapsulated shoots of African violet can serve as artificial seeds for this plant species that does not commonly form natural seeds.

CHLOROPLAST DNA RESTRICTION SITE VARIATION AND PHYLOGENETIC RELATIONSHIPS OF HELENIUM SPECIES. Andrew Rice, John Knox\* & Maryanne Simurda, Biol. Dept., Washington & Lee Univ., Lexington, VA. 24450. An initial survey of chloroplast DNA (cpDNA) polymorphisms for groups of 13 populations of the *Helenium autumnale* species complex is being done for a phylogeographic study. Grouping of the populations is based on morphological lineages revealed in our previous common garden studies. These groups include, one broad-leaved lineage of plants from Vermont and Virginia, and three narrow-leaved lineages from Canada, New Jersey, Missouri, and Virginia. The narrow-leaved lineage from Virginia has been treated by some as a global endemic, *H. virginicum*. Our morphological studies found *H. virginicum* to be scarcely distinct from the Missouri population, thus suggesting a disjunction in this lineage or a vicariance pattern between Virginia and Missouri.

Thus far, partial analysis of one single-copy region of the chloroplast DNA using 7 restriction enzymes have shown 24 restriction site changes in individuals of the *H. autumnale* populations and in individuals in the *H. virginicum* populations when compared with sites in the *Lactuca* chloroplast DNA. No significant differences among the populations have been detected.

A STAINING TECHNIQUE FOR THE ENUMERATION OF DINOFLAGELLATE CYSTS FROM NATURAL SEDIMENTS. David Seaborn. Dept. of Biological Sciences, Old Dominion University, Norfolk, VA 23529-0266. Natural sediment samples containing dinoflagellate cysts were obtained through the use of a box corer. The sediment samples were marked with the polysaccharide stain, primuline. Samples were observed under epifluorescence microscopy using a near blue light filter. The primuline stained samples were faster to enumerate, and more individuals were observed due to the fluorescence. Bloom samples from the Chesapeake Bay were also stained. The dinoflagellates that were successfully stained and identified included *Ceratium tripos*, *Gymnodinium splendens*, *Heterocapsa triquetra*, *Prorocentrum minimum*, and *Scrippsiella trochoidea*. The use of this stain may be a successful tool in mapping past dinoflagellate blooms and potential bloom areas before the blooms occur.

THE VIRGINIA PITCHER PLANT BOGS. IV. SEED DISPERSAL AND DISSEMINATION IN A SUFFOLK COUNTY POPULATION OF *SARRACENIA FLAVA* L. Philip M. Sheridan. Dept. of Biol., Virginia Commonwealth University, Richmond, Virginia 23284. A historic site for *Sarracenia flava* was rediscovered during 1983 in Suffolk County in depauperate condition. The bog had been mined for clay in previous decades and efforts were made to clear local vegetation to revive the colony. When these efforts failed forty rhizomes were relocated within the clay pits to open habitat on clay islands or shores within the extensive water-filled pits. After three years, flowering was observed and by 1991 several seedlings were found. Seedlings and young plants increased to 30 and 149 individuals by 1993 and 1996 respectively. Recruits were observed a maximum of 300 feet from parents and colonization occurred on exposed clay soils on islands and occasionally on slightly higher grassy ecotones. *Sarracenia* seeds are highly hydrophobic and it is hypothesized that this dissemination occurred through flotation or to a much smaller extent by adherence to the feet of migratory animals.

SYSTEMATICS OF BRACKEN FERN IN EASTERN U. S.: ISOZYMES AND MORPHOLOGY. William D. Speer, Khidir W. Hilu, Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061, & Charles R. Werth\*, Dept. of Biological Sciences, Texas Tech Univ., Lubbock, TX 79409. Bracken is the world's most common fern and one of the most common vascular plants. Although currently treated as a single species, *Peridium aquilinum* (L.) Kuhn, many systematists feel that the two bracken subspecies and perhaps some of its twelve varieties should be raised to the species rank. This study addressed this question by examining the two most common varieties in the eastern United States, var. *latiusculum* and var. *pseudocaudatum*, using isozymes and morphology. Fourteen isozyme loci were examined in ten bracken populations. The ten populations were very similar having a mean genetic identity of 0.973, which is in the range of values observed in angiosperms for conspecific populations. Possible gene flow between the two varieties was observed in one of the populations. Isozyme results were consistent with a single species treatment of the two taxa studied. Quantitative and qualitative characters were used both together and separately in the morphological study. Qualitative characters gave the best separation of the two taxa. Isozyme and morphological data indicate that these two taxa should be treated as two varieties of the same species.

HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY OF CHLOROPHYLLS AND CAROTENOIDS FROM MESOCOSM TANKS OF VARYING SIZE AND SHAPE. Carey P. Willey, Horn Point Environ. Lab., Cambridge, Md. and Dept. of Biol., Randolph-Macon Col., Ashland, Va. 23005. The Multi-scale Environmental Ecosystem Research Center project (MEERC) is a ten-year long experiment in which mesocosms were created in five different sized and shaped tanks and the tanks are monitored and sampled over time. The chlorophyll and carotenoid composition of filtered water samples from the mesocosms were analyzed by HPLC. The tanks were initially filled with Choptank River water, and 10% of this water was removed and replenished everyday. Data was collected for two experiments; the first in spring 1994 and the second following a nutrient enrichment in summer 1994. The Choptank River, an estuary of the Chesapeake Bay, was sampled and correlated with the monitored activity in the tanks. The concentrations of signature pigments were used with chlorophyll a/pigment ratios characteristic of different algal classes to derive the composition of phytoplankton in the tanks. Diatoms and cyanobacteria made up most of the biomass of the tanks based on ratios to chlorophyll a concentration. A negative correlation between bloom and decline was observed among populations of diatoms and cyanobacteria in most tanks. Dinoflagellates declined drastically in all experimental tanks except for Choptank, where peridinin contributed largely to the chlorophyll a concentration. This is opposite from the experimental tanks, where diatoms contributed significantly to chlorophyll a concentration. Nitrate data was obtained to explain the inverse relationship of diatoms and cyanobacteria. The two pigments appeared to compete for the available nitrate. Replication between tanks of the same set was analyzed, and the larger diameter tanks had better replication.

## Chemistry

METAL-TEMPLATED SYNTHESIS AND CHARACTERIZATION OF LANTHANUM(III) COMPLEXES OF PERIPHERALLY MONO-SUBSTITUTED SIX-NITROGEN DONOR MACROCYCLIC LIGANDS. A. M. Adeyiga(\*), Chemistry Department, Bennett College, Greensboro, NC 27401 and L.M. Vallarino, Chemistry Department, Virginia Commonwealth University Richmond, VA 23284. The synthesis of lanthanum(III) complexes of six-nitrogen-donor macrocyclic ligands with a single peripheral substituent was investigated using three related approaches: (1) Direct mixed template synthesis, consisting of the lanthanum(III)-templated cyclic Schiff-base condensation of 2,6-diacetylpyridine with a mixture of 1,2-diaminoethane and a carbon-substituted diamine,  $H_2N-CH_2-CH(R)-NH_2$ , in a 2:1:1 ratio; (2) Treatment of a pre-formed non-substituted La(III) macrocyclic complex with a carbon-substituted diamine in a 1:1 ratio, under conditions designed to promote transamination; and (3) Two-step synthesis, consisting of the acid-catalyzed Schiff-base condensation of 2,6-diacetylpyridine with 1,2-diaminoethane in a 2:1 ratio, to produce a (non-substituted) open-chain diimine-diketone, followed by a lanthanum-templated ring-closure reaction with a carbon-substituted 1,2-diaminoethane. The latter approach was successful and six mono-substituted species,  $\{La(C_{22}H_{25}N_6(R))\}^+$ , in which R is  $-CH_3$ ,  $-CH_2OH$ ,  $-C_6H_5$ ,  $-CH_2-C_6H_5$ ,  $-CH_2-C_6H_4-OH$  and  $-CH_2-C_6H_4-NH_2$ , were obtained in 60-75% yields. (Supported by Coulter Electronics, Hialeah, FL, Newport Instruments, San Diego, CA, and Virginia Commonwealth University, Richmond, VA.)

CONSTITUTIONAL AND STERIC ISOMERISM IN COMPLEXES OF La(III) WITH DI-METHYL-SUBSTITUTED SIX-NITROGEN-DONOR MACROCYCLIC LIGANDS. F. Benetollo(\*), I.C.T.I.M.A. - C.N.R., Padova, Italy, G. Bombieri(\*), Istituto di Chimica Farmaceutica, Universita' di Milano, Milano, Italy, K.M. Samaria(\*) and L.M. Vallarino, Virginia Commonwealth University, Richmond, VA 23284. Complexes of symmetrically di-substituted macrocyclic ligands,  $C_{22}H_{24}N_6(X)_2$ , can be synthesized by the lanthanide-templated 2:2 Schiff-base condensation of 2,6 diacetylpyridine and a carbon-substituted 1,2-diaminoethane,  $NH_2-CH_2-CH(X)-NH_2$ . These complexes can exist as two constitutional isomers, depending on whether the two -X substituents are adjacent to the same pyridine bridge-head or to opposite pyridines. Stereoisomers are also possible owing to the chirality of the carbon-substituted diimine side-chains. A study using La(III) acetate and (S)-1,2-diaminopropane as one of the precursors gave the two expected constitutional isomers in approximately 1:1 ratio, while the (R,S)-diamine gave three isomers in ratios that depended on the experimental conditions. The isomeric complexes were distinguished by their different proton nuclear magnetic resonance spectra and were separated by fractional crystallization. Substitution of the acetate counterions by thiocyanates gave well formed crystals for the isomers containing the (S,S)-5,15 and (R,S)-5,15 dimethyl-substituted macrocycle; their X-ray crystal structures are presented. (Supported by Coulter Electronics, Hialeah, FL, Virginia Commonwealth University, Richmond, VA, and N.A.T.O. Bilateral Project No. 184-85.)



ISOLATION OF PHENYLPROPANOID GLYCOSIDES FROM *POLYGONUM PENNSYLVANICUM*. Laverne L. Brown, Michael L. Zimmermann, and Albert T. Sneden, Dept. of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006. The isolation of the protein kinase C inhibitors, vanicoside A and vanicoside B, from *Polygonum pensylvanicum* prompted continued interest in the active principles of this plant. A new, more efficient isolation procedure has been developed to facilitate separation of homologues of vanicosides A and B from the complex extract. This procedure involves the use of preparative hplc to concentrate principles of interest into less complex fractions, followed by the use of preparative TLC for final purification. This has resulted in the isolation of two new phenylpropanoid glycosides. The structures of these principles are being determined using  $^1\text{H}$ ,  $^{13}\text{C}$ , and two-dimensional NMR techniques. The results of these investigations will be discussed.

CHEMISTRY AND OTHER HANDS-ON ENGINEERING AND SCIENCE IN A SUMMER CAMP FOR GIRLS. Kathleen Brunke, Biology, Chemistry, and Environmental Science; Shelia Greenlee\*, Psychology; and Lynn Lambert, Physics and Computer Science, Christopher Newport University, Newport News, VA 23606. A three-week, semi-residential, summer science camp for 24 middle school girls at Christopher Newport University included a variety of activities, including field trips; career counseling; visits from local scientists; engineering and technology sessions; and hands-on science activities. The NSF-supported project was intended to encourage girls to consider science as a career; the science activities were therefore central to the program. Christopher Newport University female professors in Biology, Chemistry, Mathematics, and Physics led the fourteen hour and a half hands-on science sessions with topics ranging from binary numbers to comparing human and dinosaur stride length to designing a solar home. Chemistry sessions included measuring greenhouse gases, Chemistry and food, and making polymers. In each session, concepts were taught by doing. For example, in the "Greenhouse Gases" session, girls measured methane from wetland plants and from their own breath and talked about greenhouse gases (including the role of methane) thus learning about the greenhouse effect, the ozone hole, and the importance of wetlands. In "Polymers," they made gak, learned the recycling symbols, and looked at the detrimental effect of household solvents on some polymers. In the "Food Chemistry" session, they made ice cream to demonstrate freezing point depression. Evaluation of the project indicates that knowledge of and interest in science increased significantly as a result of the camp. Anecdotal evidence given by the girls and their parents in two follow-up sessions strongly supports these results. (This work supported by NSF grant number HRD-9453678)

PREPARATION OF DERIVATIVES OF VANICOSIDES A AND B, PHENYLPROPANOID GLYCOSIDES FROM *POLYGONUM PENNSYLVANICUM*. Jean-Michel Campagne and Albert T. Sneden, Dept. of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006. Vanicosides A and B, two phenylpropanoid glycosides isolated from *Polygonum pensylvanicum*, were shown to inhibit the activity of protein kinase C, an enzyme involved in cell proliferation. These glycosides are characterized by the presence of three *p*-coumaryl esters and one feruloyl ester on a sucrose backbone. In order to begin to determine the structure activity relationships in this family of glycosides, a series of derivatives of the glycosides are being prepared. Both an octaacetate derivative and a heptaacetate derivative have been prepared. Selective acetylation of the hydroxyl moieties present on the sucrose backbone and selective methylation of the phenolic groups are being explored. Hydrogenation of the conjugated double bonds of the phenylpropanoid groups proceeded smoothly. The conditions for and results of these conversions will be discussed.

CONVERSION OF ISOFLAVANONES INTO ISOFLAVONES BY Pd CATALYZED DEHYDROGENATION. Jean-Michel Campagne, Jennifer L. Dubois, Yodit Geberemedhin, and Albert T. Sneden, Dept. of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006. Seven isoflavanoids have been isolated from the Peruvian plant *Swartzia polyphylla* in our laboratory. Of these, only the isoflavone biochanin A proved to inhibit the activity of protein kinase C. The major difference between biochanin A and the other isoflavanoids was the C-2,3 double bond found in biochanin A. To determine if this double bond was required for inhibition of protein kinase C activity, we have attempted to convert the isoflavanones into isoflavones using Pd catalyzed dehydrogenation. The reaction works smoothly on those isoflavanones which do not contain a 2'-phenol, but fails on those isoflavanones which do contain this moiety. To further explore the requirements for this dehydrogenation, several isoflavones have been converted to the corresponding isoflavanone. These isoflavanones will then be converted back into the isoflavone by Pd catalyzed dehydrogenation. The conditions for and results of these conversions will be discussed.

QUANTUM MONTE CARLO SOLUTION OF ONE-DIMENSIONAL POTENTIALS: INVERSION OF  $\text{NH}_3$ . Charles M. Castevens and Donald D. Shillady, Department of Chemistry, Virginia Commonwealth University, Richmond VA 23284-2006.

A brief review of recent developments in the calculation of very accurate energies and properties of molecules, including transition states, using electronic Quantum Monte Carlo methods is presented. A one-dimensional Electronic Diffusion Monte Carlo method is used to solve the double-well potential for  $\text{NH}_3$  yielding good agreement with the known analytical solution within the context of a non-variational energy value and a statistical variance. Hartree-Fock-Roothaan SCF energies are also given in a multi-zeta STO-6G basis for C3v  $\text{NH}_3$  (-56.18988997 au) and D3h  $\text{NH}_3$  (-56.18651139 au) giving an estimate of the inversion barrier of 2.12 kcal/mole.

THREE-IN-ONE POLARIMETRY EXPERIMENT FOR PHYSICAL CHEMISTRY LABORATORY. Kelly Christopher and Donald D. Shillady, Department of Chemistry, Virginia Commonwealth University, Richmond VA 23284-2006.

An experiment is described which measured (1) the kinetics of sucrose hydrolysis, (2) purity of commercial sucrose and (3) magnetically induced optical activity (Faraday Effect). A vernier degree ring (readings to +/- 0.1 degree) from an earlier model (No. 7025) was adapted to a Griffin polarimeter. Richfood sugar was found to be 92-98 % sucrose +/- 3%. The Nestler tube pathlength was uncertain by 2.7%. The solenoid was found to average 245 gauss along a 15 cm path at 12 amperes by calibration with pure  $\text{CS}_2$ , as given by Pedrotti and Bandettini in Am. J. Phys. v58, p542, (1990). Neat methyl salicylate and N,N-diethyl aniline allowed measurable Faraday rotations and were transparent for use of human-eye detection. Aqueous NaI and KI solutions produced linear dependence of Faraday angle at 4M, 3M and 2M.

THE INFRARED SPECTRA OF  $\text{VOCl}_3$  AND  $\text{POCl}_3$  AT MODERATE RESOLUTION

Thomas C. DeVore, Dept. of Chem., James Madison Univ., Harrisonburg, VA 22807

The infrared spectra of the  $\text{VOCl}_3$  and the  $\text{POCl}_3$  gaseous molecules have been obtained from 4000 to  $400\text{ cm}^{-1}$  at  $0.125\text{ cm}^{-1}$  resolution. Previously unobserved isotopic structure was observed for  $\nu_1$  and isotopic structure was partially resolved for  $\nu_2$  and  $\nu_4$ . Several overtone and combination frequencies that were identified by using high sample pressures. Analyses of these bands enabled the harmonic frequencies for the fundamentals and several of the anharmonic correction constants to be determined. A revised symmetry adopted force field calculated using the harmonic frequencies indicated that the bonds in these molecules are slightly stronger than the force fields presented by Filgueira had indicated.

## A NEW COMPETITIVE ENZYME IMMUNOASSAY OF (+)-CATECHIN IN HUMAN BLOOD SERUM.

Jay Fedorowicz, James Yuan and Roy Williams, Old Dominion University

Enological Research facility, Dept. of Chemistry/Biochemistry, Old Dominion Univ., Norfolk,

VA 23529. (+) Catechin is the parent compound of a very special class of polyphenolic agents

found in a variety of fruits, seeds, wine and tea. These polyphenolics have been described as

potent free radical scavengers or natural antioxidants and are considered as positive health

factors in the human diet. High pressure liquid chromatography (HPLC) is the most common

method used for the quantification of (+)-catechin levels from natural sources. This paper will

describe the development of a new competitive enzyme immunoassay method (EIA), which is

very sensitive and offers considerable advantages over HPLC. The paper will describe the

method used to develop the polyclonal antibody to a newly synthesized immunogen from (+)-

catechin. The method has been shown to quite effective with a detection limit of  $10\text{pM}$  (+)-

catechin and very little cross reactivity with the epimer (-) epicatechin. This new EIA method

is some 5 orders of magnitude more sensitive than the previously used HPLC method and should

be extremely helpful in the study of the absorption and protein binding of (+)-catechin *in vivo*.

## ELECTROSPRAY IONIZATION FOR MASS SPECTROMETRY OF LARGE

MOLECULES, John B. Fenn, Joan Rosell, Dongliang Zhan, and

Jian-Ru Cao, Department of Chemistry, Virginia Commonwealth

University, Richmond, VA23284-2006. Electrostatic dispersion of

sample solution results in a fine spray of highly charged

droplets from which intact ions of very large and complex

molecules can be formed for mass spectrometric analysis. The

mechanism by which such ions are formed is still a subject

of much debate. Meanwhile, new results keep putting proposed

mechanisms on the defensive. We present some such results

and speculate on their mechanistic implications.

FUNGI DYNAMICS: DEGRADATION OF MODIFIED CELLULOSE FILM. Christopher Foust<sup>1</sup>, Richard Mills<sup>1</sup> and Raphael

Uittenbrite<sup>2</sup>, Depts. of Biology<sup>1</sup> and Chemistry<sup>2</sup>, Va. Commonwealth Univ., Richmond, Va. 23284. An alternative strategy is

needed for plastic degradation in landfills to replace ultra violet photodegradable plastics which undergo minimal ultraviolet

degradation due to mixing and additional layers of refuse applied to the surface which effectively arrests degradation. Cellulose

occurs in a significant proportion of most consumer plastics and numerous strains of fungi are capable of utilizing cellulose

as a carbon source. Fungi also persist in the upper and middle strata of landfills.

A novel cellulose-polyethylene blend polymer film was developed in the Chemistry Department of Virginia Commonwealth

University for degradative susceptibility to brown rot or cellulasic fungi. Naturally occurring fungi were harvested from decaying

wood and cultured on full nutrient agar until individual phenotypes developed. The discrete fungal morphs were removed and

repeatedly placed on new agar plates until pure fungal strains persisted. Individual strains were transferred to Bacteriological

agar with carboxymethyl cellulose as the only carbon source. Surviving fungi were subjected to an indirect cellulase assay to

confirm cellulolytic properties. Taxonomic identification included examinations with scanning electron microscopy and optical

microscopy, using the Saccardo system of classification. Prepared modified films were cut into 1mm sample discs and placed

on growth-phase fungal colonies and incubated at 30 °C. The polymer discs were transferred to new-growth colonies every 21

days. Scans scanning electron photomicrographs documented physical degradation of the polymers when exposed to fungi over

time.

The results showed 100% surface area growth of low density polyethylene (LDPE) blended with cellulose (12:1 respectively)

by *Trichoderma viride* in 90 days. Extrapolation showed 100% growth coverage by *Gliomastix sp.* on blends of LDPE/cellulose

130:1, and 70:1, in 180 days. These data are conservative, and rates of growth can be increased substantially by the addition

of a nitrogen source and/or synergistic fungi. Incorporation of the properties of this polymer film to high-turnover packaging

such as barrier plastics and consumer food product containers would be a significant reducer of global landfill volume over

time.

A STUDY OF THE AGGREGATION BEHAVIOR OF OLIGOPEPTIDES WITH DRUGS M.Haratake, R.Zhao & R.M.Ottenbrite, Department of Chemistry, Virginia Commonwealth University

We characterized the self-aggregation and the subsequent sphere formation behavior of the acid tri- and tetrapeptides (pyroEE( $\alpha$ )F, pyroEE( $\gamma$ )F and pyroEE( $\alpha$ )F( $\gamma$ )F) by light scattering and light microscopy. The tripeptides did not produce aggregates up to 0.1 M at pH 2. On the other hand, pyroEE( $\alpha$ )F( $\gamma$ )F aggregated at relatively low concentration (11.8 mM). The pyroEE( $\alpha$ )F( $\gamma$ )F associated with the drug molecules, such as insulin and bovine serum albumin, below the concentration at which the aggregation occurred. Whether the pyroEE( $\alpha$ )F( $\gamma$ )F was associated with drugs or not, the same concentration of unassociated pyroEE( $\alpha$ )F( $\gamma$ )F was necessary to achieve aggregates. Only the pyroEE( $\alpha$ )F( $\gamma$ )F produced spheres in the presence of protein drugs tested.

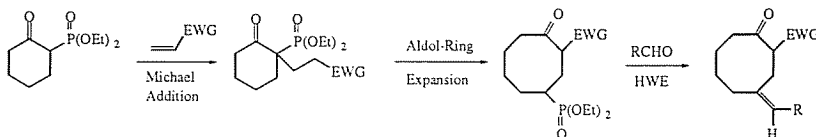
CATALYTIC ASYMMETRIC CYCLOPROPANATION BY CHIRAL METAL SALEN COMPLEXES. H. Brooks Hooper & Marcia B. France, Dept. of Chem., Washington and Lee Univ., Lexington, Va. 24450. The cyclopropane functionality is of great importance to organic chemistry. Found in a variety of natural compounds and of utility in many synthetic organic pathways, asymmetric cyclopropanes have generated widespread interest. This interest has manifested itself in a variety of asymmetric cyclopropanation catalysts. These existing catalysts have proved very effective for many reaction schemes, but a catalyst system with broad substrate generality affording high enantioselectivity remains unknown. The literature describes the preparation of several chiral rhodium(III) porphyrin complexes, but these catalysts display only moderate enantioselectivity. The salen ligand is structurally similar to the porphyrin, but possesses chiral centers closer to the coordination site, potentially affording greater stereochemical control. Several rhodium and copper salen complexes have been prepared and their ability to catalyze the desired reaction is currently under investigation. These preliminary studies have, to date, been carried out with readily available and less expensive salen derivatives.

ADSORPTION OF ZINC AND LEAD ON ALUMINIUM OXIDE AT VARIOUS pH AND IONIC STRENGTH. Anael Kimaro and Wing H. Leung, Dept. of Chemistry, Hampton Univ. Hampton, VA 23668. The adsorption of trace elements from the aquatic environment is controlled by processes that occur at the solid / liquid interface. Adsorption of zinc and lead from dilute solutions onto aluminium oxide has been investigated as a function of pH and ionic strength. The result of the adsorption experiments were fitted to Langmuir and Freundlich isotherms. Over the pH range studied (pH 5-8 ) results suggest that adsorption of zinc and lead onto aluminium oxide increases with pH and decreases with increase of ionic strength. Adsorption mechanism is also briefly discussed.

NEW ANGLES IN AEROSOL ANALYSIS. Pavel Kiselev, Joan Rosell and John B. Fenn, Department of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006. In many volatile aerosols one desires to track experimentally the composition of an evaporating droplet. We have developed a probe which allows the very rapid sampling of charged volatile droplets at various positions in a spray. The sampled liquid is then analyzed, for example by Gas Chromatography or Mass Spectrometry. Sprays of chloroform-acetone and of chloroform-alcohol mixtures have been studied. Enrichment of the less volatile component is found, indicating rapid mixing within the droplet. Although the present experiments depend on electrostatic forces to drive droplets to the probe, one could achieve equivalent results with inertial "forces".

RING EXPANSION REACTIONS OF ORGANOPHOSPHORUS COMPOUNDS. Sherry R. Kite and Suzanne M. Ruder\*, Department of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006.

Highly functionalized medium sized rings are commonly found in the structures of many natural products that possess biological activity. The intent is to develop new methodology for synthesizing medium sized rings from smaller ring precursors containing a phosphonate functionality. Addition of a side chain via Michael addition, followed by incorporation of the side chain into the ring results in ring expansion to provide a medium sized ring. These ring enlarged products containing a phosphonate group, could subsequently be transformed to an alkene by the Horner-Wadsworth-Emmons (HWE) reaction, to provide the carbon framework of a number of natural products.



COMPARATIVE PREPARATION OF ZINC OXIDE NANOPARTICLES. Shoutian Li\*, M. Samy El-Shall and S. Silvers, Dept. of Chem., Va. Commonwealth Univ., Richmond, Va. 23284-2006. The ZnO nanoparticles were prepared by wet chemical method and laser vaporization/condensation technique. In the wet chemical method, the ZnO nanoparticles were coated with a monolayer of stearic acid molecules. The crystal structure of ZnO nanoparticles is same as the bulk ZnO crystal. The particles are spherical and about 10 nm in size. Quantum size effect is observed in the UV-vis spectra of the samples prepared by the wet chemical method. The photoluminescence spectra show the bandgap emission (380 nm) and trap state emission (520 nm). In the trap state emission, the lifetime depends on the emission wavelength, i.e., longer the emission wavelength, longer the lifetime.

THE PREPARATION OF WEBLIKE AGGLOMERATION OF SILICON NANOPARTICLES AND THE STUDY OF THEIR OXIDATIVE PROPERTIES BY FTIR. Shoutian Li\* and M. Samy El-Shall. Dept. of Chem., Va Commonwealth Univ., Richmond, Va. 23284-2006. The Silicon nanoparticles were prepared in a diffusion cloud chamber by laser vaporization/condensation. The Si nanoparticles form weblike agglomeration in three dimensions and are about 10 nm in size. The FTIR spectrum of the as-deposited sample shows three IR bands:  $1100\text{ cm}^{-1}$  (very strong),  $887\text{ cm}^{-1}$  (weak) and  $460\text{ cm}^{-1}$  (strong). The oxidation of the as-deposited sample can be achieved by either storing the sample in air or heating in an oven. As the sample is oxidized, the  $887\text{ cm}^{-1}$  peak disappears, and the  $800\text{ cm}^{-1}$  peak is generated and both the  $1100\text{ cm}^{-1}$  and  $460\text{ cm}^{-1}$  bands shift to higher energy vibrations.

AN INVESTIGATION ON THE INTERACTION OF HEPARIN WITH AROMATIC COMPOUNDS, J. Liao<sup>(a)</sup>, R. Zhao<sup>(a)</sup>, J. N. Scarsdale<sup>(b)</sup>, S. Miistein<sup>(c)</sup> and R. M. Ottenbrite<sup>(a)</sup> (a) High Technology Materials Center, Department of Chemistry, Virginia Commonwealth University, Richmond, VA 23284; (b) Department of Biochemistry and Molecular Biophysics, Medical College of Virginia, Virginia Commonwealth University, Richmond, VA 23298; (c) Emisphere Technologies, Inc., 15 Skyline Drive, Hawthorne, NY 10532. Heparin is well known for its therapeutic use as an anticoagulant agent. Clinically it has to be administered via injection since the molecular structure, along with its biological activities, is sensitive to the components in the gastrointestinal tract. Recently a number of low molecular weight aromatic compounds were found to facilitate transport of heparin across the gastrointestinal epithelium and facilitated the oral delivery of heparin to rats and primates. In this work, the interaction of heparin with the aromatic compounds was investigated by using heparin affinity chromatography, equilibrium dialysis, circular dichroism and two-dimensional NOESY spectroscopy. It was observed that the interaction of heparin with the aromatic compounds is mainly hydrophobic and may induce a change in heparin conformation.

GAS PHASE REACTIONS OF IONIZED AROMATICS CONCERNED WITH OLEFIN DIMERIZATION, Yezdi B. Pithawalla, M. Meot-Ner (Mautner), J. Gao and M. Samy El-Shall. Dept of Chemistry, Virginia Commonwealth Univ, Richmond., Virginia 23284.

Rates of endothermic charge transfer reactions are enhanced by orders of magnitude when concerted with covalent bond formation. The ionization potential of toluene (T) is lower than that of the isobutene (I) by 0.3 eV, hence direct charge transfer from  $T^+$  to I is endothermic and has a reaction efficiency of  $\leq 10^{-5}$ . However, the overall exothermic three-body reaction of charge transfer concerted with condensation,  $T^+ + 2I \rightarrow I_2^+ + T$  is observed with an efficiency that is enhanced, in comparison, by a factor of  $10^3$ , leading to nominal second-order forward rate coefficients of  $5 - 25 \times 10^{-11}\text{ cm}^3\text{s}^{-1}$ . Unusual pressure effects imply that after the excited complex ( $T^+I$ ), a collisionally stabilized intermediate complex ( $T^+I$ ) is formed, which undergoes unimolecular rearrangement to a covalent adduct, in competition with a reaction giving  $I_2^+$ . Concentration effects along with temperature and simulation studies also support the formation of the collisionally stabilized intermediate complex. Potential applications involve understanding anodic electrochemical polymerization of olefins, channeling chemical reactivity and photo-induced initiation in the condensed phase.

A NEW APPROACH TO THERMODYNAMICS. L.J. Sacks, Dept. of Biol., Chem. and Environ. Sci., Christopher Newport Univ., Newport News, VA 23606. Accepting the definition of "energy" as the ability to do work changes the entire structure of thermodynamics theory, allowing three sequential Principles to replace the current three unrelated Laws. These reflect the experience that (1) Energy transfer is quantitative; (2) All processes are accompanied by a loss of energy; and (3) The energy required to displace a system from equilibrium is proportional to the displacement. Implementing the first principle is the recognition that work can only be done on a second system (which can be considered the reference system for determining the energy transfer), hence energy is not a property of any system but of the system, the surroundings with which it is to interact, and the nature of the energy transfer process. This approach conflicts directly the concept of energy conservation and eliminates the need for an entropy function, substituting directly driving forces of temperature, pressure of field differences; development is similar to that for electrochemical potentials.

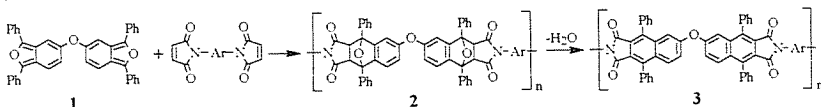
MAGNETIC CIRCULAR DICHROISM OF MELATONIN IN HELICAL POLY-L-GLUTAMATE. Alexis Warner, Charles M. Castevens, P. Ross and D. Shillady, Department of Chemistry, Virginia Commonwealth University, Richmond VA 23284-2006.

Recent discovery of a G-protein receptor for melatonin by Morgan and the tertiary structure of seven (nearly parallel) alpha helices common to G-protein structures led to consideration of measuring the MCD of melatonin in a solution of known helices. CD and MCD spectra of melatonin in solutions of Poly-L-Glutamate of 15,000 M.W. proved to be so characteristic of alpha-helix that data processing of up to eight spectral scans could not determine separate features due to melatonin. Improved calculations using a STO-6G\*\* basis in the GAMESS program permitted geometry optimization of melatonin in the presence of eight water molecules to within  $8.0E-6$  hartrees/bohr. A CNDO/S-D calculation using 99 single-excitations produced MCD band assignments with correct signs at 318 nm (amide n-pi\*), 287 nm and 253 nm in qualitative agreement with experiment.

3-METHYLINDOLE DIMERS WITH ALKYL SULFONIC ACIDS. Wayne M. Stalick and George W. Mushrush, Dept. of Chem. George Mason Univ. Fairfax, VA. 22030. Diesel fuels contain small amounts of polar nitrogen, oxygen and sulfur compounds, and many of these have been implicated in the storage instability of fuels. Analysis of various middle-distillate fuel extracts has shown that the fraction which forms the most sediment contains the largest concentration of alkylindoles. It has been proposed that sediment formation results from the interaction of the heterocyclics with acids in the fuels. 3-Methylindole, when added to a fuel, was found to be a good promoter, whereas other nitrogen heterocycles such as 2,5-dimethyl quinoline and 2-picoline were innocuous. Analysis of the sediments show no incorporation of carboxylic acids, however, sulfonic acid incorporation is quite evident. The sediments formed from 3-methylindole and dodecylbenzene sulfonic acid (DBSA) are quite similar to insolubles formed in diesel fuel and appear to be dimers of 3-methylindole complexed to DBSA. Determination of the structure was difficult so 3-methylindole was also reacted with *p*-toluene sulfonic acid and *p*-ethylbenzene sulfonic acid to give similar but less complex products for structural analysis.

PHYTOCHEMICAL INVESTIGATION OF *POLYGONUM PERFOLIATUM*. Xingzhong Sun, Michael L. Zimmermann, and Albert T. Sneden, Dept. of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006. The isolation of the protein kinase C inhibitors, vanicoside A and vanicoside B, from *Polygonum pensylvanicum* prompted investigation of extracts of other *Polygonum* species for related compounds. One of these species is *Polygonum perfoliatum*, also known as speed weed or mile-a-minute plant. Examination of the hplc chromatogram of the extract of *P. perfoliatum* indicated that phenylpropanoid glycosides related to the vanicosides should be present in this plant. The active principles of this plant. The extract was fractionated by standard chromatographic techniques. This resulted in the isolation of the known steroid,  $\beta$ -sitosterol, as well as several more polar principles. The structures of these principles are being determined using  $^1\text{H}$ ,  $^{13}\text{C}$ , and two-dimensional NMR techniques. The results of these investigations will be presented.

AN APPROACH TO POLYIMIDE SYNTHESIS VIA DIELS-ALDER POLYMERIZATION OF A BISISOBENZOFURAN AND VARIOUS BISMALIMIDES. Kent A. Watson and R.G. Bass. Dept. of Chemistry, Box 842006, Virginia Commonwealth Univ., Richmond VA 23284-2006. As part of a continuing program to develop high performance/high temperature polymers for potential use as composites and adhesives in various aerospace applications, an approach towards polyimide synthesis via a Diels-Alder reaction was investigated. A novel bisdiene, 5,5'-oxybis(1,3-diphenylisobenzofuran) (1) was synthesized and reacted with various bismaleimides via the Diels-Alder reaction. The resulting product 2 was dehydrated using a catalytic amount of sulfuric acid resulting in the fully aromatic system 3. Low molecular oligomers were formed by this process as evidenced by inherent viscosities ranging from 0.15 - 0.17 dL/g for the dehydrated products. Despite low molecular weight products being formed, the materials exhibited enhanced solubility characteristics, presumably due to the incorporation of pendant phenyl groups along the oligomer backbone. This method of polymerization potentially avoids the formation of a polyamic acid intermediate, thereby eliminating the processing problems associated with the conventional method of polyimide synthesis. Optimization of this reaction to produce higher molecular weight polymers is currently being investigated.



#### TRANS AND CIS-RESVERATROL: THEIR POTENTIAL BIOLOGICAL ACTIVITY.

R.L. Williams, and Mark Elliott, Old Dominion University Enological Research Facility, Dept. of Chemistry/Biochemistry, Old Dominion University, Norfolk, VA. 23529. The phytoalexin known as trans-resveratrol (trans-3,4',5'-trihydroxystilbene) has been described as an effective natural antioxidant found in low concentrations in red wine. We have now shown that this compound is also a potent anti-estrogenic agent. This estrogenic activity is associated with the compound's ability to bind effectively to both the type I and the type II estrogen receptors. An examination of the structure activity relationships(SAR) of trans-resveratrol and other estrogenic agents will be discussed together with information that would suggest that certain of the estrogenic activity may be due to a rapid equilibrium between the trans and cis forms of this compound. Information from a molecular modeling study of these two agents and other estrogenic agents will be presented.



**SYNTHESIS OF POLYMETHYLSILOXANE PARTICLES (I) UNHYDROLYZED ETHOXIDE GROUPS ON POLYMETHYLSILOXANE PARTICLES**

R. Yin, R. M. Ottenbrite, Dept. of Chem, Va Commonwealth Univ., Richmond, Va 23284, J. A. Siddiqui, ICI Film, Bermuda Hundred, Hopewell, Va 23860. A simple approach was explored in our laboratory to achieve the synthesis of hybrid particles by using methyl triethoxysilane (MTEOS) as a monomer. The TGA traces of MTEOS particles indicated that three weight loss regions were related to three distinctly different reaction processes. The first weight loss was ascribed to the alcohol condensation of unhydrolyzed ethoxide groups which was directly affected by ammonia concentration and  $r$ -value ( $r = \text{H}_2\text{O}/\text{Si}$ ). There was a large amount of unhydrolyzed ethoxide remaining in the MTEOS particles when a low ammonia or water concentration was employed in sol-gel process. Dehydrolysis rate was more dependent upon the  $r$ -value than the ammonia content in reaction system. The average number of unhydrolyzed ethoxide group is approximately 1 per parent silicon atom. The unhydrolyzed ethoxide groups may be attributed to reesterification.

**AN INVESTIGATION OF OLIGOPEPTIDES INTERACTION WITH HEPARIN.** R. Zhao, M. Haratake & R. M. Ottenbrite, Department of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006. Based on a proteinoid microsphere oral drug delivery system reported earlier, several series of specifically sequenced oligopeptide trimers and tetramers were synthesized and their interaction with heparin, a popularly used anticoagulant, were investigated. It was found that one of the oligopeptide tetramers, which contains aromatic rings, was bound to heparin stronger than the others at low pH. Further research indicated that this interaction is due to H-bonding and hydrophobic interactions. Currently, this carrier is being tested in vivo with heparin.

## Computer Science

**VIRTUAL REALITY MODELING LANGUAGE.** Peter R. Clark, Department of Computer Science, Mary Washington College, Fredericksburg, VA 22401. Virtual Reality Modeling Language (VRML) is an object-oriented programming language designed to bring a three-dimensional interface to the World Wide Web. The current version (1.0) of the language provides a means to both define static objects within a three-dimensional scene and link these objects to other files on the Internet. These scenes are displayed and browsed using either VRML-specific browsers, or plug-ins for current HTML browsers such as Netscape. Users can design worlds either by coding VRML with a standard text-editor or by using a 3D modeling program that supports the VRML 1.0 file type.

Liquid Reality, designed by Dimension X, Inc., is a set of Java classes that programmers can use to extend VRML beyond its original specification. Users may animate objects, handle events, and even create multi-participant scenes. To date, VRML has been used in creating both recreational and informational environments, such as Worlds, Inc.'s AlphaWorld: users may walk around a virtual community with the ability to interact with other citizens and even build virtual homes.

INTERFACING POLAROID SONAR SENSORS TO A 6.270 MICROCONTROLLER BOARD. Dan Werner, & Dr. Rhonda Eller-Meshreki, Department of Computer Science, Randolph-Macon College, Ashland, VA 23005. We began building an interface between a Polaroid sonar transducer and a 6.270 microcontroller board with a 68HC11 microprocessor chip. We initially chose Interactive C to create programs that would drive the sonar transducer. However, the low-level details of interacting with this hardware conflicted with the internals of the Interactive C package. Therefore, we began writing 68HC11 assembly programs which could deal with the low-level details of the hardware in assembly but interface with Interactive C programs through function calls. We wrote assembly code using the 68HC11's Input Capture mechanism with a bumper sensor to simulate receiving the sonar echo. This was accomplished by tying the code for polling the bumper sensor to the Interactive-C system interrupt. Whenever the bumper was pressed, the time of this action would be saved in a hardware register. This register could be checked later to find out how much time had elapsed from the start of the program execution to the time recorded when the bumper was pressed. This mechanism can be used for determining the time that a sonar transducer echo was received by hardware. This time can then be used to compute the distance of the object from which the echo signal reflected. We will present the details of the simulated sonar echo and our ideas on how we hope to overcome the difficulties encountered with the physical sonar transducer during our work.

A SERIAL INTERFACE FOR A WORTHINGTON BAR CODE READER AND A 6.270 MICROCONTROLLER BOARD. Adam Rabung, Department of Computer Science, Virginia Polytechnic Institute and State University, Blacksburg, VA, & Dr. Rhonda Eller-Meshreki, Department of Computer Science, Randolph-Macon College, Ashland, VA 23005. The robot that we considered is a LEGO robot controlled by an MIT 6.270 microcontroller board using the Interactive C programming language. The goal of this project was to program a full serial interface between these two hardware devices. Serial communication between the microcontroller board and the laser barcode reader can be done using either interrupt-driven methods or polling. With polling, the software continuously checks its serial port to see if any data has been scanned by the bar code reader. While this is simpler to program, it is restricting in that the processor is wasting a lot of time in a tight loop waiting to receive data. This approach is generally avoided by operating systems and modem communication software. Instead, they generate an interrupt to the processor when data arrives so that the processor can stop other tasks immediately when there is data to be handled. We began with a polling technique, due to its simpler nature. Using this technique we were able to successfully scan several character bar codes into the robot's microcontroller memory using 68HC11 assembly programs called by higher level Interactive C programs. However, we soon found timing difficulties with longer bar codes due to characters overrunning one another at the serial port of the microcontroller board. We will discuss the details of constructing our polling serial interface and address how we hope to overcome the difficulties that arose in our work.

## Education

EXPLORING THE RATE OF CHANGE OF THE EXPONENTIAL FUNCTION: A PRECALCULUS PERSPECTIVE, Brian Bradie, Dept. of Mathematics, Christopher Newport Univ., Newport News, VA 23606-2998.

An activity has been designed which allows Pre-Calculus students to explore the key mathematical property which gives rise to the appearance of exponential functions in applications, namely, that the value of an exponential function changes at a rate proportional to its value. The introductory part of the activity develops the concepts of average rate of change and instantaneous rate of change for a function and also presents a procedure for calculating each quantity. In particular, a straight-forward graphical procedure for determining instantaneous rates of change is described. The second half of the activity then leads students through an exploration of the instantaneous rate of change of the exponential function. The exercises contained in this latter half of the activity divide into two categories: exploration exercises and algebraic/proof exercises. The exploration type exercises make use of graphing calculators and computer software and are designed to allow students to formulate hypotheses. The algebraic/proof exercises are intended to place the use of technology in proper perspective: calculators and computers are excellent tools, but students must learn that technology can never replace mathematical reasoning and skills.

AN INQUIRY-BASED APPROACH TO GENERAL BIOLOGY CURRICULUM: AN OVERVIEW. Marion B. Lobstein, Associate Professor of Biology, NVCC-Manassas Campus, NVCC-Manassas Campus, 6901 Sudley Rd., Manassas, VA 22110. This presentation is an overview of a three-year National Science Foundation grant to revise general biology curriculum for community and two-year colleges. The proposal for this grant was developed by and is being administered through Biological Sciences Curriculum Study (BSCS). BSCS has been involved since the late 1950's in developing inquiry-based biology curriculum at the high school and later at the middle and elementary school levels. In the early 1990's BSCS staff developed the proposal for this grant in order to extend these efforts to the community and two-year college level. Biology faculty from community and two-year colleges from around the United States have been recruited to serve on a Design Team to assist in the development of this curriculum. The Design Team, of which Marion Lobstein is a member, met with BSCS staff in Colorado Springs, Colorado in June 1995 and again in January 1996 to begin development of this project. The teaching materials developed from these initial efforts have been field-tested by Marion Lobstein in her general biology courses at NVCC-Manassas Campus during the 1995-1996 academic year. This presentation focuses on the field-testing progress made to date and on the possible future direction of this new curriculum effort.

CHARACTERISTICS OF WOMEN SCIENTISTS: SCIENCE IN DIFFERENT VOICES. Juanita Joan Matkins. This qualitative study involved the discovery of the enabling factors in the life stories of six women scientists, for the purpose of determining how they persevered in science. Participants included a meteorologist, two astronomers, a geologist, a forensic pathologist, and a physicist/astronaut. Data were obtained through individual semi-structured interviews. The primary factors included their view held from childhood of their "possible self as a scientist," strong maternal role models, support of parents, and expectation of financial responsibility. Secondary factors included childhood opportunity to participate in activities outside the school setting, and single-sex schools. Potentially disabling factors included sexist aspects of some graduate schools and of professional life in science, paternalism of institutions, and living apart from husbands. Implications for bringing more females into the sciences included supportive families, freedom for out-of-school proportional reasoning experiences, the availability of single-sex schools, graduate programs which were more supportive of females, and strong female role models. Patterns of sexism in the stories of these women indicated the need for critical examination of assumptions about women and science. Recommendations for further study included examining the importance to young women of a cooperative versus a competitive environment in school and examination of the qualities of single-sex schools as well as comparisons of women scientists who went to single-sex high schools and colleges to those who did not.

CHEMISTRY 101 STUDENTS' VIEWS OF THE STATES OF MATTER. Pamela C. Turpin, Dept. of Chem., Roanoke College, Salem, Va. 24153-3794. Answers from students' laboratory data sheets and tests provide a look at the misconceptions of college students, who are non-science majors, about the structure of the states of matter. Student responses show that misconceptions remain even after experiencing first hand activities involving state changes in a laboratory setting. When asked to explain changes in state of different materials observed in the laboratory, many students were unable to communicate effectively their ideas. Those who did communicate well, often had glaring misconceptions about energy changes and the motion of molecules that occurred in the state changes. This author suggests several reasons why this may be: difficulty of the concept, lack of communication skills on the part of students, picky laboratory instructor, time limitations of the pre-lab and laboratory periods, poor preparation in previous schooling, non-science majors work for grades not knowledge, science as a foreign language and the incorrect usage of terms by students, and students as "objects to be changed" and not as "participants in practice" in a community.

THE EFFECT OF STUDENT-PAID PORTION OF COLLEGE EXPENSES ON ACADEMIC ACHIEVEMENT AND PERSISTENCE AMONG COMMUNITY COLLEGE STUDENTS. Doris M. Velazquez, Debra L. Vendi, Maria E. Marscheider, Linda E. Miller<sup>1</sup>, and James P. O'Brien, Social Sciences Div., Tidewater Cmnty. Col., Virginia Beach VA 23456 (and <sup>1</sup>SUNY, Old Westbury). Personal contacts with leaders in the field revealed that students' personal financial burden (SB) was considered (1) important, (2) extremely complex, (3) difficult to measure, (4) absent from the research literature, and (5) qualitative measures were recommended. Trials of the qualitative survey indicated that military and veterans (MV) students presented unique problems and a second version for these students was developed (MV data was not analyzed here). It was hypothesized that SB would be positively related to GPA and negatively related to Persistence (P) for community college students (N=79). As existing literature does support, r's were significant for the Parental Non-Support measure x GPA,  $r = +.397$ , and x P,  $r = -.308$ , beyond .0005 and .005 levels of significance (1-tailed tests), respectively. More direct SB measures, however, must be rescored since the ranking devices used in these analyses appear to be too coarse, although some reached significance beyond the .05 level. This study apparently represents the first reported treatment of the effects of student-paid vs. parent-paid portions of college costs.

## Environmental Science

PRELIMINARY ECOLOGICAL ASSESSMENT OF MASSAPONAX CREEK, SPOTSYLVANIA COUNTY, VIRGINIA. Michael L. Bass Department of Environmental Science and Geology, Mary Washington College and John Tippet, Friends of the Rappahannock, Fredericksburg, VA. The rapid urbanization of parts of Spotsylvania County has shifted attention of negative nonpoint source runoff into streams from agricultural to commercial and suburban development. Investigators using the Izaak Walton League, SOS protocol sampled a rural low impacted stream, Hunting Run, and an urbanization impacted stream, Massaponax Creek. Massaponax Creek exhibited higher sediment deposition, fluctuating pH, increased algal growth and decrease in quality macrobenthic habitat along its course to the Rappahannock River. Hunting Run showed significantly higher indices for sensitive macroinvertebrates while Massaponax Creek showed higher indices for somewhat sensitive and tolerant macroinvertebrates. Total Indice Values for Hunting Run was twice that of the downstream Massaponax Creek stations. Methods to improve water quality and decrease negative urbanization impacts are being pursued.

CLASSIFICATION OF FLUORIDE RELATED TOOTH LESIONS IN MULE DEER (*Odocoileus hemionus*): A PROPOSED SIMPLIFIED SYSTEM. Luz M. Borrero and P. F. Scanlon, Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The primary method for rating lesions due to fluoride toxicity in ruminants is that of Shupe et al. 1963 (Am. J. Vet. Res. 24:964-979) which was developed for used mainly with cattle. In our experience evaluators have not been consistent in rating lesions in mule deer. Teeth from deer collected at the US Air Force Academy Colorado Springs, CO were evaluated using a modified Shupe et al. 1963 technique. The technique scored incisor lesions varying from 0 to 5 where 0 had no lesions and 5 had severe lesions with hypoplasia and hypomineralization of the enamel. Ten volunteers, sophomores majoring in wildlife science at VPI & SU, were trained to use the method. Scores of 0, 1 and 5 were less likely to be missed. In general, most volunteers tended to underestimate scores greater than 0 rather than overestimate scores. The proposed evaluating method concentrates on quantifiable characteristics related to the enamel lesion rather than on wear, staining and chipping which may be associated with age, diet and handling of samples. The proposed system may be more appropriate for use with smaller ruminants and be valuable for less experienced personnel in recognizing fluoride related problems. The system follows: *A Normal*; Normal shape and size; enamel smooth, translucent glossy white. *B Slight effect*; Lesions vary from light white spots, striations and/or mottling that involves less than 50 % of the tooth. *C Marked effect*; Same as *B* but the lesions involve more than 50 % of the enamel. *D Severe effect*; Along with mottling there is hypomineralization and hypoplasia of the enamel. [Funding: US Air Force, V.P.I. & S.U., Fulbright Grant and Encyclopedia Britannica.]

CONCENTRATION OF FLUORIDE IN BONE AND TEETH OF MULE DEER (*Odocoileus hemionus*) FROM COLORADO. Luz M. Borrero and P. F. Scanlon, Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. In recent years mule deer at the US Air Force Academy (USAFA) at Colorado Springs, CO have shown unusual antler fractures and tooth lesions. Brittle bones and tooth lesions have been associated with ingestion of high fluoride levels in the diet. The purpose of the present project was to determine tooth lesions severity and its possible relationship to fluoride contents in teeth and bone. Jaw bones with teeth were recovered from deer at the USAFA (N=262), Piñon Canyon Maneuver Site (N=24, PCMS, Model, CO), and Game Management Units (N=16, GMU's, northwestern CO) between 1993 and 1995. Incisor lesions were scored from 0 to 5 using a modified Shupe et al. 1963 (Am. J. Vet. Res. 24:964-979) method. Fluoride concentrations were measured using an ion selective electrode. No differences among median tooth lesions were found in the three sites, but the highest rated lesions were found only at USAFA. The median concentrations of fluoride were higher in teeth and bone from deer at the USAFA than in those from other areas. Among deer from the USAFA teeth with lesions had higher concentrations of fluoride than those without lesions. Females had higher concentration of fluoride than males. Presence of tooth lesions in adult deer is indicative of high fluoride exposure but chemical analysis is necessary for objective analysis of a fluoride contamination problem. [Funding: US Air Force, V.P.I. & S.U., Fulbright Grant and Encyclopedia Britannica.]

A COMPARISON OF PHYTOPLANKTON COMMUNITIES IN THE MARY WASHINGTON COLLEGE MESOCOSM AND IN THE YORK RIVER. Virginia Clarke & Stephen Gough, Dept. of Biol. Sci., Mary Washington Col., Fredericksburg, Va. 22401. Advanced mesocosms have the potential of simulating natural sites, thus aiding basic research and potential impact assessment. Adequate proof of emulation requires rigorous tests of—among other things—biotic community comparability. In this study, phytoplankton diversity and density at both the York River, Virginia, and the Mary Washington College mesocosm were determined using small-mesh collecting nets and a Sedgwick-Rafter cell counting technique. Results showed vast differences between the mesocosm and the site, suggesting the former was not faithfully emulating the latter. Among the reasons for the lack of fidelity may be that the intermediate disturbance theory was operative at the natural site and not in the mesocosm. Also, the estuarine system we attempted to simulate is highly complex hydrologically and may not be amenable to mesocosm replication methods.

ZOOPLANKTON DYNAMICS IN AN ARTIFICIALLY DESTRATIFIED RESERVOIR, LAKE BARCROFT, FAIRFAX COUNTY, VIRGINIA. Theresa E. Connor and R. Christian Jones, Dept. of Biology, George Mason Univ., Fairfax, VA. 22030. Zooplankton dynamics in Lake Barcroft were investigated through bi-monthly sampling from May-October, 1995. Crustacean zooplankton were identified and enumerated from vertical tow samples collected with a 202  $\mu$ m mesh conical net. Animals identified were: Eurytemora affinis, Diaptomus pallidus, cyclopoid copepodid, harpacticoid copepodid, Daphnia pulex, Diaphanosoma brachyurum, Ceriodaphnia, and chydorid species. E. affinis was the dominant copepod with densities from 10-90 animals per liter with high densities in May-June and August. D. brachyurum was the dominant cladoceran with densities from 18-120 animals per liter with high densities in early June through early August.

NITROGEN AND CARBON LOSS TO THE ENVIRONMENT DURING STORAGE OF DAIRY CATTLE WASTE. James D. Cox, J. H. Herbein, & J. J. Loor. Dept. of Dairy Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Obtaining reliable estimates of nitrogen (N) and carbon (C) residue in dairy cattle waste storage facilities when the waste is scheduled for application to crop land requires knowledge of organic matter (OM) loss to the atmosphere during storage. Predictions of N and C kinetics in stored waste were estimated using feces and urine from 4 lactating cows. Feces (363 g), urine (130 g), and tap water (13 g) were mixed in 800 mL plastic containers designated for analysis after 0, 2, 4, 8, 16, or 32 days (d) of storage at 25 °C. Data from 28 containers at each d of storage indicated a linear decrease in total mass across time, with only 60% remaining at 32 d. The OM and C content also declined linearly, such that 63% and 64%, respectively, remained at 32 d. However, 95% of total N remained at 16 d, then declined to 67% at 32 d. Loss of N was from the liquid phase (separated by centrifugation at 20,000  $\times$  g) of the waste, with only 35% remaining in the liquid after a linear decline from 8 to 32 d. Ammonia-N was 25% of total liquid N at 0 d, then became the primary form of N (50 to 60%) in the liquid. Ammonia concentration in the liquid increased from 0 to 2 d, remained elevated until 16 d, then declined until 32 d. Loss of C during storage may be due to microbial fermentation of fecal OM, indicated by a decline in pH from 8.5 at 0 d to 6.5 at 8 d. The pH remained at 6.5 until 16 d, then increased to 7.5 at 32 d. Overall, results indicated loss of approximately 35% of N and C due to volatilization during the first month of dairy cattle waste storage. (Supported by funding from Virginia Agricultural Council, Project No. 282)

MONITORING CO<sub>2</sub> EVOLUTION FROM MERCURY TREATED FOREST SOILS. Andy P. Damalas, Dept. of Biol., Old Dominion Univ., Norfolk, VA. 23529. Greatest amounts of soil CO<sub>2</sub> evolution result from microorganismal activity. Ten-gram composite field soil samples were obtained from selected spots in forest stands, incubated in flasks and were allowed to evolve CO<sub>2</sub> for about 85 hours. A center-well in each flask contained 0.5 N NaOH absorbing the CO<sub>2</sub>. Amounts absorbed were determined by a conductivity cell and conductivity bridge. Calibration curves and preliminary tests for standardizing the methodology were performed in the lab using field soils. Differences in the magnitude of change in CO<sub>2</sub> evolution were found and are believed to be indicative of the ability of sites to recover from certain stresses. Three mercury compounds-mercuric chloride (HgCl<sub>2</sub>), mercuric oxide (HgO), mercuric sulfate (HgSO<sub>4</sub>)-were chosen as possible heavy metal pollutants of forest soil ecosystems, i.e. possible airborne mercury compounds emitted from fossil fuel plants. Application of these mercurials to forest soils simulated mercury emissions from coal burning industries. All three chemicals were applied in powder form with sand to soil. Treatment with 128 ppm and 256 ppm HgCl<sub>2</sub> and 128 ppm HgO did not inhibit CO<sub>2</sub> evolution. Treatment with 256 ppm HgO and 128 ppm and 256 ppm HgSO<sub>4</sub> depressed CO<sub>2</sub> evolution. A methodology was developed and tested for rapidly, efficiently, and effectively monitoring amounts and rates of CO<sub>2</sub> evolution from soils. It may be also be useful for estimating ecosystem change, making robust comparisons of areas, and gaining information about ecosystem structure and dynamics from one integrating index. (Supported by grant from Center for Environmental Studies, Virginia Tech).

USE OF THE *IN VITRO* BRAINSTEM PREPARATION OF *RANA CATESBEIANA* IN THE DEVELOPMENT OF A PHYSIOLOGICALLY-BASED TOXICOKINETIC COMPUTER SIMULATION MODEL FOR LEAD-INDUCED NEUROTOXICITY RISK ASSESSMENT. Michael D. Druitt, James A. Wise, Edward G. Smith, Dept. of Biol., Hampton Univ., Hampton VA 23668. To date no complete paradigm exists that satisfactorily integrates both the proposed anatomical and functional substrates of lead-induced neurotoxicity. A series of studies was conducted using the *in vitro* brainstem preparation and the intact larval form of *Rana catesbeiana* to accomplish this goal, and therefore reduce the uncertainty in risk assessment for lead-induced neurotoxicity from exposure to low concentrations of lead. Our studies have shown that early stage larva exhibit a lower LC<sub>50</sub> for lead. The LC<sub>50</sub> for Group I (stages IX-XII) was 7.9 ppm versus 13.4 ppm for Group II (stages XIV-XVI) and Group III (stages XVII-XX). This corresponds to the increased sensitivity of young children to lead toxicity when compared to adults. The strategy of this project is to use this preparation to develop a physiologically-based toxicokinetic and a computer simulation model based on electrophysiological studies using the isolated brainstem preparation of *Rana catesbeiana*, toxicity studies using the intact larval form, and a quantitative structure activity relationship model (QSAR) for lead. These studies will ultimately result in the use of *Rana catesbeiana* as a sentinel species whose ventilatory responses to CO<sub>2</sub> can be monitored to signal potential lead-induced toxicity risk to other species, including humans.

A COMPARISON OF FORESTED AND NON-FORESTED RIPARIAN BUFFERS IN THE REDUCTION OF NONPOINT SOURCE POLLUTION IN THE UPPER RAPPAHANNOCK RIVER BASIN. Kristen Eberly and Michael L. Bass, Department of Environmental Science and Geology, Mary Washington College. Forested riparian buffers are excellent nutrient and sediment filters when adjacent to agricultural or urban sources of nonpoint source pollution and streams. A survey was sent to landowners on the Rapidan River in Orange County to determine awareness of the benefits of restoring and maintaining forested riparian zones, and of cost-share programs available to landowners to participate in land stewardship practices. Survey results showed 71% of landowners were willing to participate only with 50% government support. Water samples were taken from forested and non-forested feeder streams in an area on the Rapidan river in order to compare the uptake and filtering of nutrients in these two different zones. It was found that the streams in the forested riparian areas contained lower levels of phosphorus and nitrogen and also had lower hardness levels. Preliminary analysis of the macrobenthic community showed streams with adequate vegetated riparian buffer exhibited good macrobenthic community diversity. Forested riparian buffers are effectively filtering nonpoint source pollution from agricultural areas in the upper Rappahannock. Continued correspondance with landowners and further sampling in planned.

UPTAKE OF HEAVY METALS BY THE HALOPHYTE *Suaeda maritima*. Kimmara E. Evans, B.G. Shipes, and W. Leung, Depts. of Biology and Chemistry, Hampton University., Hampton, VA 23668. *Suaeda maritima* (L. Dum.), Family Chenopodiaceae is a succulent halophyte. This plant grows in high saline environments as well as some non-saline environments. The growth of this plant on a dredged disposal site has prompted research on the bioaccumulation of heavy metals in *S. maritima*. The purpose of this study is to determine whether *S. maritima* takes up and stores heavy metals. Samples taken from Craney Island Disposal Facility were separated into leaves roots and stems, to test for the compartmentalization of the heavy metals, cadmium (Cd), lead (Pb), zinc (Zn), copper (Cu), and nickel (Ni). The samples were dried, ground, and digested in concentrated nitric acid. These solutions were diluted and then tested by atomic absorption spectroscopy for the indicated metals. Preliminary testing confirms the bioaccumulation of some of these metals in the test plant, allowing further testing to continue in determining whether or not this plant is a likely candidate for phytoremediation.

PHYSIOLOGICAL INDICATORS OF STRESS IN FISHES IN A UNIQUE MESOHALINE MICROCOSM SYSTEM. Heidi Ferrell & Stephen Gough, Dept. of Biol. Sci., Mary Washington Col., Fredericksburg, Va. 22401. A microcosm is a simulation of a natural ecosystem, and such tools are currently an area of intense research for studying complex community interactions. However, the validity of these systems is an issue of debate; therefore assessment of their accuracy is necessary before results can be extrapolated to the natural environment. This study examined fish stress levels in the Mary Washington College microcosm, an emulation of a mesohaline region of the York River, Virginia. Chronic stress was determined in the Atlantic silverside (*Menidia menidia*) using a hepatosomatic index (HSI). The data were compared to fish in the river and in a traditional experimental aquarium. HSI was consistently lower in the York River than in the microcosm, indicating chronic stress in the former. HSI was elevated in the aquarium population, suggesting exposure to specific stressor(s). The results seemed to support the intermediate disturbance hypothesis (IDH), and the microcosm may be simulating a climax (i.e., stable) community instead of a fluctuating, nonequilibrium environment like the York River.

BETA-GLUCOSIDASE AND DEHYDROGENASE SOIL ENZYME ACTIVITY AS AN INDICATOR OF DEGRADED SITE RECOVERY. Andrew C. P. Heaton, John R. Heckman & John Cairns, Jr., Dept. of Biol., Virginia Tech, Blacksburg, Va. 24060. To demonstrate the feasibility of using soil dehydrogenase activity as a gauge of the temporal recovery of damaged terrestrial systems, a section of land was degraded and parts of the site were restored using different seedings and amendments. After nine months of recovery, dehydrogenase activity was measured monthly for several of ten months. Initial dehydrogenase levels exhibited differentiation of only reference (undegraded) sites from all other sites. As recovery progressed, dehydrogenase levels differentiated among several treatment combinations, indicating a potential differential recovery among the treatment combinations. Amendment status was determined to be a more important variable than seeding type in effecting these differentiations.  $\beta$ -glucosidase enzyme activity was measured concurrently with the last two dehydrogenase measurements in order to draw a relationship between dehydrogenase activity and cellulose decomposition activity in the recovering plots. The two enzymes indicated substantial correlation to one another, though  $\beta$ -glucosidase appeared to be a more sensitive estimation of amendment status than dehydrogenase. Despite the complicating factor of possible seasonal variability in enzyme activity, these measurements demonstrated the potential utility of dehydrogenase and possibly  $\beta$ -glucosidase activity levels as estimations of soil recovery from disturbance events.

PRIMARY RESTORATION OF INDUSTRIALLY DEGRADED LAND: PRELIMINARY TESTS FOR CORRELATION BETWEEN INITIATED COMMUNITY STRUCTURE AND RETURN OF FUNCTIONAL CAPACITY. John R. Heckman, and John Cairns, Jr. Virginia Tech, Blacksburg, VA, 24061, USA. A primary concern with ecological restoration lies in the ability to determine the point at which a system has satisfactorily recovered. Common recovery indices center around the development of a macro-community structure similar to the pre-disturbance condition or another suitable reference. An alternative basis for measuring restoration efficacy is a comparison of ecological functions. To test this hypothesis, structural (vegetational community) and functional ( $\text{CO}_2$  efflux,  $\text{CH}_4$  uptake, cellulose decomposition rate and enzymatic activity) end-points are being observed on homogeneous, grassland soils treated with an array of reclamation treatments. Undisturbed, adjacent old field systems provide for reference comparisons. Recovering soils in 1995 showed a higher mean  $\text{CH}_4$  uptake rate (mean = 1.9 g  $\text{CH}_4\text{-C}/\text{ha}/\text{day}$ , SD = 0.3) than reference soils (mean = 1.05 g  $\text{CH}_4\text{-C}/\text{ha}/\text{day}$ , SD = 0.38) with high seasonal variance.  $\text{CO}_2$  efflux in reference soils was higher (mean = 48.9 kg  $\text{CO}_2\text{-C}/\text{ha}/\text{day}$ , SD = 23.5) than recovering soils (mean = 28.1 kg  $\text{CO}_2\text{-C}/\text{ha}/\text{day}$ , SD = 11.7). The developing trend shows treatments with higher soil organic matter amendment and more diverse seed mixes to be more functionally similar. Robust conclusions concerning reclamation treatment and similarity of functional capacity cannot yet be made. The study continues through 1996.



PHYTOPLANKTON DYNAMICS IN AN ARTIFICIALLY DESTRATIFIED RESERVOIR, LAKE BARCROFT, FAIRFAX COUNTY, VIRGINIA. SAIFUL ISLAM AND R. CHRISTIAN JONES, DEPT. OF BIOLOGY, GEORGE MASON UNIVERSITY, FAIRFAX, VA 22030. Lake Barcroft is artificially destratified through aerators during summer months to control blue-green algae which may form surface-scum in the lake. Sampling was done bi-weekly during may through october in 1995. Identification, density, and biovolume suggest that blue-greens still dominant in the lake during summer period especially Coelosphaerium naeglianum. Diatoms dominated biovolume levels in the fall. Greens were sporadic but were represented by more species than blue-greens.

INTER-ANNUAL TRENDS IN WATER QUALITY AT AN EMBAYMENT AND NEARBY MAINSTEM OF THE TIDAL FRESHWATER POTOMAC RIVER. R. Christian Jones & Dann M. Sklarew, Dept. of Biol., Geo. Mason Univ., Fairfax, Va. 22030-4444. From 1983-1994, water quality was monitored regularly in and around Gunston Cove, an embayment of the tidal freshwater Potomac River. Time-series analysis revealed no significant inter-annual trends ( $P < 0.05$ ) in summertime surface water quality. Such trends may be obscured by abiotic factors, particularly the local flushing regime. To test this hypothesis, we examined the correlation between average (1- to 28-day) flow and major water quality parameters (chlorophyll A, N and P species) at two stations (cove, mainstem). Statistically significant flow correlation existed with total phosphorus, organic nitrogen, and chlorophyll A in the cove, and with ammonia in the mainstem. Best fitting curves were then used to derive flow-corrected residuals. Residuals' time-series failed to reveal any underlying linear changes at either site. Thus, while flushing contributes to temporal variability, it apparently has not masked any persistent inter-annual trends in the water quality of this system. (Supported by the Fairfax County Department of Public Works and the Interstate Commission on the Potomac River Basin.)

ASSESSMENT OF POINT-SOURCE POLLUTION IN STONY CREEK, VIRGINIA USING BENTHIC MACROINVERTEBRATES. Robert W. Louque & Brian C. Caldwell\*, Biol. Program, Shenandoah Univ., Winchester, VA 22601. The study investigated whether discharge from a chicken processing plant affected the downstream benthic macroinvertebrate community. Methodology was adapted from the EPA's Rapid Bioassessment Protocol III. Two sites--a mile upstream and a mile downstream of the discharge pipe--were assessed bimonthly for macroinvertebrates, temperature, dissolved oxygen and chloride ion concentration. Data were gathered seven times at each site. Although no significant differences using the Family Biotic Index and the EPT Index were found, two measures of community similarity indicated that macroinvertebrate diversity was indeed lower at the downstream site. Further examination of data revealed an absence of two chloride sensitive genera [Pteronarcys (Plecoptera) and Ephemereilla (Ephemeroptera)] and had a significantly higher chloride ion concentration ( $p=0.009$ ) at the downstream site. These genera were frequently found at the upstream site. Since the chicken plant uses ferric chlorides to kill bacteria, the discharge is possibly causing an impairment to the creek. Further study is recommended.

SEASONAL VARIATION IN THE ABUNDANCE OF MESOZOOPLANKTON IN THE LOWER CHESAPEAKE BAY. George Mateja, Dept. of Biological Sciences, Old Dominion Univ., Norfolk, VA 23529. Monthly collections of mesozooplankton were carried out within the lower Chesapeake Bay mainstem from August 1985 to September 1995. Calanoids are the dominant zooplankton within the bay, making up 50 to 60 percent of the total zooplankton abundance, and cladocerans comprise 12 to 40 percent of the population. Seasonally, the zooplankton appear to have two periods of maximum densities; the initial occurring during the early spring (March to May), and the latter occurring during the fall (July to October). Three of the four stations display the primary abundance mode during the fall. The zooplankton community is reduced during the summer and the minima occur during the winter (November to January). This pattern is consistent for all the reported mainstem stations. Long-term trends indicate mesozooplankton abundance is declining at all the mainstem stations. Supported by Va. Dept. of Environmental Quality

SOIL CONTAMINATION AND ITS INFLUENCE ON TRACE METAL UPTAKE BY PLANTS AT CRANY ISLAND. Eshete, Matthewos\*. Wing H. Lueng, Dept. of Chemistry, Hampton Univ., Hampton, Va. 23668. Barbara G. Shipes, Dept. Biology, Hampton Va. 23668. A study was conducted to correlate the contamination of soil at Crany Island with the heavy metal uptake by plants. Various concentrations of five heavy metals ( Cu, Zn, Ni, Cd, Pb ) were detected in the soil of Crany Island. These five heavy metals accumulated in different parts of *Phragmites communis* and *Spartina alterniflora* were also measured. Results suggest that metal uptake by these plants is closely related to the metal concentration in soil. Accumulation of heavy metals by these plants is also found to vary from each other. Generally *Phragmites communis* show higher accumulation of these five heavy metals.

REMEDICATION DIFFICULTIES ASSOCIATED WITH A LARGE HYDROCARBON PLUME LOCATED UNDER A DENSELY URBANIZED AREA IN NORTHERN VIRGINIA. Douglas Mose, Chemistry Department, George Mason University, Fairfax, VA 22030. Recently approximately 200,000 gallons of hydrocarbon fuels were discovered to have been lost into the soil below a fuel storage terminal in northern Virginia. The subsurface plume now extends more than 2000 feet into an adjacent business and residential community. The plume is about 500 feet wide, and rests on the local water table at depths of 20-40 feet. The low permeability of the soil has prevented rapid fuel removal and soil remediation. Soil evacuation will not be utilized because of the estimated cost and the disruption of the community. Less disruptive technologies have been evaluated, of which a combination of bioremediation and removal of contaminated groundwater has been selected. Estimates of remediation down to reasonably safe levels (less than 100 ppm Total Petroleum Hydrocarbon) are on the order of 20 to 200 years.

ZOOPLANKTON COMMUNITY ASSEMBLAGES AS BIOINDICATORS OF A STRESSED SYSTEM. Gyung Soo Park, Dept. of Biological Sciences, Old Dominion Univ., Norfolk, VA 23529. Micro- and mesozooplankton abundances were determined at five stations in the Chesapeake Bay and tributaries from January 1993 through December 1994. Principal component analysis was used to characterize the stations based on the nutrient loading, dissolved oxygen, water temperature and pH. The Elizabeth River stations were designated as highly stressed due to the high nutrient loading, low dissolved oxygen, high water temperature and low pH. Zooplankton composition in the highly stressed system (Elizabeth River stations) was significantly different from the moderately stressed system (Bay stations). Rotifers and aloricated ciliates were more abundant in the stressed water body. On the other hand, loricated ciliates, copepod nauplii and mesozooplankton showed high abundances in the moderately stressed system.

Supported by Department of Virginia Water Quality and the EPA.

RECOVERY OF COMMUNITY STRUCTURE AND LEAF PROCESSING IN A HEADWATER STREAM FOLLOWING USE OF A PASSIVE TREATMENT SYSTEM TO ABATE COPPER POLLUTION. Alicia Slater Schultheis & A. C. Hendricks\*, Dept. of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Prior to treatment, copper concentrations ranged from 8.9 to 32.0  $\mu\text{g/L}$  at the impacted sites and from 0.1 to 7.7  $\mu\text{g/L}$  at the reference site. Insect abundance (n) and number of taxa (#) were reduced at the impacted sites (n = 31, 22, 33, 24 and # = 190, 246, 266, 345) relative to the reference site (n = 52, # = 973). Red maple (*Acer rubrum*) leaves broke down twice as fast at the reference site (k = -0.029) than at sites receiving the untreated effluent (k = -0.016, -0.013, -0.013, -0.013). Following treatment, copper concentrations at the impacted sites ranged from 0.1 to 14  $\mu\text{g/L}$ . Functional recovery preceded recovery of community structure by at least six months. Decomposition rates were similar at all sites after six months of treatment (k = -0.012, -0.011, -0.011, -0.012). Recovery of community structure was not complete after 1 year of treatment. Collector-filterers and predators recovered quickly following treatment, while recovery of collector-gatherers and shredders was slower.

A COMPARISON OF PERIPHYTON ON *RUPPIA MARITIMA* IN A MESOCOSM AND THE YORK RIVER. Timothy York & Stephen Gough, Dept. of Biol. Sci., Mary Washington Col., Fredericksburg, Va. 22401. Mesocosms can be useful tools to mimic natural sites for efficient analysis of basic ecosystem processes and impact potential. However, any given mesocosm must be validated as a model of the true location. One mechanism for accomplishing this is to examine the community structure of its various components. In this study, the community dynamics of periphyton existing on blades of *Ruppia maritima* were compared in a novel mesocosm and a mesohaline site on the York River, Virginia. Periphyton was removed using the standard F.A.A. wash method of Gough and Woelkerling (1976), and Sedgwick-Rafter (S-R) cell counting procedures were employed to obtain densities. Shannon and Simpson diversity indices and community structure were then determined. In community structure, the two systems did not emulate each other, but diversity indices were similar. It appears that while the two ecosystems were functional, they were not similar to each other, probably due largely to intermediate disturbance that was prevalent at the river.

**Geography** (*No Abstracts Submitted*)**Geology**

THE MECHUM RIVER FORMATION IN ALBEMARLE COUNTY, VIRGINIA. C. M. Bailey, Dept. of Geology, College of William & Mary, Williamsburg, VA 23187. The Late Proterozoic Mechum River Formation crops out in a 0.5 to 2 km wide, NE-SW trending belt in the central Virginia Blue Ridge province. In the southern portion of the belt boulder conglomerates are overlain by arkosic sandstones. To the north, laminated metasiltstones and phyllites are overlain by arkosic sandstones. A greenschist facies foliation defined by aligned phyllosilicates and elongate detrital grains is common in the arkosics and phyllites. The Mechum River belt has previously been interpreted as a graben, half-graben, thrust-faulted inlier and structural infold. In Albemarle County the belt is characterized by a series of asymmetric northeast-plunging overturned folds. Both the southeastern and northwestern contacts of the belt dip moderately to the southeast. At the southeastern contact, Grenvillian basement is thrust over metasedimentary rock. The Mechum River Formation unconformably overlies Grenvillian basement at its northwestern contact. In its present geometry, the Mechum River belt is not a graben. Line-length restorations reveal between 40 and 70 percent shortening across the belt, but penetrative strains throughout the unit require greater than 100 percent total shortening. Cross section restoration of the Mechum River belt yields little information as to the original geometry of the depositional basin. Field relations and microstructures indicate that folding and metamorphism of the Mechum River belt predate thrusting along its southeastern margin.

GIV AND ABICAS (TM): EFFECTIVE SOFTWARE FOR DIGITAL GEOLOGIC MAPPING. C. R. BERQUIST, JR., Virginia Division of Mineral Resources, Dept. of Geology, College of William and Mary, Williamsburg, VA, 23187. GIV (Geologic Information Visualization) is a group of public domain computer programs that enable a user to view and create digital and paper maps on DOS (TM) -based PCs. Scanned geologic and topographic maps are displayed on the video monitor and points (lines) are entered with a mouse. Limited attribution of points, lines and areas is possible in GIV. Additional features, such as creating DRGs and autotracing ("autovectorizing") and the capability to define multiple attributes to spatial data is available in ABICAS, a commercial "upgrade" to GIV. Over the past two years we have digitally replicated over 30 published geologic maps (1,24,000) and are creating several new geologic maps by using this software. Productive work by individuals who are familiar with topographic and geologic maps and who use this software is achieved commonly with less than a day of training. Our digital data is in ASCII format and has been successfully imported to ATLAS-GIS (TM) and hence to ARC\_INFO (TM).

STRATIGRAPHIC VARIABILITY OF RADON, SOUTHEASTERN VIRGINIA. C. R. BERQUIST, JR., Bruce K. Goodwin, and Stephen C. Clement, Dept. of Geology, College of William and Mary, Williamsburg, VA, 23187. We have mentored a number of students whose research projects involved the measurement of radon in the ground. At all study sites in Richmond and Williamsburg areas, the underlying stratigraphy was determined in detail by hand-augering the sediments or saprolite. Charcoal and alpha-track detectors were suspended in sealed auger holes for time periods of a week or less. Summary statistics for radon concentrations measured in the ground (picoCuries/liter) since 1989 are shown in the table below.

	Yorktown Fm (n = 92)	Bacons Castle Fm (n = 38)	Other Pleistocene Fm (n = 24)	Petersburg Granite (n = 55)
Mean	904	554	546	1215
SD	538	458	521	994
MAX	2302	1962	1974	4449
MIN	157	32	29	4

We believe that uranium-enriched fossilized bones at the base of the Yorktown Formation is the most probable source of elevated radon in the Williamsburg area. The characteristically large standard deviations suggest multiple measurements should be made over time and area of a site in question.

SEDIMENT CHARACTERISTICS IN A DEBRIS FAN EXPOSURE, MADISON COUNTY, VIRGINIA: S. E. Chase, A. S. Rutherford, and W. C. Sherwood, James Madison Univ., Harrisonburg, VA 22807. On June 27, 1995, approximately 27 inches of rain fell on portions of Madison County. High energy discharges from the Blue Ridge resulted in incisions of pre-existing alluvial fans to a depth of 3 meters or more. The present study concentrated on a fresh exposure along Kinsey Run, 1 mile west of Graves Mill. Near the west end of the exposure a total of 13 unlithified units ranging from coarse, bouldery, gravel to clayey silt were identified. The third oldest unit contains abundant organic matter which yielded a carbon date of 34,700 years B.P. Two coarse gravel beds in the sequence show significant rounding of charnockite clasts indicating a source to the west. Interbedded with these strata are units containing very angular clasts of a strongly foliated gneiss, rich in blue quartz. This material has its source to the south. Easterward, the stratified sediments are replaced by a jumble of fines, and angular gneissic clasts up to one meter across. The stratified sequence at the west end of the exposure is interpreted as interlayered alluvium (charnockite) from the west and gravity flow (solifluction?) of gneissic material from the south. The unstratified eastern part of the exposure is interpreted as resulting from one or more viscous debris flows.

THE USE OF "MICRODEM" IN TEACHING GEOLOGY. Stephen C. Clement, Dept. of Geology, College of William and Mary, Williamsburg, VA 23187-8795. The DOS-based computer program "MICRODEM" has been used effectively for several years in Physical and Historical Geology laboratories and in advanced courses at the College of William and Mary. The program displays digital elevation data, available from the U.S.G.S. and several commercial sources, and allows the student to construct topographic profiles and 3-D views. Students manipulate, learn and visualize the effects of vertical exaggeration, contour interval and scale. Slope, aspect and reflectance maps are used in geomorphic interpretation. Geophysical data such as bathymetry, gravity and magnetics can be displayed in adjacent panels and profiles constructed that relate the features. Student-generated xyz ASCII data can be entered and manipulated. The program is freeware and can be obtained by anonymous ftp from: <ftp.nadn.navy.mil/pub/ocean/microdem>. The author, Dr. Peter Guth, Associate Professor, can be contacted at: [pguth@nadn.navy.mil](mailto:pguth@nadn.navy.mil)

EFFECTS OF HUMAN IMPACT AND POLITICS ON WETLAND DELINEATION: CASE STUDY IN THE DISMAL SWAMP. Debra Duffy, James Lawrence and Robert Heffner, Applied Marine Research Laboratory, Old Dominion University, Norfolk, Va. 23529. Historically policies of the US federal government encouraged the conversion of wetlands into filled or drained lands for agriculture or development. These policies and private efforts of similar nature resulted in the loss of millions of acres of wetlands throughout the US. As valuable attributes of such habitats became apparent, political support for protection of wetlands emerged in the 1970's primarily through Section 404 of the Clean Water Act (CWA). Private and political sectors for economic growth and the environmental community disagreed on the nature of federal regulation of wetlands. As a result, regulatory agencies began to develop wetland delineation manuals for the purpose of identifying jurisdictional wetlands. In 1989 the FWS, ACOE, NRCS and EPA adopted the Federal Interagency Manual, intended to ensure consistent regulation of wetlands, only to receive immediate complaints from regulated groups. A 1991 revision received criticism from the scientific and environmental community. In the interim, Congress directed the ACOE to revert to its own 1987 delineation manual to determine jurisdictional wetlands under the CWA. In 1993, at the request of Congress, the National Research Council (NRC) evaluated the scientific basis for characterization of wetlands in the federal regulatory system. The NRC study agreed with the regulatory basis of the 1989 Interagency Manual. Currently, Congress is ignoring the NRC study by considering legislation that would classify wetlands based on importance with only those of "critical importance" receiving protection now provided to all wetlands under the CWA. The Dismal Swamp of Va. is a classic example of wetlands that have been impacted by human and political efforts. Human impacts include drainage, dredging and filling of the Swamp. The newly proposed House bill, if passed, will leave much of the existing Dismal Swamp federally unprotected and subject to more degradation.

SWELLING PRESSURE INVESTIGATIONS OF ENDCAV AND FREDERICK SOILS. K. Hattori and W.C. Sherwood. Dept. Geology, James Madison Univ., Harrisonburg, VA 22807. Two residual soils (Endcav and Frederick Series), weathered from limestone in Rockingham County, VA, tested using a Potential Volume Charge (PVC) instrument. First, the Endcav soil, mapped as expansive, was tested for expansion at several different moisture contents. Expansion was found to increase progressively with moisture content up to 7.5% then to decrease from 7.5% to 15%. The pressure generated at 7.5% reached 3522 lbs/sq.ft., which is rated as critical. A second experiment involved 10 identical tests using air dried soils for each series to determine test variability. Pressures were found to range from 1601 lbs/ft<sup>2</sup> to 3122 lbs/ft<sup>2</sup>, with a mean of 2424 lbs/ft<sup>2</sup> and standard deviation of 431 lbs/ft<sup>2</sup> for the Endcav, and 1665 lbs/ft<sup>2</sup> to 2722 lbs/ft<sup>2</sup> with a mean of 2071 lbs/ft<sup>2</sup> and a standard deviation of 317 lbs/ft<sup>2</sup> for the Frederick. Using a 5% value for tolerance and sampling risk it was determined that 51 tests for the Endcav and 38 tests for the Frederick would be required in order to secure a statistically valid mean. Finally, a t-test was conducted using the Endcav and Frederick test results. It was determined, that the means while appearing to be significantly different did not show a statistically valid difference at the 5% confidence level. High test variability, resulting from operator inexperience, was interpreted as the cause of the inconclusive results.

EFFECTS OF ORGANIC MATTER RICH TOPSOIL AND pH ON GERMINATION, GROWTH, AND METAL UPTAKE BY CORN GROWN IN FLUE DUST CONTAMINATED SOIL. Christopher A. Impellitteri, Prog. in Geol., Old Dominion Univ., Norfolk, VA 23529. The effect of pH on the mobility and availability of trace metals in soil is well documented. Trace metal mobility (and availability) generally increases with decreasing soil pH. This effect may cause mortality in plants grown in contaminated soil at low pH. Mortality may be decreased with the addition of an organic rich topsoil amendment. Preliminary experiments suggest that corn, germinated and grown in heavy metal contaminated soil with an organic rich topsoil amendment, has a higher biomass at harvest than corn grown in contaminated soil alone. For some metals, the higher biomass resulted in greater overall removal of the metal from the soil (e.g. Zn). For other metals (e.g. Pb), removal from the soil by plants was greater without the topsoil amendment. Further research is necessary in order to optimize conditions for phytoremediation of contaminated soils.

POSITION OF THE SALTWATER/FRESHWATER INTERFACE OF ACCOMACK COUNTY, VIRGINIA: PRELIMINARY RESULT OF A BASELINE SURVEY USING RESISTIVITY METHODS. Ali A. Nowroozi, Director, Program in Geological Sciences and Department of Mathematics and Statistics, and Stephen B. Horrocks\*, Program in Geological Sciences, Old Dominion Univ., Norfolk, VA, 23529. Ground water is the only source of freshwater in the Eastern shore of Virginia. Large volume of groundwater withdrawals for various uses have caused water-level declines and concern about the possibility of future saltwater intrusion. Positions of the poor quality and salty waters are known at several locations from the well log data. Good quality freshwater has a resistivity of more than 70 Ohm m, while saline water has a resistivity of less than 4.5 Ohm m. Preliminary results from a baseline direct current resistivity survey consisting of 47 soundings, may provide distributions of saltwater, brackish water, poor quality and good quality water at resistivities of about 4.5, 15, 30, and 70 Ohm m respectively. We produced contour maps of depths variations to 70, 30, 15 and 4.5 Ohm m resistivity surfaces. Analysis of the contour maps reveals that good quality water is limited to a small area in the middle part of the county, at a depth of 30 to 40 m, mostly away from the coast. However poorer quality water may be found in a larger area up to a depth of about 150 meters. Depths to the saline water with 4.5 Ohm m resistivity are as shallow as 20 to 40 meters near several coastal areas and below 150 m in the interior region. We also produced contour maps of the resistivity variations at 5, 10, 20, 30, 50, 70, 100, and 150 m depth levels, and assumed the 30 Ohm m contour as the resistivity at the saltwater freshwater interface. At 5 and 10 m levels this contour is slightly inland close to coastal region of the Chesapeake Bay, in the east, and close to the Wallops and Assateague Islands, in the west. Between 20 to 70 m this contour penetrates from the Nandua Creek area in the southwest toward the township of Accomac in the northeast direction. Finally between 100 and 150 m, this contour moves further north toward Temperanceville. Additional surveys near Accomac, Temperanceville and Chicoteague are needed to provide the detailed geometry of the interface in these area.

## INTERACTIVE GEOLOGIC HAZARDS INVENTORIES ON THE COMPUTER.

J.J. VanDerHurst<sup>1</sup> and C.F. Watts<sup>2</sup>, <sup>1</sup>Dept. of Geological Sciences, Virginia Tech, Blacksburg, VA 24061, and <sup>2</sup>Dept. of Geology, Radford University, Radford, VA 24142. The development of an interactive computer system for managing geologic hazards data bases is vital and overdue. As highway rock slopes continue to age and become more unstable and earthen dams are subjected to ever increasing flood events, a more proactive management system is required in order to provide timely information to planners and emergency personnel on demand. In recent years, fatalities have occurred associated with both highway rock slides and earthen dams failures in Southwestern Virginia. By producing a "geologic hazards" map for Southwestern Virginia, critical information concerning highway rock slopes and dams will be readily available. GIS-type applications are the ideal tool for this necessity.

We believe state agencies will find this a useful tool once a prototype is developed. Agencies that will benefit from such a computer model are the Virginia Department of Emergency Services, the Virginia Division of Mineral Resources, the Virginia Department of Transportation, and the Virginia Department of Conservation and Recreation. GIS-type applications are repeatedly proving to be on the cutting edge of geologic data management systems.

THE OLD LEAD MINES AREA IN WYTHE COUNTY, VIRGINIA: A TREASURE TROVE OF GEOHISTORICAL RESOURCES. Robert C. Whisonant, Dept. of Geology, Radford Univ., Radford, VA 24142. Few Virginians seem aware of the rich cultural heritage combining geology, geography, and human history afforded by the old lead mines area in southern Wythe County. The lead deposits are part of a Mississippi Valley-type, carbonate-hosted metallic sulfide belt in the Shady Dolomite in the Great Valley just west of the Blue Ridge. Pre-Civil War historic notes of interest include: opening of the lead mines in 1756 by Col. John Chiswell; writing of the Fincastle Resolutions in 1775; birth of Stephen F. Austin in 1793; and construction of the Shot Tower from 1807 to 1812. During the Civil War, 1861-1865, the Wythe County lead mines produced virtually all of the Confederacy's domestic lead supply. Despite Union threats in July 1863 and May 1864, the lead mines remained untouched until December 1864, when Gen. George Stoneman's troops destroyed not only the lead works, but salt and iron operations in the region as well. This same raid also devastated the Virginia and Tennessee railroad, over which the lead and other valuable materials moved. After the Civil War, the Austinville-Ivanhoe mines produced primarily zinc until final closure in 1981.

REVISING THE GEOLOGY CURRICULUM: A NEW COURSE IN EROSION AND SEDIMENT CONTROL/STORMWATER MANAGEMENT. Robert C. Whisonant, Dept. of Geology, Radford Univ., Radford, VA 24142. The geology profession is changing rapidly as environment-related jobs replace mineral extractive ones. College and university geology curricula must change also or face extinction. Radford University's geology program has long emphasized engineering geology, which we broadly define to include hydrogeology and environmental geology as well as other topics typically found in applied geology. I developed a new course in erosion and sediment control/stormwater management to enhance our curriculum. Inspiration for the course came through my involvement as a technical expert in a sediment injury case when I realized how poorly trained most geologists are in this new field. The course was designed to provide senior-level geology majors (or those in related fields) with training normally found only in courses in civil engineering, agronomy, or landscape architecture. The course involved a mix of lectures, classroom discussions of reading assignments, problem solving, field trips, computer software demonstrations, and interaction with guest professionals. A major written research paper and oral presentation of that material were required as "capstone" activities. Feedback from the students was very positive. They seemed genuinely excited about their research projects and particularly about participating in one of the few erosion and sediment control/stormwater management courses taught in a geology department in the nation.

GEOMORPHOLOGY AND PALEOBOTANY OF A MAMMOTH-BEARING SITE, RUSSELL COUNTY, VIRGINIA. Thomas A. Wynn and G. Richard Whittecar, Prog. Geological Sciences, Old Dominion Univ., Norfolk, Va. 23529. The Ratcliff Pleistocene Site lies in a first-order valley on the north-western slope of Clinch Mountain that drains into Moccasin Creek. Preserved within the deposit are mastodon bones, logs, pine cones, and other plant macrofossils. Radiocarbon analyses indicate the age of the organic-rich sediments range from 29,100 BP to >44,000 BP, a time period with no fossil remains reported in this region of the Appalachians. The stream which carved the valley was diverted midway down the mountain by a large landslide, presumably before the Late Pleistocene. Debris flows and other alluvial deposits from adjacent streams raised the valley bottom of Moccasin Creek and dammed the abandoned lower valley. As much as 5.2 m of organic-rich sediments accumulated in the hollow prior to 29,000 BP. Uniformly dark grey, this sediment consists of alternating layers of compact silty clay and poorly sorted stoney silty clay. Sedimentation rates increase upward through the section with radiocarbon dates from 0.009 cm/yr to 0.02 cm/yr to 0.05 cm/yr, probably due to increased influence of debris flow deposition. After 29,000 BP, debris fan deposits from adjacent valleys buried the site in nearly 5 m of pebbly colluvium.

Oldest sediments preserve plant remains of a boreal forest that became increasingly wet by ~35,000 yBP. By 29,000 yBP the site became boggy with grass and some open water areas.

ELEVATION AS A CONTROL ON THE FORMATION OF BOULDER STREAMS IN THE BLUE RIDGE OF VIRGINIA. Marc D. Zamkotowicz and G. Richard Whittecar, Prog. Geological Sciences, Old Dominion Univ., Norfolk, Va. 23529. Bouldery colluvium carpets the bottoms of high-altitude valleys in the Blue Ridge Mountains from Pennsylvania to North Carolina. Some of these deposits contain tightly-wedged clasts with a sandy matrix that fills only the lower portions, often exhibit a convex-upward cross-valley profile, and are continuous and relatively uniform masses that grade up-valley into talus. Many workers now recognize these features as boulder streams (block streams) formed by periglacial processes. If this periglacial hypothesis is correct, boulder streams with these characteristics should be ubiquitous in small valleys above a critical elevation that rises to the south, a gradient controlled by Pleistocene climates. Mapping in four study areas across Virginia with relatively massive, crystalline rock types and with a variety of valley head elevations suggests that the critical elevation for the formation of boulder streams increases to the south (approximate latitude::estimated critical elevation - 39.2°::500 ft; 37.8°::1600 ft; 37.5°::2500 ft; 36.7°::4300 ft). Initial analyses of clast orientation data indicate that high-angle tabular clasts, usually oriented subparallel to the valley axis, are common in Virginia boulder streams. Such "vertical" clasts are a very common feature in modern periglacial environments due to frost action. Thus all results of this study support the periglacial hypothesis for boulder stream formation.

## Materials Science

CONSTRAINED-FILM SINTERING OF GLASS. Jaecheol Bang and Guo-Quan Lu\*, Dept. of Materials Science and Engineering, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061-0237. The densification behavior and microstructural evolution of constrained film were studied in a borosilicate glass (BSG)+silica system because of their applications in microelectronic packaging technologies. Powder packings with varying ratios of BSG to silica were prepared by casting powder + binder slurries into freestanding films and films constrained on a rigid substrate. Sintering experiments were carried out in a hot stage at temperatures between 715°C and 775°C. Optical techniques were developed for measuring the densification rates of the free and constrained films, and in-plane stresses generated in the constrained-sintering films. The densification rates measured in the constrained films were slower than those in the free films. However, the substrate constraint had no effect on the activation energy of densification which was found equal to  $385 \pm 10$  kJ/mol, the same for both free and constrained films. We also measured in-plane stresses developed in a BSG film during its constrained sintering on a rigid substrate. The measured stresses were tensile and rose rapidly from zero to a maximum level of 20 kPa during the initial stage of sintering and gradually decreased to zero at the final stage; these stresses are considerably smaller than those calculated from available microstructural models. We believe that the stresses could have prevented a few large pores from shrinking during the initial stage of sintering, which then leads to an overall lower density and larger pores in the constrained film.



MEASUREMENT OF IN-PLANE STRESSES DURING THE SINTERING OF CONSTRAINED ZINC OXIDE FILMS. Jesus Noel Calata & Guo-Quan Lu\*, Dept. of Materials Science and Engineering, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061-0237. Many microelectronics products such as packages and substrates undergo constrained-film sintering during fabrication. Sintering of constrained films not only leads to reduced densification but also to a buildup of in-plane stresses in the film. These stresses can be particularly large in polycrystalline materials compared to amorphous materials due to the absence of a fast relaxation mechanism. They can lead to defects in sintered products such as camber, distortion and cracking. In this study, the in-plane stresses during the isothermal sintering of zinc oxide powder films constrained on silicon were experimentally determined using an optical setup. In this technique, the curvature of the constrained film was monitored using a position sensitive photodetector. The results indicated stress levels an order of magnitude higher than those observed in constrained glass films. The time-dependent stress profiles show a stress buildup during the early stage of sintering corresponding to rapid densification. The stress then gradually decreases as the densification rate decreases. There was a significant level of stress that remained after sintering. This behavior was observed at all the sintering temperatures used. For the same relative density, the stress also decreased with increasing sintering temperature which suggests a temperature dependence of the in-plane stresses.

*Structure/Property relationships for a single tow ceramic matrix composite*, P.E. Cantonwine and H.N.G. Wadley\*, University of Virginia, Charlottesville, VA. As an alternative to SiC monofilaments, both 3M and UVa have investigated reinforcing metal matrices with a lower cost  $\text{Al}_2\text{O}_3$  tow fiber (Nextel 610). To avoid the many difficulties of trying to uniformly distribute  $10\ \mu\text{m}$  fibers in a metal matrix, a novel processing technique was developed. This technique involves "gluing" the 420 filaments of the  $\text{Al}_2\text{O}_3$  tow together with a porous alumina binder. The result is a single tow ceramic matrix composite (CMC) or  $\text{Al}_2\text{O}_3/\text{Al}_2\text{O}_3$  hybrid fiber which may be coated with matrix material via physical vapor deposition, tape casting or plasma spray deposition. Our current objective is to fully understand the process/structure/property relationships of the  $\text{Al}_2\text{O}_3/\text{Al}_2\text{O}_3$  hybrid fiber. The process involves infiltrating a single fiber tow with an alumina tape casting slurry followed by a burn-off and sintering stage. The sintering was done at  $1100\ \text{°C}$  for 10 hr. which created a partially consolidated (i.e. porous) alumina binder. The volume fraction of filaments in the hybrid fiber were between 50 and 65%. Tensile tests were performed on both as-received fiber tow and  $\text{Al}_2\text{O}_3/\text{Al}_2\text{O}_3$  hybrid fiber. Ideal bundle theory models over-estimated the tensile results and it is hypothesized that non-ideality in the tow (e.g. misalignment) caused the lower than predicted strengths. Initial observations indicated the load transfer was controlled by the shear strength of the porous binder.

CONTROLLING THE FORMATION OF IRON-ZINC ALLOYS IN COMMERCIAL GALVANNEALED STEEL. <sup>†</sup>Desmond C. Cook<sup>†</sup> and Richard G. Grant<sup>‡</sup>, <sup>†</sup>Department of Physics, Old Dominion University, Norfolk, VA 23529, and <sup>‡</sup>Department of Physics, Roanoke College, Salem, VA 24153. Analyses of thirty commercially produced galvaneal, (Zn-Fe alloy), coatings on steel have been completed using Mössbauer spectroscopy and Scanning Electron Microscopy. Scattering Mössbauer spectra were recorded in-situ using conversion electrons, (CEMS), to identify the surface phases and re-emitted  $\gamma$ -rays, (GMS) to identify all phases present in the coatings. The measured phase fractions in each coating were compared with SEM metallographic cross-section analysis, galvaneal production parameters and mechanical properties of the coatings. It has been concluded that the zinc-rich Zeta phase forms only at low anneal temperatures less than  $500\ \text{°C}$ . At higher temperatures up to  $550\ \text{°C}$ , the amount of Delta phase which forms, as well as its iron concentration, increases. For anneal temperatures between  $550\ \text{°C}$  and  $600\ \text{°C}$ , the fractions of the Gamma-1 and Gamma phases increases at the expense of the Delta phase. #Supported in part by the International Lead Zinc Research Organization, Inc., grant ZM-403 and Virginia's Center for Innovative Technology, grant MAT MFG-95-0-130.

AN IMPROVED N-TYPE MATERIAL FOR THERMOELECTRIC COOLING DEVICES IN THE  $(\text{Bi}_2\text{Te}_3)(\text{Sb}_2\text{Te}_3)(\text{Sb}_2\text{Se}_3)$  ALLOY SYSTEM. M. H. Ettenberg, W. A. Jesser and F. D. Rosi\*, Department of Materials Science and Engineering, University of Virginia, Charlottesville, Virginia, 22903. The pseudoternary alloy of  $(\text{Bi}_2\text{Te}_3)(\text{Sb}_2\text{Te}_3)(\text{Sb}_2\text{Se}_3)$  has been explored for over twenty-five years with little progress in the figure of merit. The p-type alloy was established as  $(\text{Bi}_2\text{Te}_3)_{2.5}(\text{Sb}_2\text{Te}_3)_{1.2}(\text{Sb}_2\text{Se}_3)_3$  with Te as a dopant and this produced material with a figure of merit of  $3.4 \times 10^{-3}/\text{K}$ . The n-type alloy was  $(\text{Bi}_2\text{Te}_3)_{90}(\text{Sb}_2\text{Te}_3)_4(\text{Sb}_2\text{Se}_3)_5$  doped with  $\text{SbI}_3$  with a figure of merit of  $3.2 \times 10^{-3}/\text{K}$ . Increasing the composition of  $\text{Sb}_2\text{Te}_3$  in the alloy theoretically increases the figure of merit by lowering the lattice contribution to the thermal conductivity, at the same time making the alloy more p-type in nature. Using multiple dopants, Te and  $\text{SbI}_3$ , has permitted the creation of an n-type alloy with a single dopant because the material is inherently a strong p-type material and the solubility of the dopants would be exceeded before the optimum thermoelectric properties were reached. Using multiple dopants in this new alloy produces n-type material with a figure of merit of  $3.4 \times 10^{-3}/\text{K}$ . The present p-type material also benefits from the use of multiple dopants, Te and  $\text{SbI}_3$ . Higher figure-of merit material has been achieved without precipitating pure Te commonly found as a deleterious second phase in the p-type alloy. Using a combination of the two dopants, figures of merit as high as  $3.7 \times 10^{-3}/\text{K}$  have been achieved in the p-type alloy.

FILM SYNTHESIS VIA DIRECTED VAPOR DEPOSITION. James F. Groves and Haydn N. G. Wadley\*. Materials Science and Engineering Dept. Univ. of Virginia, Charlottesville, VA 22903. Economic considerations are motivating the development of new, less expensive vapor deposition processing technologies capable of beneficially manipulating process parameters to create high quality thick and thin film microstructures. A directed vapor deposition (DVD) technique has been invented and is now being explored as a potential thick or thin film synthesis tool. The technique exploits supersonic inert carrier gas jets in combination with electron beam evaporation under low vacuum conditions (0.01-10 Torr) to atomically spray deposit a potentially wide variety of monolithic and composite materials. The most important processing parameters that control deposition (the carrier gas velocity and the deposition chamber pressure) have been identified, and their effect upon deposition efficiency for flat and fiber substrates has begun to be systematically explored as the first step in a study of process-property relationships in the DVD system. A computational fluid dynamics model is being used in combination with a kinetic theory of gases based vapor atom tracking model to help identify the role of carrier gas dynamics in controlling adatom deposition efficiency, energy, distribution, and angle and to assess the ability of the technique to manipulate other important process parameters.

EVALUATION OF INTERFACIAL ADHESION OF FIBER REINFORCED POLYMER COMPOSITES BY VIBRATION DAMPING. Weiqun Gu<sup>1</sup>, Guo-Quan Lu<sup>1\*</sup>, H. Felix Wu<sup>2\*</sup>, and Stephan L. Kampe<sup>1\*</sup>, <sup>1</sup>Department of Materials Science and Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0237, and <sup>2</sup>Composites Innovation, Owens-Corning Science and Technology Center, Granville, OH 43023. The mechanical behavior of fiber reinforced composites is largely determined by adhesion at fiber-matrix interfaces. A fundamental understanding of the interfacial region and a quantitative characterization of the level of interface adhesion can contribute to an evaluation of the mechanical behavior and capabilities of composite materials. Among numerous techniques for interface characterization, vibration damping method has attracted ever more attention, because it provides a sensitive and nondestructive detection of the interfacial region. The damping at the interfaces will therefore enable us to quantify the interface adhesion. The technique will facilitate the materials industry to rapidly determine the mechanical properties of composites. In present research, a new optical system for measuring vibration damping was introduced, and a model for evaluating the adhesion between fiber and matrix from damping parameters was developed. A quantitative relationship between the dynamic (vibration damping) and static (interfacial shear strength) adhesion measurements was established. The experiment data from glass fiber reinforced epoxy resin composites with different interfacial treatment showed a good agreement with the developed model.

TENSILE BEHAVIOR OF CROSS-PLY BLACKGLAS™ CMC'S. Rebecca K. Herrmann\*, Stephen L. Kampe\* and William A Curtin\*, Materials Science and Engineering Department, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061. The tensile behavior of a symmetric cross-ply Blackglas™ ceramic matrix composite (CMC) reinforced with Nicalon fibers was observed. Initial observations of the composites showed significant porosity and some cracking in the Blackglas™ samples. Fracture mirror measurements were observed on the fracture surface of the fibers to determine the in-situ strength of the Nicalon fibers. Resulting characteristic strength and Weibull modulus values combined with measured fiber pullout lengths were then used to determine material parameters such as the ultimate tensile strength, strain to failure, work of pullout, sliding distance at the characteristic strength, and interfacial shear stress. Comparisons of measured and calculated ultimate tensile strengths and strains to failure showed good agreement. This research was sponsored by the Naval Surface Warfare Center (NSWC) in Dahlgren VA.

IDENTIFICATION OF THE CORROSION PRODUCTS ON THREE WEATHERING STEEL SAMPLES USING IN-SITU MÖSSBAUER ANALYSIS. Sei Jin Oh and D.C. COOK, Department of Physics, Old Dominion University, Norfolk, VA 23529.

The atmospheric corrosion products formed on the three samples of weathering steel, have been identified using Mössbauer spectroscopy and x-ray diffraction. The three samples were exposed to the atmosphere for times between 11-29 years in two different industrial environments (one in Bethlehem, Pennsylvania, U.S.A. and the another in Amagasaki, Japan). The scattering Mössbauer spectroscopy and x-ray diffraction were used to analyze the iron oxide phases while they remained intact of the steel substrate. The coatings on the three samples were found to be very similar, with each containing a large fraction (>80%), of  $\gamma$ -FeOOH (lepidocrocite), and a smaller fraction (~15%), of  $\alpha$ -FeOOH (goethite). Two samples contained a very small amount (3%), of  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> (maghemite). No  $\beta$ -FeOOH (akaganeite) was not found in the corrosion products. The result suggest that, due to the similar fractions of the iron oxide phases in each corrosion coating, the three samples had reached phase stability and that weathering steel probably does not undergo any appreciable weathering after 11 years with exposure .

THE CREEP BEHAVIOR OF TI-6242S/SCS-6 CONTINUOUS FIBER COMPOSITES AT 600°C. Dana T. Russell and H.N.G. Wadley\*, Dept. of Materials Science and Engineering, Univ. of Va, Charlottesville, VA 22903. The longitudinal creep behavior of a Ti-6Al-2Sn-4Zr-2Mo-0.1Si (wt%) matrix unidirectionally reinforced with about 40 vol% silicon carbide (SCS-6) fibers fabricated by plasma-spray deposition has been experimentally investigated and compared to a recent creep rupture model. The Ti-6242S/SCS-6 creep response has been measured at 600°C in argon at stresses ranging from 759 to 1112 MPa. The composite rupture life followed the trend of the creep model (exhibiting a decreasing life with increasing applied stress) but exhibited a 275 MPa strength degradation relative to the model prediction. Modifications of the creep model to account for the effects of 1) thermal residual axial stresses in the matrix and the fibers, 2) matrix transient creep and 3) pre-existing fiber fractures and fiber bending stresses (observed metallographically) were investigated to explain this strength loss. Only the latter contribution had a significant effect on the creep rupture life and the best correlation with the data was obtained assuming 50 breaks per meter of fiber which was similar to the effective number of fractures observed in the as-consolidated composites. The creep response of the Ti-6242S/SCS-6 composites was therefore found to be dependent on processing damage.

PROCESSING OF ALUMINUM ALLOYS CONTAINING DISPLACEMENT REACTION PRODUCTS. M. T. Stawovy, A. O. Aning and S. L. Kampe, Materials Science and Engineering Department, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 24061. The use of aluminum alloys at high temperatures requires the use of dispersion strengthening as the primary strengthening mechanism. Historically, mechanical alloying (MA), followed by powder metallurgy consolidation techniques, has been used to produce dispersion strengthened aluminum alloys. In that case, surface oxides or other oxides added to the powder mixture are primarily responsible for strengthening. In this study, composite powders of aluminum - (1-20 mol%)  $Fe_2O_3$  were first produced using MA. A "thermite-type" displacement reaction, which leads to the formation of the dispersoids of  $Al_2O_3$ ,  $Al_{13}Fe_4$  and  $AlFe$ , was initiated in two different ways. The reaction was triggered in the mill by prolonged milling, or the premilled powders were annealed to produce the dispersoids. Dispersoid size formed in this manner depended on the MA milling conditions. Longer milling times resulted in a reduction of the reaction product size.

ATOMISTIC SIMULATION OF DEFECTS IN INTERMETALLICS. Christophe Vailhé and Diana Farkas, Dept. of Materials Science and Engineering, Virginia Tech, Blacksburg, VA 24061-0237. Although aluminides with the B2 crystal structure have good properties for high temperature applications, the strong ordered bonds that make them durable at high temperature also make them too brittle at room temperature for industrial fabrication. In order to better understand this lack of ductility, molecular statics simulations of planar fault defects and dislocation core structures were conducted in a series of B2 aluminides with increasing ordering energy (FeAl, NiAl, CoAl). As the cohesive energy increases from FeAl to CoAl, antiphase boundary and unstable stacking fault energies increase resulting in more constricted dislocation core spreadings. This constriction of the cores decreases the mobility of dislocation with planar core structures and increases the mobility of dislocations with non-planar cores. The simulation results in NiAl were compared with in-situ straining observations of dislocation motions. Both in-situ observations and atomistic simulations agreed on the zig-zag shape of the  $\langle 100 \rangle$  dislocation with an average screw orientation. In this configuration, the mobility of the dislocation is severely reduced.

## Medical Science

DIFFERENTIAL EXPRESSION OF CB1 CANNABINOID RECEPTOR mRNA IN THP-1 MACROPHAGE-LIKE CELLS. Douglas L. Anders\*, Denise A. Dove Pettit<sup>†</sup>, Guy A. Cabral. Dept. of Microbiology and Immunology, Va. Commonwealth Univ., Richmond, Va. 23298. Cannabinoids, such as delta-9-tetrahydrocannabinol (THC), exhibit a multiplicity of physiological effects such as anamnesia, analgesia, and suppression of immune cell function. The recent identification of both neural (CB1) and peripheral (CB2) cannabinoid receptor subtypes suggests a mechanism by which cannabinoids mediate these diverse effects. The objective of this study was to apply a novel and highly sensitive mutagenic reverse transcription-polymerase chain reaction (MRT-PCR) strategy for the definition of differential cannabinoid receptor mRNA expression in immune cells. MRT-PCR allows for discrimination of amplification of genomic DNA versus that of cDNA and for standardization for relative quantities of mRNA using genomic DNA as an internal standard. Using this technique, mRNA for CB1 was identified in human pre-monocytic THP-1 cells. Total RNA collected from interferon-gamma (IFN- $\gamma$ )-primed THP-1 cells, LPS-activated THP-1 cells, or THP-1 cells simultaneously exposed to IFN- $\gamma$  and LPS, was subjected to MRT-PCR and results were compared with those obtained for untreated THP-1 cells. Analysis of amplification products indicated that IFN- $\gamma$  and LPS treatment alone reduced CB1 mRNA expression in THP-1 cells. Furthermore, the reduction of CB1 mRNA was maximal (>90%) when THP-1 cells were treated with IFN- $\gamma$  plus LPS. These results suggest that CB1 receptor mRNA expression in THP-1 macrophage-like cells is modulated during macrophage progression to full activation. Supported by NIH awards DA05832, DA09158, and <sup>†</sup>T32 DA07027.

CHARACTERISTICS OF NICOTINE'S DISCRIMINATIVE STIMULUS IN C57/BLACK 6 MICE. David Arthur, Stephen Varvel, Lori Karan, J. Randy James, and John A. Rosecrans, Dept. of Pharmac., Va. Commonwealth Univ., Richmond, Va. 23298-0613. Previous research conducted in this and other laboratories has examined the role of genetic factors in determining sensitivity to nicotine in a variety of behavioral and physiological measures the rat. More recent research further indicates that genetic factors can also influence the level of sensitivity to nicotine when serving as a discriminative stimulus (DS) in different rat strains. However, there has been little work examining the influence of genotype on the DS properties of nicotine in mice, a species that has played a major role to understanding the relationship between genetics and nicotine's pharmacological effects. To further our understanding of the role genetics and the ability of nicotine to exert DS control of behavior in the mouse, a group of C57BL/6 mice was trained to discriminate 0.4mg/kg (-)nicotine from saline using a two-lever operant procedure. Nicotine's DS in C57BL/6 mice appears to be similar to that generated in the rat. Results from behavioral tests with other drugs indicated that (+)amphetamine exhibited a partial generalization while (+)nicotine fully generalized with nicotine. Tests of antagonism with mecamylamine and scopolamine further showed the cholinergic specificity of the nicotine DS in the mouse; mecamylamine but not scopolamine did completely antagonize the nicotine DS. This work lays the groundwork for future comparisons of different mouse strains' sensitivities to nicotine's DS as well as using this behavioral model to search for new nicotinic-acetylcholinergic receptor (nAChR) agonists and antagonists. (NIDA grant DA-00183)

CYCLIC NUCLEOTIDE-DEPENDENT KINASES HAVE DIFFERENT ROLES IN THE BRAIN AND SPINAL CORD OF MORPHINE-TOLERANT MICE. Marissa A. Bernstein and Sandra P. Welch, Dept. of Pharmacology and Toxicology, Virginia Commonwealth Univ., Richmond, VA 23298. Many studies suggest that phosphorylation plays a role in the neuroplasticity associated with opioid tolerance. We examined the effect of inhibiting cyclic nucleotide-dependent protein kinase activity in the brain or spinal cord of morphine-tolerant mice. KT5720, a cAMP-dependent protein kinase (PKA) inhibitor, or KT5823, a cGMP-dependent protein kinase (PKG) inhibitor, was centrally administered in morphine-tolerant and placebo-treated mice prior to a systemically administered challenge dose of morphine. KT5720 administered intracerebroventricularly (i.c.v.) completely reversed morphine tolerance in the tail-flick assay; KT5823 had no effect on morphine via this route. When either of these compounds was administered intrathecally (i.t.), the activity of morphine was greatly diminished in the tolerant animals, with no effect on morphine antinociception in the placebo group. Upregulation of PKA activity in the brain may be critical to the expression of tolerance to the antinociceptive effects of morphine. In the spinal cord, however, the activity of cyclic nucleotide-dependent protein kinases, and possibly their substrate proteins, may be affected by chronic morphine exposure such that inhibition of these kinases produces hyperalgesia. (Supported by NIDA grants DA07027, DA00186, DA06031.)

ETHANOL-LIKE DISCRIMINATIVE STIMULUS PROPERTIES OF SEVERAL ALKYL BENZENE SOLVENTS. Scott E. Bowen, M. Tokarz and R.L. Balster. Dept. of Pharmacology & Toxicology, Med. Col. of Va., Richmond, VA 23298-0613. It has been hypothesized that abused solvents may have behavioral and pharmacological effects that are similar to those of abused depressant drugs such as barbiturates and ethanol. Drug discrimination procedures have been used previously in our laboratories to access the perception of several of these inhalant effects in laboratory animals. In an attempt to further clarify these discrimination effects, the present experiment was designed to compare the discriminative stimulus effects of ethanol (ETOH) and several volatile alkylbenzenes. Male albino mice were trained to discriminate between i.p. injections of ETOH (1.25 g/kg) and saline in a two-lever operant task in which responding was under the control of a fixed-ratio 20 (FR20) schedule of food presentation. Stimulus generalization was examined after 20-min inhalation exposures to toluene (1000-6000 ppm), ethylbenzene (500-4000 ppm) and propylbenzene (500-4000 ppm). Concentration-related increases in ETOH-lever responding were observed for all three volatile compounds with toluene displaying the highest levels of ethanol-lever responding. Supported by NIDA grant DA-03112 and DA-05670.

A NOVEL CLASS OF COVALENT CROSS-LINKERS OF HEMOGLOBIN SUBUNITS AS ENHANCERS OF OXYGEN RELEASE. Telih Buyiri and Donald J. Abraham. Dept. of Medicinal Chemistry, Va. Commonwealth Univ., Richmond, Va. 23298-0540. The N-terminal amino region of hemoglobin (Hb)  $\alpha$  subunits was modeled, using GRID, with the aim of finding additional binding interactions after a Schiff base has formed between the protein and an aldehyde molecule. The GRID carboxylate and hydroxyl probes identified two sites for electrostatic and hydrogen bonding interactions. Monoaldehyde acids were modeled to form a Schiff base with the Val 1 $\alpha$  and a salt bridge with Arg 141 $\alpha$  of the opposite subunit. It was envisioned that these molecules would produce high affinity hemoglobins. X-ray analyses indicated that the molecules did bind as modeled *de novo* in symmetry related pairs. However, all Hb-effector solutions exhibited right shift oxygen dissociation curves opposite to that expected. It was hypothesized that the observed right shift was due to the formation of a salt bridge between the carboxylate ion of the monoaldehyde and the guanidinium ion of Arg 141 $\alpha$  of the opposite subunit. The salt bridge ties together the  $\alpha$  subunits across the molecular symmetry axis and as a result, shifts the allosteric equilibrium in favor of the T-state. To investigate this hypothesis a series of bisaldehydes with varying chain lengths were designed, synthesized, and evaluated as allosteric effectors of Hb. X-ray analyses of all the bisaldehyde-Hb complexes revealed exclusive cross-links between Val 1 $\alpha$  and Lys 99 $\alpha$  of the opposite chain. Even though the two Val 1 $\alpha$  nitrogens are ideally spaced to form cross-links, the long flexible bisaldehydes did not bind to this locale; they prefer to bind along cavity walls rather than span large open spaces with few chances for interaction. The tighter the cross-link, the more stabilized the T-state and the stronger the allosteric effect that is produced. The cross-linked hemoglobins retain cooperativity, exhibit low oxygen affinity, and may be potential candidates for use as cell-free Hb based blood substitutes.

PARTIAL PURIFICATION OF GLYCOPROTEINS FROM NAEGLERIA FOWLERI. Timothy M. Breeden, Dept. of Chem., Fl. State Univ., Tallahassee, Fl. 32306, & F. M. Cabral, Dept. of Micro. and Immunol., Va. Commonwealth Univ., Richmond, Va. 23298. The genus Naeqleria is comprised of a distinctive group of free-living amoebae found in soil and freshwater lakes and ponds. Both pathogenic and nonpathogenic species have been identified but only one species, Naeqleria fowleri, has been isolated from infected human patients. N. fowleri is the causative agent of Primary Amoebic Meningoencephalitis (PAME); a rapidly fatal disease of the central nervous system (CNS). Membrane proteins (specifically surface glycoproteins) are under investigation because they may play a role in pathogenicity by mediating recognition, attachment and invasion. Surface proteins of highly pathogenic N. fowleri may function to resist complement mediated-lysis. The present study was undertaken to identify possible virulence factors associated with the highly pathogenic strain of N. fowleri, LEEmp. Membrane proteins from LEEmp were partially purified using preparative SDS-PAGE gel electrophoresis. The fractions of interest (42-46 kDa) were pooled and concentrated. Lectin analysis and 2D SDS-PAGE gel electrophoresis were used to characterize these protein(s). (Supported in part by grant J-294 from the Thomas F. and Kate Miller Jeffress Memorial Trust, Richmond, Va.)

SCHISTOSOMA MANSONI: SEQUENCE OF A PUTATIVE FEMALE-SPECIFIC cDNA. Catherine Cardullo, Suzanne Wirth\* & Maryanne Simurda. Biol. Dept., Washington & Lee Univ., Lexington, VA 24450. A clone isolated from the female-specific cDNA derived by the subtractive hybridization with male mRNA of the adult worm, *S. mansoni*, has been analyzed. By restriction enzyme mapping, this cDNA, designated 4.28, is 660 base pairs. From the partial cDNA sequence data obtained to date and potential open reading frame this cDNA encodes a 128 amino acid protein.

ISOLATION OF PDGF- $\alpha$  mRNA IN INTIMAL CELLS FOLLOWING ANGIOPLASTY BY IN SITU POLYMERASE CHAIN REACTION. Aubri L. Charboneau, Gary L. Brown & Kathryn E. Loesser, Dept. of Biol., Mary Washington Col., Fredericksburg, Va. 22401. The exact mechanism for development of atherosclerosis has not been determined, although platelet-derived growth factor (PDGF- $\alpha$ ), is thought to play an important role in this process by acting as a chemotactic factor attracting smooth muscle cells to the intima and stimulating them to divide. Recent discoveries have shown that dehydroepiandrosterone (DHEA) attenuates the progression of the proliferative responses thought to be involved in the restenosis and atherosclerosis process. The specific aim of this project was to show that DHEA attenuates the proliferative events in restenosis by inhibiting the expression of PDGF- $\alpha$ , and therefore inhibiting the atherogenic actions of PDGF- $\alpha$ . This theory was tested by localizing the mRNA for PDGF- $\alpha$  in the cell following treatment with DHEA. I proposed that there would be a reduced expression of mRNA for PDGF- $\alpha$  in animals treated with DHEA. The results of this experiment show that 100% of the sections in the high DHEA treated group had no PDGF- $\alpha$  expression and 100% of the control (no DHEA) treated group showed significant presence of PDGF- $\alpha$  mRNA in the intima. Therefore DHEA could prove very beneficial in reducing the incidence of restenosis after angioplasty in the future.

EVALUATION OF ASIAN PLANT EXTRACT MATERIALS AS POTENTIAL THERAPEUTIC AGENTS AGAINST *ACANTHAMOEBA*. Dan-My T. Chu, D. Toney\*, F. Marciano-Cabral, Dept. Micro. & Immunol., Va. Commonwealth Univ., Richmond, Va. 23298, & H. Miles\*, Dept. of Chem., Univ. of Central Fl., Orlando, Fl. 32816. Members of the genus *Acanthamoeba* are pathogens which cause amebic keratitis and Granulomatous Amebic Encephalitis (GAE). GAE generally occurs in immunosuppressed and chronically ill individuals. Amebic keratitis can occur in healthy individuals who injure the cornea and are exposed to *Acanthamoeba*. *Acanthamoeba* infections are difficult to treat because the amebae encyst in tissues. We have evaluated empirically, 100 extracts derived from flowers, stems, leaves, roots, or whole plants obtained from Southeast Asia for amebicidal activity against 3 species of *Acanthamoeba*. Plants were extracted with methanol to obtain a polar fraction, designated fraction B, or with methylene chloride to obtain a nonpolar fraction, designated fraction A. Extracts were incubated with  $^3\text{H}$ -uridine labeled amebae and the release of radiolabel was used as an index of lysis. Of the 100 plants tested, three contained natural constituents which exhibited amebicidal activity or growth inhibitory activity in vitro. Plant extracts, 29B and 74A, lysed *Acanthamoeba* but 29A and 74B were ineffective. Extract 75A did not lyse the amebae but exhibited growth inhibitory activity. Further purification of plant extracts are necessary to identify the active amebicidal components.

CANNABINOID ANTAGONIST PRECIPITATES WITHDRAWAL IN MICE AFTER CHRONIC CANNABINOID EXPOSURE. S. Cook and B. Martin, Dept. of Pharmacology and Toxicology, Med. Col. of Va.-Va Commonwealth Univ., Richmond, Va 23298. The existence of physical withdrawal development to cannabinoids has been difficult to establish especially because cannabinoids have such a long half-life. The recently characterized cannabinoid antagonist, SR141716A (SR), has been used to precipitate withdrawal in rats chronically treated with  $\Delta^9$ -THC. Precipitated withdrawal behaviors include tremors, facial rubbing, and hyperactivity. Based on our hypothesis that SR will precipitate withdrawal in mice chronically treated with  $\Delta^9$ -THC, the objective of this study was to develop a mouse model for physical dependence. A dose-response curve for SR was conducted first. Mice were treated with  $\Delta^9$ -THC (10 mg/kg) or vehicle s.c. for 6.5 d.. On day 7, various doses of SR or vehicle were administered i.p. 4 hrs after the last  $\Delta^9$ -THC injection. Immediately following the SR delivery, the mice were observed for 30 mins for unique and typical withdrawal behaviors. Using the same protocol as above, mice were treated with different doses of  $\Delta^9$ -THC or vehicle chronically and then challenged with an acute dose of SR (10 mg/kg or 30 mg/kg) or vehicle. Numerous withdrawal behaviors were observed in both experiments but paw tremors were the most pronounced and dose-dependent with respect to increasing doses of antagonist and  $\Delta^9$ -THC. In summary, SR precipitated withdrawal in mice chronically treated with  $\Delta^9$ -THC and this observation is consistent with SR-induced precipitated withdrawal in rats. Supported by NIDA grants DA07027 and DA03672.

TRAUMATIC BRAIN INJURY-INDUCED LIMBIC EPILEPTOGENESIS: ANATOMICAL AND ELECTROPHYSIOLOGICAL EVIDENCE. Douglas Coulter<sup>1,2\*</sup>, Azhar Rafiq<sup>1\*</sup>, Melissa Shumate<sup>2</sup>, Q-Z. Gong<sup>3\*</sup>, Robert J. DeLorenzo<sup>1\*</sup>, Bruce Lyeth<sup>2\*</sup>, Dept. of Neuro., Phys.<sup>2</sup>, and Neurosurg.<sup>3</sup>, VA. Commonwealth Univ., Richmond, Va. 23298. A major cause of remote symptomatic epilepsy in young adults is traumatic brain injury (TBI). Mechanisms underlying this increased susceptibility are unknown. To model a closed head TBI, adult rats were subjected to a moderate (2.0 atm) lateral fluid percussion injury and studied 7-180 days post-injury. In physiological studies, hippocampal entorhinal cortical (HEC) slices were prepared from TBI and sham-operated control animals and results compared to an animal model of temporal lobe epilepsy, pilocarpine-treated rats (PILO). Ipsilateral HEC slices prepared from TBI animals 1 week post-injury displayed stimulus-evoked afterdischarges which, after  $\geq 5$  trains, developed into continuous epileptiform activity lasting  $> 30$  min in  $> 50\%$  slices. HEC slices prepared 1, 2, and 6 months post-TBI showed greater excitability than control, but much less than the 1 week post-TBI slices. Activity in contralateral TBI slices was similar to controls. PILO slices were similarly hyperexcitable as seen in 1 week post-TBI slices. In anatomical studies, brains were prepared for cresyl violet or Timm's stain. Both two month post-TBI and PILO animals showed similar 20-30% cell loss in hippocampal CA3 and CA1 areas. However, in hilus, TBI animals showed 35-40% while PILO animals showed 70-75% cell loss. Only PILO animals exhibited mossy fiber sprouting into the inner molecular layer. This data suggests that TBI animals have a window of increased susceptibility to epileptic activity which decreases over time. Supported by NIH grants NS-32403 and PO1 NS-25630 to DAC, and NS-29995 to BGL.

PHARMACOLOGICAL INVESTIGATION OF NEW NICOTINIC ANALOGS AT THE  $\alpha_4\beta_2$  RECEPTOR. Kimberly R. Creasy, M. Imad Damaj, and Billy R. Martin. Department of Pharmacology/Toxicology, Virginia Commonwealth University/Medical College of Virginia, Richmond, VA 23298. The predominant nicotinic acetylcholine receptor (nAChR) subtype found in mammalian brain is  $\alpha_4\beta_2$  which therefore, may underlie several of the pharmacological effects of (-)-nicotine. The objective of this study was to identify the effects of nicotine mediated by this receptor subtype. Several novel nicotinic analogs were evaluated for receptor affinity (<sup>3</sup>H-nicotine binding), pharmacological potency (antinociception and locomotor activity) and current induction in *Xenopus* oocytes transfected with the  $\alpha_4\beta_2$  subunits. Our results indicate that the analogs fall into one of three general categories: those similar to (-)-nicotine, such as epibatidine and isonicotine, which bind well to nAChRs, have their behavioral effects blocked by the nicotinic antagonist, mecamylamine and generate currents in oocytes injected with  $\alpha_4\beta_2$  mRNA; secondly those, such as lobeline and N-ethyl-N-norisonicotine, which bind well, are not blocked by mecamylamine and do not illicit currents; and finally those, such as the bridged nicotine analogs and N-cyclopropylmethyl-N-nornicotine, which do not bind, yet produce behavioral effects insensitive to mecamylamine and do not induce currents in oocytes. These results suggest that binding affinity and sensitivity to mecamylamine are corequisites to  $\alpha_4\beta_2$  receptor subtype binding while agonists with different profiles may associate with other nicotinic receptor subtypes. (Supported by PHS grant #DA-0527)

INFLUENCE OF EXOGENOUS UNSATURATED FATTY ACIDS ON *DE NOVO* SYNTHESIS OF SATURATED FATTY ACIDS IN MOUSE AND BOVINE MAMMARY CELL CULTURES. Shella E. Dawson & J. H. Herbein. Dept. of Dairy Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 20461. The capacity of mouse and bovine mammary cells to incorporate cis-9-octadecenoic (18:1), 9,12-octadecadienoic (18:2), 9,12,15-octadecatrienoic (18:3), or conjugated linoleic acid (CLA) into cell lipids was evaluated at 0, 12.5, 25, 50, and 100  $\mu\text{M}$  in the culture medium with 100  $\mu\text{M}$  18:0. Fatty acid treatments were applied daily for 3 days to confluent cells on uncoated plastic petri plates. Data for cellular fatty acid content were expressed as  $\mu\text{g}/\text{mg}$  protein. Mouse cells incorporated 18:1 and 18:2 to a greater extent than bovine cells; whereas, bovine cells incorporated 18:3 and CLA to a greater extent than mouse cells. Inhibition of *de novo* synthesis of 16:0 and desaturation of 18:0 to 18:1 were proportional to extent of 18:3 or CLA uptake by mouse and bovine cells. Due to the anticarcinogenic effects of CLA, which is a byproduct of ruminal biohydrogenation of 18:3 and 18:2, enhancement of the CLA content of bovine milk fat is desirable. Data suggest that bovine milk with increased 18:1, 18:3, and CLA content and decreased saturated fatty acid content can be produced if the supply of these unsaturated fatty acids to the mammary gland are increased. The lack of CLA uptake by mouse cells when CLA concentration in the medium was less than 100  $\mu\text{M}$  suggests that the capacity for enhancement of CLA content of milk of nonruminant species such as humans may be limited. (Supported by a scholarship and operating funds from the John L. Pratt Animal Nutrition Program, College of Agriculture & Life Sciences, Va. Polytechnic Inst. & State Univ.)



**NICOTINE DISCRIMINATION IN RATS: CORRELATION WITH AFFINITY TO NICOTINE RECEPTORS IN THE BRAIN.** Michael A. Dewey, Imad Damaj, John A. Rosecrans, Billy R. Martin. Department of Pharmacology/Toxicology, Virginia Commonwealth University/Medical College of Virginia, Richmond, VA 23298. Nicotine serves as a discriminative stimulus in conditioning experiments. Using rat discrimination model, we investigated the relationship between receptor affinity ( $^3\text{H}$ -nicotine binding) and pharmacological potency in nicotine-trained rats. Results were expressed as percent correct lever presses (% Test). Nicotine agonists of diverse chemical structure and receptor affinity were tested in this model. Nicotine fully generalized in nicotine trained rats with an  $\text{ED}_{50}$  of 0.1 mg/kg. Its effect was blocked by mecamylamine but not hexamethonium, a peripheral nicotinic antagonist. These results suggest the involvement of central nicotinic receptors in the nicotine cue. Furthermore, a high correlation coefficient was found ( $r = 0.991$ ) between receptor affinity ( $K_1$  values) and pharmacological potency ( $\text{ED}_{50}$  value) in nicotine-trained rats for various nicotine agonists tested. Our results suggest the involvement of neuronal nicotinic receptors containing  $\alpha_4\beta_2$  subunits combination in nicotine discrimination stimulus. (Supported by PHS grant #DA-0527)

**DELTA-9 THC ENHANCES THE BLOCKADE OF MECHANICAL NOCICEPTION BY MORPHINE.** Ken L. Fujimori, Sandra P. Welch and Forrest L. Smith, Pharmacology and Toxicology, Medical College of Virginia/ Va. Commonwealth Univ., Richmond, Va. 23298. Morphine is one of most commonly used analgesic agents for pain management. However, in some cases morphine and other opiates used alone have been found to be ineffective in relieving chronic pain and other forms of resistant pain. Furthermore, patients often require increasing doses of morphine with long-term use, and high doses are associated with an increased incidence of unacceptable side effects. The use of Delta-9 Tetrahydrocannabinol (THC) as a therapeutic analgesic agent has been limited because of its psychoactive side effects. However, several studies indicate that inactive doses of THC can enhance the potency of morphine in tests of radiant heat nociception. This study was conducted to test the hypothesis that delta-9 THC enhances the potency of morphine against mechanical nociception. Antinociception was tested using the Ugo Basile test apparatus for mechanical nociception in the hind paw of Sprague Dawley rats. Simultaneous i.p. administration of vehicle and morphine produced an  $\text{ED}_{50}$  value for morphine of 5.0 mg/kg. Simultaneous administration THC (2 mg/kg) and morphine failed to significantly increase the  $\text{ED}_{50}$  value of morphine ( $\text{ED}_{50}$  2.6 mg/kg). However, a 60 minute pretreatment of THC (2 mg/kg) produced an 8.9-fold increase in the potency of morphine ( $\text{ED}_{50} = .44$ ). Our result support the potential value of combining THC and opiates for treating chronic or resistant pain. These data also indicate the importance of time of exposure for the enhancement to occur. In the future we would like study these drug combinations in the Freund's adjuvant chronic pain model.

**DISCRIMINATIVE STIMULUS EFFECTS OF ANANDAMIDE AND METHYLATED FLUOROANANDAMIDE IN  $\Delta^9$ -THC-TRAINED MONKEYS.** Keith M. Golden, Jenny L. Wiley, Raj K. Razdan\*, and Billy R. Martin, Dept. of Pharmacol. & Toxicol., Va. Commonwealth Univ., Richmond, VA 23298 and Organix, Inc., Woburn, MA. In previous research anandamide has been shown to produce behavioral effects in mice characteristic of psychoactive cannabinoids and to substitute for  $\Delta^9$ -THC in rat drug discrimination. However, anandamide has a more rapid onset, lower potency, and a shorter duration of action than does  $\Delta^9$ -THC. The present study examined the discriminative stimulus effects of anandamide in rhesus monkeys trained to discriminate  $\Delta^9$ -THC from vehicle. Anandamide failed to produce reliable substitution for  $\Delta^9$ -THC and did not reduce response rates at doses up to 10 mg/kg. In a second investigation, the discriminative stimulus effects of methylated fluoroanandamide, a theoretically more stable form of anandamide, were investigated. Methylated fluoroanandamide produced full dose-dependent substitution for  $\Delta^9$ -THC and caused no significant changes in response rates at doses up to 0.3 mg/kg. These results suggest that anandamide may have been metabolized before behaviorally active concentrations could reach the brain and provide further support for anandamide's role as an endogenous cannabinoid ligand. (Supported by NIDA grants DA-03672 and DA-05488.)

EFFECTS OF MORPHINE ON EXTRANEURONAL LEVELS OF ASPARTATE AND GLUTAMATE IN THE NUCLEUS ACCUMBENS (NA). Valerie E. Hite, Dept of Bio.VCU, Richmond, Va. 23284, & Susan E. Robinson and Paul M. Kunko\*, Dept of Pharm and Tox, VCU, 23298-0613. Excitatory amino acids(EAA), glutamate (GLU) and aspartate (ASP), occur in high concentrations in the brain and exert powerful stimulatory effects on neuronal activity. Previous investigations indicate that administration of cocaine increases ASP and GLU in the NA. The excitatory state associated with cocaine could be related to the motor effects observed with the drug instead of the reward pathway in the NA. Morphine has reinforcing effects similar to cocaine but does not increase locomotor activity, therefore we hypothesized that if there is an increase in the EAA after morphine injection, it is not precipitated by locomotor activity. Male rats were stereotaxically implanted with a guide cannula in the region of the NA. Three treatment groups: saline (1 ml/kg), morphine (10 mg/kg), and cocaine (30 mg/kg) were studied. A microdialysis probe collected neuronal fluid in 10 minute fractions. Behavioral analysis was observed to quantify locomotor activity. Neurotransmitter analysis was achieved via a gas chromatograph/mass selective detector. Data interpretations indicate no statistically significant difference in behavioral analysis or the effects of morphine in EAA, ASP or GLU. These results are based on a N=2 (within each treatment group), therefore, all results could not be deemed statistically significant. Further analysis will be necessary to reach conclusive results.

BEHAVIORAL EFFECTS OF PERINATAL EXPOSURE TO 1,1,1-TRICHLOROETHANE IN MICE. Hendree E. Jones and R.L. Balster, Dept. Pharmacology and Toxicology, Medical College of Va.-Va. Commonwealth Univ., Richmond, Va. 23298. Studies of prenatal exposure to 1,1,1-trichloroethane (TCE) have focused on concentrations relevant to occupational use. Little is known about *in utero* exposure to TCE concentrations subject to abuse. Previous experiments have indicated that intermittent (8000 ppm for 60 min. 3 times/day)*in utero* exposure to TCE produces a pattern of developmental and behavioral delays. In order to better characterize a minimal exposure level necessary to produce behavioral teratology in offspring, dams were exposed to either 0 ppm, 350 ppm, 2000 ppm or 4000 ppm TCE 3 times per day for 60 min. during gestation days 12-17. No differences were seen in maternal weight gain, food consumption or initial litter variables of gestation length, litter size, litter weight or sex ratio. Nor were there differences between any of the TCE-exposed pups and sham-exposed pups on weight gain, eye opening, pinnae detachment, incisor eruption, righting reflex, rooting reflex or grip strength. Delays were observed between the TCE-exposed (4000 ppm) pups and sham-exposed pups on the negative geotaxis task and the inverted screen test on postnatal days 8 and 9. These data provide evidence for a concentration-effect relationship for the behavioral teratogenic effects of TCE and establish minimal exposures necessary for these effects. Taken together with results of other studies, evidence is emerging that there may be severe risks associated with TCE abuse during pregnancy. (Supported by NIDA grant DA03112 and pre-doctoral fellowship DA05665).

INTERPRETATION OF THE DIVERSE ACTIVITY OF ALLOSTERIC MODIFIERS OF HEMOGLOBIN ON THE BASIS OF X-RAY CRYSTALLOGRAPHIC ANALYSIS. Jayashree A. Kurup and Donald J. Abraham, Dept. Of Medicinal Chemistry, Va. Commonwealth Univ., Richmond, Va. The gem-dimethyl substituent of RSR 4 and RSR 13, potent allosteric modifiers of hemoglobin, was replaced by a methylene moiety, large cyclic and branched hydrophobic substituents such as cyclobutyl, cyclopentyl, cyclohexyl, isopropyl and 2,2-dimethylpropyl. The effect of these substituents on allosteric activity as measured by P<sub>50</sub>, was correlated to the binding of these compounds to hemoglobin. The 3,5-dimethyl cyclopropyl carboxylic acid proved to be the best effector. X-ray analysis revealed a single pair of symmetry related binding sites for four of the six compounds studied in the central water cavity of hemoglobin. The effectors stabilize the deoxy conformation of hemoglobin by making interactions with three different subunits. These studies revealed that steric and entropic factors govern the binding of these analogs to hemoglobin and determine the degree of biological activity. No continuous electron density was observed for the des-methyl derivative or the bulky 2,2-dimethylpropyl analog.

**ANANDAMIDE-INDUCED HYPOTENSION IS MEDIATED VIA PERIPHERAL CB<sub>1</sub> RECEPTORS.** Kristy D. Lake, Karoly Varga\*, and George Kunos\*. Dept. Pharmacology and Toxicology, MCV-VCU, Richmond, VA 23298-0613. Cannabinoids affect blood pressure and heart rate in animals and humans, yet, relatively little is known regarding the mechanisms by which they produce these effects. Our previous studies in urethane-anesthetized rats, showed that anandamide (ANA) and  $\Delta^9$ -tetrahydrocannabinol (THC) elicit hypotension. We also have found that the magnitude of ANA-induced hypotension is dependent on the basal intrinsic sympathetic tone. We investigated the target site and mechanisms by which this hypotension is induced. Other research in our lab has indicated that ANA acts at the synaptic terminals of postganglionic sympathetic neurons, most likely the presynaptic membrane. To directly evaluate a presynaptic site of action, we utilized a tissue bath assay to measure electrically-evoked, vesicularly released <sup>3</sup>H-noradrenaline (NA) from atria tissue. ANA and THC dose-dependently (0.3-10  $\mu$ M;  $p < 0.05$ ) attenuated the % fractional release of electrically-stimulated, vesicularly released NA. This attenuation by ANA and THC was blocked by the CB<sub>1</sub> receptor antagonist, SR141716A (1-10  $\mu$ M). To further support our hypothesis that the CB<sub>1</sub> receptor is located on the presynaptic terminals of the postganglionic sympathetic neurons, we looked for message for the CB<sub>1</sub> receptor in the cell body located in the cervical sympathetic ganglia using RT-PCR. Gel analysis of the cDNA to the CB<sub>1</sub> primers showed bands in the cervical ganglia which hybridized to a <sup>32</sup>P-labeled probe for the CB<sub>1</sub> receptor. From these data we conclude that ANA activates CB<sub>1</sub> receptors located on the presynaptic nerve terminals of postganglionic sympathetic neurons. Activation of these CB<sub>1</sub> receptors attenuates vesicularly released NA, resulting in hypotension. The discovery of cannabinoid receptors in the periphery involved in sympathoinhibition provides an important starting point for further therapeutic development for antihypertensive agents.

**MALONALDEHYDE AFTER 24 AND 48 HOURS OF PRESERVATION IN RAT SMALL BOWEL TRANSPLANTATION.** K. L. Lewis, R. E. Sonnino, and R. Franson, Dept. of Biology, Division of Pediatric Surgery, and Dept. of Biochemistry, Va. Commonwealth Univ., Richmond, VA 23298. Small bowel transplantation is important in the treatment of short bowel syndrome in children; however, at the present time its use is limited. One problem is due to poor organ preservation and reperfusion injury during the transplantation. The long term objective of this project is to determine if prolonged storage of the viable small bowel in a solution known as UW (University of Wisconsin) prior to the transplantation is possible. The aim of this study centers around developing the appropriate solution to increase the time span for preservation of the small bowel before transplantation to 48 hours. In each experiment of our study, a MDA assay was run on each animal's blood sample and the UW solution that the bowel had been preserved in to establish a correlation between MDA levels and tissue injury. It was shown that storage does have some effects on MDA levels in the UW solution, used to store the bowel (preservation) before transplantation. It was also concluded that sites four through seven were probably segments that should be used in the transplantation procedures.

**Ellagic Acid a Dietary Anticarcinogenic Phytochemical Does Not Protect Against Dermal Benzo(a)pyrene Induced Humoral Immune Suppression.** G. Craig Llewellyn and Kimber L. White Jr, Dept. of Pharmacology and Toxicology, Med. Col. of Va., Va. Commonwealth Univ., Richmond, VA 23298. Suppression of immune function by environmental contaminants has been well documented. Among these contaminants are the polycyclic aromatic hydrocarbons (PAH's). Benzo(a)pyrene (BaP), a prototypical PAH, selectively inhibits humoral immune function, i.e. antibody formation. Ellagic acid (EA) is a phenolic compound isolated from fruits and nuts commonly found in the diet of humans. EA has been shown to protect from many types of cancers induced by environmental contaminants, including BaP. The objective of these studies was to evaluate potential protection from BaP-induced immunosuppression by EA. EA (30, 100, 300, 600, and 1000 mg/kg) administered daily to female B6C3F1 mice by oral gavage for 31 days did not affect IgM or IgG production to the T-dependent antigen sheep red blood cells (sRBC). However, a dose-dependent increase in hepatic glutathione S-transferase activity, a biomarker of EA exposure was observed. Oral EA (1000 mg/kg) co-exposed for 29 days with dermal BaP (0.625, 2.5, 5, and 20 mg/kg) in female B6C3F1 mice did not alter the BaP-induced suppression of the IgM response. Effects on the IgG response were inconclusive because the characteristic BaP-induced suppression not observed. *In vitro* evaluation of the T-dependent antibody response by Mishell-Dutton assay (10 nM - 10  $\mu$ M) demonstrated dose-dependent increases in the antibody forming cell (AFC) response. However, the increase did not reach the level of statistical significance. *In vitro* co-exposure of EA (10  $\mu$ M) and BaP (10 nM - 10  $\mu$ M) did not alter BaP-induced AFC suppression. Although EA has been shown to protect from BaP-induced carcinogenesis, EA appears not to provide protection *in vivo* or *in vitro* from BaP-induced suppression of the humoral immune response. Supported in part by NIEHS contract ESO 9522 and NIEHS training grant ESO 7087.

The Potential Use of Lymphocyte Phenotype from Draining Lymph Nodes of Xenobiotic Exposed Animals in Identifying Contact and Respiratory Sensitizers. T. Scott Manetz, A. E. Munson and B. Jean Meade\*. Pharmacology and Toxicology, Med. Col. of Va./VCU, Richmond, VA. There remains a need to develop new methods for detecting chemicals capable of inducing respiratory and dermal sensitization. Studies are underway to investigate the potential use of flow cytometric analysis of draining lymph node memory B cell phenotype from xenobiotic exposed animals to differentiate between the two types of sensitizers. Using a known respiratory (Type I) sensitizer, toluene diisocyanate (TDI), and contact (Type IV) sensitizer, dinitrofluorobenzene (DNFB), phenotypic analysis was conducted on lymphocytes from animals following topical exposure to either xenobiotic for 4 consecutive days. Doses for sensitization, the maximal nonirritating concentration (MNC) and minimal irritating concentration (MIC), were identified based on an irritancy assay. The MNC and MIC for TDI were 1.0% and 2.5%, respectively and for DNFB were 0.10% and 0.15%. Both chemicals induced lymph node cell proliferation in the local lymph node assay (LLNA). Antibodies to CD3, CD4, CD8, B220, IgG<sub>2a</sub>, IgM, and IgE were used for phenotyping. Differentiation between Type I (antibody mediated) and Type IV (cell mediated) hypersensitivity reactions could not be made based on these markers with one exception. The percent of IgE positive cells represents a potential marker for distinguishing the two responses. TDI (2.5%) exposed animals showed a four fold higher level of membrane IgE than DNFB (0.15%) exposed animals. In a time course study phenotyping cells between 6 and 14 days following initial exposure, an increase in IgE positive cells began after day 6, peaking on day 10. Based on these studies, it appears that phenotypic analysis of draining lymph node memory B cells in xenobiotic exposed animals 10 days post initial exposure may serve as an indicator of test article sensitizing potential. These studies were conducted at the Med. Col. of Va. Immunotoxicology Laboratory under NIEHS Contract ES 05288.

**ACUTE INTRATHECAL ADMINISTRATION OF  $\Delta^9$ -THC INDUCES ANTINOCICEPTION IN CONJUNCTION WITH AN INCREASE IN SPINAL DYNORPHIN A (1-17) CONCENTRATION.** David J. Mason and Dr. Sandra Welch, Department of Pharmacology and Toxicology, Medical College of Virginia/Virginia Commonwealth University, Richmond, Virginia 2329. Dynorphin A (1-17) and the  $\kappa_1$  opiate receptor have been implicated as key components in the production of  $\Delta^9$ -THC - induced spinal antinociception. Using a spinal perfusion technique, the thoracolumbar cavity of male Sprague Dawley rats was rapidly perfused and the eluting CSF collected from the open cisternal space in conjunction with an assessment of tail - flick latency 3, 10, and 30 minutes post administration of  $\Delta^9$ -THC, CP55,940 or DMSO vehicle. Fractions collected 3 minutes post administration of  $\Delta^9$ -THC (300  $\mu$ g) exhibited a 5 fold increase in dynorphin A (1-17) levels in comparison to animals administered vehicle alone. A 12 fold increase was seen in spinal dynorphin levels 10 minutes post administration of 300  $\mu$ g  $\Delta^9$ -THC in comparison to animals receiving vehicle. Acute administration of CP55,940 (100  $\mu$ g) failed to increase spinal dynorphin levels. Dynorphin levels appeared unchanged 30 minutes post administration of  $\Delta^9$ -THC (300  $\mu$ g) in comparison to animals receiving vehicle. DMSO alone failed to significantly alter tail - flick latency.  $\Delta^9$ -THC (300  $\mu$ g) induced 58% MPE 10 minutes post administration and 100% MPE 30 minutes post administration. A 100  $\mu$ g dose of CP55,940 produced 100% MPE 10 minutes post administration. These data support a hypothesis suggesting that the development of  $\Delta^9$ -THC - induced antinociception in the spinal cord involves the release of the endogenous dynorphin A (1-17).

**STRUCTURAL STUDIES OF HEMOGLOBIN-DRUG COMPLEXES. IMPLICATIONS FOR THE ALLOSTERIC MECHANISM.** M. Carmen Moure, Donald J. Abraham, Dept. Of Medicinal Chemistry, Va. Commonwealth Univ., Richmond, Va. Allosteric effectors that stabilize the T (tense) state of hemoglobin have been synthesized and their activities measured as  $P_{50}$  values. Allosteric activity cannot be explained solely on the basis of their affinity binding constants. Previous crystallographic studies showed that these effectors bind at the same site in the hemoglobin central water cavity. Interaction with the binding site residue Lys99 has been proposed to contribute to the allosteric activity observed for the most potent compounds. To prove this, X-ray data was collected to 2 $\text{\AA}$  resolution on complexes of hemoglobin with different allosteric effectors, and the data refined using native hemoglobin coordinates. Electron density maps showed additional binding sites in the central water cavity which were not observed previously for the most potent members of the series. Our results suggest that the new sites could be contributing to the increased allosteric activity by adding more constraints to the T state.

INTERLEUKIN-12 EXPRESSION DURING TUMOR GROWTH. D.W. Mullins and K.D. Elgert. Dept. of Biol., Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061-0406. Cancerous tumors use a variety of mechanisms to evade detection and destruction by the immune system, including production of elevated levels of inhibitory cytokines. Tumor-derived signals dysregulate immune balance, leading to altered immune cell function and compromised immune response to cancer. We have previously defined mechanisms by which tumor-bearing host (TBH) macrophages (M $\phi$ ) mediate immunosuppression, in part, through increased production of cytokines which suppress T-cell responsiveness. Because the M $\phi$ -derived immunostimulatory cytokine interleukin-12 (IL-12) drives cell-mediated (T<sub>H</sub>1-type) immune responses, and tumor growth compromises T-cell antitumor activities, we studied whether murine fibrosarcoma growth altered M $\phi$  IL-12 production. Using a novel IL-12-responsive T-cell line (Kit225/K6), we developed a bioassay for active IL-12. We report that tumor growth dysregulates M $\phi$  production of IL-12, which may partially explain tumor-induced immunosuppression. Further, these results suggest new immunotherapeutic approaches using IL-12 to reconstitute host antitumor responses. Supported by the Virginia Academy of Science Small Projects Fund, the Virginia Tech Graduate Student Association, and *Sigma Xi*.

EXPRESSION OF A CANNABINOID RECEPTOR USING THE SEMLIKI FOREST VIRUS. John M. Olson<sup>1</sup>, Denise A. Dove Pettit<sup>2</sup>, Douglas L. Anders, and Guy A. Cabral, Dept. of Microbiology and Immunology, Medical Coll. of VA/VA Commonwealth Univ. Richmond, VA 23298-0678. Delta-9-tetrahydrocannabinol (THC), the major psychoactive component in marijuana, has been shown to elicit some of its effects through cannabinoid receptors CB1 and CB2, found in the brain and the periphery, respectively. Research in our laboratory has focused on the expression, isolation, and purification of these receptors in order to provide insight into receptor ligand interactions. The Semliki Forest Virus gene expression system is being used to express the human neural cannabinoid receptor, CB1. CB1 cDNA was sub-cloned from pSKCANR into the pSFV1 expression vector creating pSFV1-CB1. RNA transcribed *in vitro* from pSFV1-CB1 was co-transfected into BHK-21 cells with pSFV-Helper2 RNA to generate SFV-CB1 recombinant virus particles. <sup>35</sup>S methionine was used for metabolic labeling of CB1-recombinant virus-infected BHK-21 cells. Lysates of cells collected at various time points were separated by SDS-PAGE and subjected to autoradiography and western-immunoblotting. Novel protein species with relative molecular weights consistent with that for the CB1 receptor based on extrapolation of the cDNA coding sequence were observed. At later times (i.e., 15-20 h), larger molecular weight products were detected which may either represent receptors coupled with G-proteins or receptor dimers. These results suggest that the Semliki Forest Virus system may prove ideal for the production of preparative levels of CB1 receptor. Supported by NIH awards DA05832, DA09158, T32 AI07407<sup>1</sup>, and T32 DA07027<sup>2</sup>.

CHARACTERIZATION OF ACUTE TOLERANCE TO NICOTINE-INDUCED ANTINOCICEPTION IN MICE AFTER INTRATHECAL ADMINISTRATION. G.S.Patrick, M.I.Damaj, B.R.Martin, Dept. of Pharmacology and Toxicology, Virginia Commonwealth University, Richmond, VA 23298-0613. Acute tolerance to nicotine is believed to be a major factor in the development of nicotine dependence. It has been previously shown that acute tolerance develops to nicotine's pharmacological effect after subcutaneous injection in mice. The focus of this study was to investigate and characterize the development of acute tolerance to nicotine-induced antinociception following intrathecal (i.t.) injection using the tail-flick test. Using ICR mice, nicotine-induced antinociception was dose-dependent with an ED50 of 10ug/mouse. Acute tolerance developed to nicotine after pretreating mice with inactive doses of i.t. nicotine. Tolerance peaked at 10 minutes after the pretreatment and dissipated 2 later. Pretreatment with higher doses of nicotine significantly extended the tolerance time course. Furthermore, acute tolerance to nicotine was blocked by an i.t. injection of mecamylamine, a nicotinic antagonist, suggesting the involvement of neuronal nicotine receptors in this phenomena. Finally, nicotinic agonists whose antinociceptive effects are blocked by mecamylamine, such as (+)-nicotine and epibatidine isomers, were found to be cross-tolerant to nicotine. In contrast, compounds which are not sensitive to mecamylamine, such as (+)-bridged nicotine and lobeline, showed no cross-tolerance to nicotine. Our data suggest that multiple mechanisms are involved in the development of acute tolerance to nicotine. (Supported by DA-0527)

2', 3'-DIDEOXYINOSINE INHIBITS THE HUMORAL IMMUNE RESPONSE IN FEMALE B6C3F1 MICE BY TARGETING THE B LYMPHOCYTE. Kathleen E. Phillips\* and Albert E. Munson. Department of Pharmacology and Toxicology, Medical College of Virginia, Virginia Commonwealth University, Richmond, VA 23298. 2',3'-Dideoxyinosine (ddI) is a purine nucleoside analogue currently being used for the treatment of HIV positive individuals and patients with AIDS. Preliminary immunotoxicity studies have shown that a consequence of ddI treatment in female B6C3F1 mice is the inhibition of the humoral immune response. These studies were undertaken to investigate the immune cell target of ddI and to begin to determine the mechanism of this toxicity. B6C3F1 mice were treated with 1000 mg/kg/day by oral gavage for a treatment period of 28 days. The B lymphocyte was identified as the cellular target of ddI through separation-reconstitution experiments of the adherent and non-adherent cell populations and of the T and B lymphocyte populations. These studies revealed a deficit in the ability of the non-adherent cells from ddI-treated mice to mount a normal antibody response to sRBC. A further separation of the non-adherent cells into T and B cells revealed a decreased ability of ddI-treated B cells to develop specific humoral immunity. Additional studies were undertaken to determine the mechanism by which ddI is affecting the B cell. Surface marker analysis to show changes in the cell populations revealed no difference between vehicle and ddI-treated mice. Proliferation of the B cells was also unaffected as shown by stimulation with LPS and anti-IgM plus IL-4. These results indicate that the primary cellular target of ddI is the B lymphocyte and that, although ddI does not affect proliferation, its mechanism of toxicity may be through inhibition of differentiation and/or secretion in the B lymphocyte. Supported by NIH contract ES 9522.

#### CLEARANCE OF GROWTH HORMONE FROM THE BLOOD-VASCULAR SYSTEM IN NEPHRECTOMIZED RATS. Kathleen P. Phillips, Dept. of Biol., Va.

Commonwealth Univ., Richmond, Va. 23284, & R.J. Krieg, Dept. of Anatomy, Va. Commonwealth Univ./Medical College of Va., Richmond Va. 23284. Children with kidney disease have been shown to have lower than normal growth rates despite elevated levels of GH circulating in the blood. Therefore, this experiment was designed to measure the clearance of GH in a uraemic rat model. Male rats were made uraemic by 5/6 nephrectomy (NX). Two other groups of rats were studied: sham-operated fed *ad libitum* (SH), and sham-operated pair-fed with nephrectomized rats (PF). Two weeks after 5/6 Nx, blood samples were taken via intra-atrial catheters. For sampling, octreotide was given to suppress GH release, and then ratGH was injected and periodic samples were taken. GH was measured in the plasma by radioimmunoassay. Concentration of GH was plotted against time to generate clearance curves. There was an increase in half-life of GH in NX rats as compared to both SH and PF rats. Further studies with slightly altered designs are being performed to confer results.

#### BIOCHEMICAL AND PHYSIOLOGICAL EFFECTS INDUCED IN MALE ACCESSORY SEX GLANDS BY 5- $\alpha$ -DIHYDROTESTOSTERONE AND THE EPIDERMAL GROWTH FACTOR. Ryan Phillips, Dept. of Chemistry, James Madison Univ., Harrisonburg, Va. 22801,

& Derek Gingerich\* and Treasure Sucheck, Dept. of Biol., Eastern Mennonite Univ., Harrisonburg, Va. 22801. The biochemical effects of 5- $\alpha$ -dihydrotestosterone (DHT) and the epidermal growth factor (EGF) on accessory sex gland tissue of male Swiss Webster mice were analyzed. Groups of prepubescent mice were injected with 1.0 mg of DHT and 50 $\mu$ g of EGF for ten days. The anterior prostate and seminal vesicle were removed and weighed. The tissues were homogenized. Soluble proteins were analyzed by SDS-PAGE. Polyamines were derivatized with dansyl chloride and separated by high performance liquid chromatography (HPLC). For the seminal vesicle and anterior prostate, DHT treatment significantly increased organ weights above the control group, whereas EGF treatment slightly enhanced the organ weights. For the seminal vesicle, DHT significantly increased the production of two proteins (10 kDa and 16 kDa). DHT and EGF did not have significant effect on the polyamine levels relative to the control group.

THE *LAC* REPRESSOR MOUSE. Heidi Scrable, Dept. of Neuroscience, University of Virginia, Charlottesville, VA 22908. The introduction of foreign genes and DNA fragments into the genome of the mouse has led to the elucidation of the function of many normal genes, and to an understanding of how mutations in particular genes disrupt phenotype. The ability to introduce exogenous DNA sequences that code for either normal or mutant gene products, however, has been limited so far to those which result in benign or sub-lethal phenotypic changes. In an effort to circumvent problems that arise from the unregulated expression of introduced sequences, we have been constructing a regulatable transgenic system that is based on the lactose (*lac*) operon of *E. coli*. Like analogous systems that use temperature sensitive mutations to study lethal mutations in bacteria and lower eukaryotes, this system would allow the introduction and analysis of embryonic lethal genes at the organismal level without compromising the viability of their host, thereby greatly expanding the repertory of genes that can be altered and analyzed within the context of an organism closely related to the human. We have succeeded in producing two independent lines of homozygous *lac* repressor mice in which transgenes encoding the *lac* repressor (*lacI*) are transcriptionally active by altering either the genetic background or the DNA sequence of *lacI* itself. We are now ready to evaluate how well an experimental transoperon can regulate gene expression *in vivo*.

EXPRESSION OF THE *LAC* REPRESSOR IN TRANSGENIC MICE. Wendy Siemon and Heidi Scrable, Dept. of Neuroscience, Univ. of Va., Charlottesville, Va. 22908. The *lac* repressor mouse is the key and final component of a system for regulating gene expression in the mouse that is based on the *lac* operon of *E. coli*. The focus of this project was to acquire detailed information about when and in which tissues and cell types the *lac* repressor is expressed in homozygous mice transgenic for a gene encoding the repressor (*lacI*) under the control of the human  $\beta$ -actin promoter. Using Northern blot analysis of total RNA extracted from tissues of adult mice, we found ubiquitous expression of the transgene that ranged from high (muscle, heart, and thyroid), to moderate (brain, testis, kidney, and spleen), to low (liver, ovary, seminiferous tubules, and lung). We confirmed this result in adult tissues using a combination of reverse transcription and polymerase chain reaction (RT-PCR), then extended this assay to detect expression in single embryos from e7.5 to e12.5, and in neonatal tissues. We found that the *lac* repressor is expressed in post-implantation embryos and in maternal decidua, but not in extra-embryonic tissues, at all embryonic stages analyzed. We also detected ubiquitous expression in neonatal tissues. These results establish a data bank of information about expression that will allow us to evaluate and interpret how well the *lac* repressor can regulate the expression of target genes in the transgenic mouse.

FOLLICULAR DENDRITIC CELLS (FDC) MAINTENANCE & RETENTION OF HIV INFECTIVITY. Beverly A. Smith, J. G. Tew, A. K. Szakal and G. F. Burton\*, Dept. of Mic. & Immunol., Va. Commonwealth Univ., Richmond, Va. 23298. Infection with Human Immunodeficiency Virus (HIV) results in large amounts of virus being trapped on follicular dendritic cells (FDC) in germinal centers of secondary lymphoid tissues. Active infection is confined to these sites during the many years of clinical latency when the CD4+ T cell population declines prior to AIDS. Recently, we have shown that FDC trapped HIV is infectious and that infection persists even in the presence of a vast excess of neutralizing antibody. Since FDC retain conventional antigens in their native or unprocessed form for many months, we reasoned that FDC may not only retain HIV but also may maintain HIV infectivity for long periods. The objective of this present study was to determine how long FDC can retain HIV and maintain its infectious nature. We have devised a murine model for *in vivo* trapping of HIV on FDC under physiological conditions. Since the mouse is nonpermissive for HIV infection, no viral replication is possible *in situ*. Mice are passively immunized with Ab to HIV and injected in several sites with virus to allow immune complex formation and trapping on FDC in multiple draining lymph nodes. FDC bearing trapped HIV were isolated weekly. The amount of virus trapping was determined by p24 ELISA and the ability of that virus to cause infection was tested by coculture of the FDC with susceptible target cells. Infection was assessed by PCR for proviral DNA and by p24 production. Preliminary results indicated that FDC trapped HIV maintained its infectious nature well beyond the period predicted by *in vivo* half life studies on free virus in plasma. These data support our hypothesis that FDC retain HIV for long periods and maintain infectivity. This finding may have important implications for design of intervention strategies that can target this reservoir of infectious virus. (Support: NIAID Grant #32406 & MCV/VCU HIV/AIDS Center)

**GONADAL STEROID REGULATION OF DENDRITIC MORPHOLOGY IN**

**PREGNANT RATS.** G. Stafisso-Sandoz, C. Hearon, L. Keyser & C.H. Kinsley, Dept. of Psych., Univ. Richmond, Va, 23173. A newly-parturient female must be capable of learning a new repertoire of behaviors in order to adequately care for her offspring -- learning in which hippocampus (HI), a structure capable of hormone-induced plasticity during estrus (Wooley & McEwen, *J. Comp. Neurol.*, 336: 293-306; 1993), is involved. Pregnancy exposes a female to similar hormones for significantly longer; thus, we examined whether the hormones of pregnancy altered neurons of the CA1 region of the HI. Virgin females were ovx and sequentially-implanted with Silastic capsules containing progesterone and estradiol (11 days and 10 days, respectively) or blank capsules. Brains were removed, Golgi-stained and the primary branch of the apical dendrite of completely-stained HI-CA1 neurons was traced with oil-immersion at x1600 using NeuroLucida. Dendritic spine density (# spines/10 um) was increased in hormone-treated females. Unpublished research from our laboratory has found that females with reproductive experience are capable of learning to run a maze better than their nulliparous counterparts. Therefore, pregnancy may alter a population of neurons relevant for maternal behavior-related learning.

**MORPHINE DISRUPTION OF MATERNAL BEHAVIOR: MEDIATION THROUGH**

**REDUCTIONS OF C-FOS ACTIVATION.** G. Stafisso-Sandoz, D. Polley, W. Carpenter, B. Holt, N. Jones, K.G. Lambert<sup>1</sup> & C.H. Kinsley, Depts. of Psych., Univ. Richmond, VA, 23173 and <sup>1</sup>Randolph-Macon College, Ashland, Va, 23005. Morphine significantly impairs maternal behavior (MB); Naloxone, an opiate antagonist, restores it. MB is associated with c-fos expression in medial preoptic area (mPOA) of females. We examined the relative effects of morphine and Naloxone on the expression of this immediate early gene product. On postpartum day 5 or 6, females were injected with morphine or saline (Exp. 1), or morphine+Naloxone or morphine+saline (Exp. 2) and placed back in the homecage, separated from their pups by a wire-mesh partition. Sixty-minutes later processing for c-fos immunohistochemistry commenced. The c-fos positive cells in a proscribed portion of mPOA were then counted. Morphine-treated females had fewer c-fos cells in mPOA compared to saline-treated females. Further, morphine+naloxone-treated females expressed more c-fos cells compared to morphine+saline females. Morphine-treated females, therefore, may exhibit reductions in MB because of relative opiate-induced inactivation of areas of the brain devoted to the regulation of MB.

**THE CHARACTERIZATION OF MALE ACCESSORY SEX GLAND PROTEINS INDUCED BY 5- $\alpha$ -DIHYDROTESTOSTERONE.** Treasure Sucheck, Nate Derstine\*, Trent Hummel\* and Andrew Pennington\*, Dept. of Biol., Eastern Mennonite Univ., Harrisonburg, Va. 22801. The 5- $\alpha$ -dihydrotestosterone (DHT) induced proteins in male accessory sex glands (ASG) were characterized. Prepubescent mice were injected with varying doses of DHT for 10 days. The anterior prostate (AP) and seminal vesicle (SV) were removed and weighed. The tissues were homogenized and soluble proteins were analyzed by SDS-PAGE. The SV and AP organ weights increased with increasing DHT dose. The expression of two proteins, (16 kDa and 10kDa) in the seminal vesicle and one protein (10 kDa) in the anterior prostate were influenced by the dose of DHT. Protein sequence analysis identified the 16 kDa SV protein as being "Seminal Vesicle Protein IV" (Chen et al.). The effect of endogenous testosterone on male ASG proteins was studied as the mouse developed through puberty. The SV and AP were removed and weighed from mice at the ages of 26, 30, 32, 24, 36, 40, 44, and 58 days. The tissues were homogenized and the soluble proteins were analyzed by SDS-PAGE. The SV and AP organ weights increased as the mouse went through puberty. The DHT induced seminal vesicle proteins (10 kDa and 16 kDa) were expressed by the age of 40 days. The DHT induced 10 kDa anterior prostate protein was not expressed by 58 days of age.



**MOLECULAR CHARACTERIZATION OF COMPLEMENT RESISTANCE IN PATHOGENIC *NAEGLERIA FOWLERI* AMOEBAE.** D. Tonev\*, D. Anders\*, G. Cabral, F. Marciano-Cabral. Dept. of Micro. & Immuno. and E. Westin\*, Dept. of Med., Div. of Hematology and Oncology, Med. Col. of VA/VCU, Richmond, VA 23298. *Naegleria fowleri* is the etiological agent of primary amoebic meningoencephalitis, a fatal central nervous system disease. The ability of pathogenic *N. fowleri* to evade host immunity and resist complement-mediated lysis is believed to be an important determinant of virulence. Enzymatic treatment of complement-resistant *N. fowleri* increased susceptibility to complement implicating a cell surface protein in the mechanism of complement resistance. Regulatory proteins, specifically CD59, have been shown to protect eukaryotic cells from complement-mediated destruction. In the present study, Northern analysis and reverse transcription-polymerase chain reaction (RT-PCR) were employed to establish whether pathogenic *N. fowleri* possess CD59 homologous transcripts. Northern analysis of *N. fowleri* total RNA revealed the presence of a 2 kb RNA species which hybridized to a human CD59 cDNA probe. RT-PCR employing degenerate oligonucleotide primers homologous to highly-conserved sequences between human and rat CD59 resulted in the amplification of three products of 344, 241, and 147 basepairs from *N. fowleri* RNA. Each of these products was cloned and subjected to DNA sequence analysis. One clone, pMP18, containing the 344 bp product, possessed 43% nucleotide identity and 26% amino acid identity with human CD59. Northern analysis of *N. fowleri* RNA demonstrated that pMP18 hybridized to a 2 kb RNA transcript suggesting that pMP18 may represent a *Naegleria*-specific homolog to human CD59. (Supported in part by NIH grants AI-27807 and DA-05832).

**NEUROLOGIC DEFICITS AFTER CARDIOPULMONARY BYPASS SURGERY: AN EXPERIMENTAL MODEL.** Anubha Tripathi, Chris Kyrus\* , Andrew Beaumont\* and Anthony Marmarou\*, Dept. of Neurosurgery, Va. Commonwealth Univ., Richmond, Va. 23298. The leading source of morbidity and disability in cardiac surgeries is cerebral complication. Although several clinical studies have reported post-operative neurological deficits associated with cardiopulmonary bypass surgery, only a few experimental laboratory studies have attempted to duplicate the deficits in the laboratory setting. The present study focused on developing a model for investigation of neurologic deficits occurring after cardiopulmonary bypass surgery. The development of this model in the rat involved simulating the conditions under which cardiopulmonary bypass surgery is performed in humans. The model was subjected to conditions of hypothermia, hemodilution, and opening of the thoracic cavity with simultaneous monitoring of various parameters including arterial blood pressure, brain and core temperatures, sampling of blood gases, and EKG. This study establishes the feasibility for developing a rodent model useful in research of cerebral insufficiency following cardiac bypass operation.

**A POSSIBLE PHOSPHATE AND THREONINE INTERACTION IN *N*-ASPARAGINE GLYCOSYLATION: A MOLECULAR MODELING APPROACH.** Catherine W. White, Dept. of Pharmacology and Toxicology, Va Commonwealth Univ., Richmond, VA 23298-0613. Asn-Xxx-Ser/Thr (Xxx is any amino acid except proline) is a necessary sequence for transfer of an oligosaccharide from a dolichol pyrophosphate to the asparagine nitrogen in a protein. Why a threonine or serine is required has never been satisfactorily explained. Molecular modeling was used to investigate the spacial possibility of interaction between the alpha phosphate and the hydroxyl of the threonine. This was done by comparing these distances with Asn-Leu-Thr and Asn-Pro-Thr after minimizing energies. The distance with the Leu peptide is 4.14Å as compared to 7.97Å with the Pro peptide. (Supported in part by USPH grant T32-DA-07027.)

ANTI-ESTROGENIC COMPOUNDS IN WINE. R.L. Williams, Mark Elliott, Old Dominion University Enological Research Facility, Dept. of Chem./Biochem., Old Dominion Univ., Norfolk, Va. 23529, & R.Perry, Division of Surgical Oncology, Dept. of Surgery, Eastern Virginia Medical School, Norfolk, Va. 23508. Trans-resveratrol (trans-3,4',5'-trihydroxystilbene) has been described as a phytoalexin or anti-fungal agent in a variety of grapes. It has also been described as a potent inhibitor of protein-tyrosine kinase. Based on the structural similarity of this compound to the estrogenic agent diethylstilbestrol (DES), we have initiated a study of the potential estrogenic activity of this compound. Our preliminary results show that trans-resveratrol effectively binds to both the estrogen type I receptor as well as the estrogen type II receptor in MCF-7 human breast cancer cells. Using estrogen positive MCF-7 cells and estrogen negative MDA-231 cells, we have shown that trans-resveratrol is cytotoxic in both cells lines. The 50% inhibitory concentrations of trans-resveratrol were 14.2 +/- 2.0 ug/ml for the MCF-7 cells and 10.5 +/- 2.4 ug/ml for MDA cells. Trans-resveratrol has recently been described as a component in red wine. Based on the literature values of the levels of trans-resveratrol in various red wines, we would suggest that moderate consumption of red wine (400 ml) would provide approximately 250-260 ug of this agent. Assuming a 20% absorption rate, this volume of red wine should provide approximately 53 ug of trans-resveratrol to the consumer. Although this concentration would not fall in the cytotoxic range, this amount of trans-resveratrol may influence or antagonize estrogen binding and provide some beneficial effects in areas such as breast cancer.

THE ISOLATION AND KINETICS OF POLYPHENOLOXIDASE. Armando Wyatt and H. Alan Rowe, Department of Chemistry, Center for Materials Research, Norfolk State University, Norfolk, Virginia 23504

Polyphenoloxidase (PPO) is the enzyme responsible for the browning of fruit. Aromatic 1,2-di alcohols are oxidized and ultimately result in the production of melanin. An isolation procedure for PPO from the South American cavendish banana was developed and the kinetics of this enzyme was studied using catechol and dopamine as substrates. The  $K_m$  and  $V_{max}$  for the enzymewith these substrates were determined with crude and purified PPO. The enzyme assay was optimized and the effects of non-aqueous solvents initiated. Long range plans include the use of this enzyme in organic synthesis reactions and the comparison of the kinetics and structure of the PPO from this banana with the multiple Sri Lankan varieties. Supported by CHR-NSU.

## Microbiology and Molecular Biology

METALLOTHIONEIN IN MARINE SYNECHOCOCCUS SPP. Arunsi C. Brown, Patricia A. Pleban<sup>1</sup>, and Andrew S. Gordon<sup>2</sup>, Dept. of Biol. Sci., and <sup>1</sup>Dept. of Chemistry., Old Dominion Univ., Norfolk, Va 23529. *Synechococcus* spp. are abundant in oceanic ecosystems and are responsible for a significant fraction of oceanic primary production. The levels of free cupric ion in surface seawater are close to the toxic threshold for marine cyanobacteria. Therefore we are interested in the interaction between marine *Synechococcus* and copper. Marine cyanobacteria have previously been reported to produce metallothionein (mt) under cadmium and zinc, but not copper, stress. Mt is believed to mediate metal detoxification. In this study we found that copper can induce two strains of marine *Synechococcus* spp. to produce < 10,000kDa (mt-like) protein within 2 hours of copper exposure. This is, to our knowledge, the first report of mt induction by copper in marine *Synechococcus* spp.

BEHAVIOR OF *NAEGLERIA GRUBERI* IN VISCOUS FLUIDS. Stephen Gallik and A. Moshos\*, Department of Biological Sciences, Mary Washington College, Fredericksburg, VA. 22401. The viscous drag experienced by cells crawling on solid surfaces is thought to be a major physical force on the cell surface. Yet, we know very little about the effect of fluid viscosity on the behavior of crawling cells. The principal objective of this study is to determine the effect of fluid viscosity on the proliferation and viability of the freshwater/soil protist *Naegleria gruberi* in preparation for future investigations on cell adhesion and movement. Series of flasks were seeded with *N. gruberi* cells at a density of 16,000 cells/cm<sup>2</sup>. The culture medium was then changed to one of three media varying in viscosity: 0.8, 10 and 50 centipoise (cp). Viscosity of the culture medium was enhanced through the addition of methylcellulose. Cell number and cell viability were determined at 24 hour intervals for a period of 5 days. Methylcellulose-enhanced fluid viscosity of up to 50 cp had no effect on the viability of these cells. The population doubling time for all three groups was approx. 12 hours. Methylcellulose-enhanced fluid viscosity had a small effect on the population plateau density. (Supported by a grant from Mary Washington College.)

THE ROLE OF PROHIBITIN IN BREAST CANCER. J.Keith McClung\*, Eldon Jupe, Robert Dell'Orco. \*Radford University, Radford VA 24142, Oklahoma Medical Research Foundation, Oklahoma City, OK, 73104. Prohibitin is a putative tumor suppressor gene, is an evolutionarily conserved with homologues isolated from organisms ranging from yeast to man, is a gene with antiproliferative activity in mammalian cells, is required for the proper development of *Drosophila*, and is associated with the development of sporadic breast cancer. Our preliminary studies using breast cancer cell lines and breast tumor samples show that 80% of the samples are homozygous for one of the prohibitin alleles, the B type. Preliminary structural and functional studies also found a linkage between alterations in the 3' untranslated region (3'UTR) of the prohibitin gene and the disease state. The inhibitory activity was found to be in the 3'UTR and not in the protein coding region of the mRNA. Breast cancer cell lines and breast tumors which were homozygous for the B type allele were found to have mutations in this 3'UTR. In addition, these mutants did inhibit growth in control cells using our microinjection-based growth assay. Therefore, the 3'UTR may be involved in the development of breast cancer.

UNUSUAL RNA STRUCTURES ISOLATED FROM THE ARCHAE-BACTERIUM *SULFOLOBUS SOLFATARICUS*. Sarika Z. Singh and Thomas O. Sitz, Dept. of Biochem., Virginia Tech, Blacksburg, VA 24061. The examination of 30 *Sulfolobus* mRNA sequences in GeneBank did not find a Shine-Dalgarno Sequence (-AGGAGGU-) or any consensus sequence complementary to the 3'-end of 16S rRNA. How do ribosomes bind to mRNA in *Sulfolobus*? Are "cap like" (GpppNp-) structures found in *Sulfolobus* RNA? Recently *Sulfolobus* has been classified as an Eocyte, a microorganism more closely related to eucaryotes than other archaeobacteria. Whole cell RNA from *Sulfolobus* and yeast was digested with 0.3N NaOH. The alkaline resistant fragments were isolated and radioactively labeled by treatment with periodate followed by reduction with (<sup>3</sup>H)NaBH<sub>4</sub>. Both RNA samples contained a possible "cap like" structure as characterized by DEAE-Sephadex column chromatography. A method using HPLC anion exchange column chromatography was developed to characterize these unusual RNA structures.

## Natural History & Biodiversity

TEMPORAL VARIATION IN SHREW ASSEMBLAGES: A PITFALL REMOVAL STUDY. Charlene R. Couch and John F. Pagels, Dept. of Biology, VA Commonwealth Univ., Richmond, VA 23284. We examined temporal and spatial distribution of five species of shrews collected by the use of pitfall traps with drift fences in five forest stands of different ages on Shenandoah Mountain, Virginia. All species, Sorex cinereus, S. hoyi, S. fumeus, S. dispar and Blarina brevicauda, were collected in all stands. S. cinereus was most abundant in all stands. Captures increased gradually from early spring with the exception of S. dispar, which was not caught prior to July. Captures in all stands rose in late spring, particularly in the clearcut, and were highest in late summer to early autumn. Captures of S. cinereus were greatest in August, while the remainder of the species peaked in October. There were very few captures of any species during the coldest winter months. These temporal variations in shrew captures illustrate the importance of selectively trapping in late spring and during late summer to early fall in order to maximize trapping success.

COMMUNITY STRUCTURE OF AN ANURAN COMMUNITY AT FORT A. P. HILL, VIRGINIA. Mark Dunaway, Barry Knisley, Dept. of Biol., Randolph-Macon Col., Ashland, VA 23005, and Joseph C. Mitchell, Dept. of Biol., Univ. Richmond, Richmond, VA 23173. Habitat, microhabitat, and seasonality were studied for nine species of anurans at seven sites at Fort A. P. Hill, Caroline Co, VA from March to August, 1995. A spring (March to April) active group included three species (R. palustris, B. americanus, P. crucifer) and a summer (May to September) active group included the remaining six species (R. clamitans, R. catesbiana, R. virgatipes, B. woodhousei, H. chrysosecelis, A. crepitans). Only R. clamitans, R. catesbiana and A. crepitans had overlapping microhabitats during the same season. R. palustris moved from its vocalizing microhabitat when R. virgatipes began calling. The two largest permanent ponds had the most species (7 and 8) and small temporary ponds the fewest species (2-4). There was no observed relationship between vegetation around the pond perimeter and the species' distributions. Among species which co-occurred spatially and temporally, there were apparent differences in microhabitat, diet, and predator defense mechanisms that may serve in niche segregation within this anuran community.

CONSERVATION PLANNING FOR NATURAL AREAS IN THE CITY OF VIRGINIA BEACH: A COOPERATIVE VENTURE. Sandra Y. Erdle, Dept. of Conservation and Recreation, Division of Natural Heritage, 1500 E. Main St., Richmond, Va. 23219 & H. Clayton Bernick III\*, City of Virginia Beach, Environmental Management Ctr., Virginia Beach, Va. 23456. An inventory of Virginia Beach, by Dept. of Conservation and Recreation, Division of Natural Heritage revealed 77 rare plant species, 29 rare invertebrate species, 11 rare vertebrate species and 17 rare community types. A cooperative venture between the Div. of Natural Heritage and the City of Virginia Beach resulted in conservation planning for 11 identified high priority natural areas. Conservation planning integrates available information for specific sites through an analysis of ecological information, land uses and stewardship needs. A stress assessment, management and protection recommendations are compiled for natural areas within refined conservation planning boundaries. This information is intended to facilitate planning and land use decisions, to guide endeavors to actively protect natural diversity and to increase awareness regarding regional biodiversity issues. (This project was funded in part, by the Va. Dept. of Environmental Quality's Coastal Resources Management Program, pursuant to a grant from the Nat. Oceanic and Atmospheric Administration, Office of Ocean and Coastal Resource Management, under the Coastal Zone Management Act of 1972, as amended. Additional funds were provided by the City of Virginia Beach.)

ARTHROPOD INHABITANTS OF THE PITCHERS OF *NEPENTHES MIRABILIS* FROM FAR NORTH QUEENSLAND, AUSTRALIA. Norman J. Fashing, Dept. of Biology, Col. Of William and Mary, Williamsburg, Va. 23187. The genus *Nepenthes*, the eastern tropical pitcher plant, contains about 80 species scattered throughout the tropics of the Old World. Members of this genus are characterized by leaves with tips modified into pitchers designed to lure and trap insects which are digested in the pitcher liquid. A number of arthropod species, primarily flies, have adapted to live in the apparently inhospitable environment of the pitcher fluid. A sample of thirty-nine pitchers from *N. mirabilis* collected near Weipa, Far North Queensland, Australia, were found to contain species from seven arthropod families (numbers indicate percentage of pitchers inhabited followed by mean relative abundance excluding mites): Insecta, Diptera - Ceratopogonidae (*Dasyhelea?* sp., general saprophage, 89.7%, 0.5758), Sarcophagidae (*Sarcosolomonina papuensis*, macrosaprophage, 33.3%, 0.0198), Phoridae (*Megaselia?* sp., macrosaprophage, 20.5%, 0.0274), Culicidae (*Tripteroides* sp., microsaprohage, 92.7%, 0.3448), Cecidomyiidae (*Lestodiplosis?* sp., predator, 12.8%, 0.0237), Chironomidae (*Pentaneura?* sp., top predator, 2.6%, 0.0086); Acarina, Astigmata - Histiostomatidae (*Zwickia* sp. 1, macrosaprophage; *Zwickia* sp. 2, microsaprohage; *Creutzeria* sp., microsaprohage, 84.6%). Members of the genus *Zwickia* were found in 92.3% of the pitchers examined.

ECOLOGICAL LANDSCAPE UNITS OF THE LAUREL FORK AREA IN HIGHLAND COUNTY, VIRGINIA: AN OVERVIEW. Gary P. Fleming and William H. Moorhead, Va. Dept. of Conservation and Recreation, Div. of Natural Heritage, Main Street Station, 1500 E. Main St., Suite 312, Richmond, VA 23219. Situated in northwestern Highland County, the Laurel Fork area is a high elevation region which supports several significant natural communities and more than eighty occurrences of state-rare plants and animals. In 1994, DCR-DNH entered into a cooperative agreement with the George Washington National Forest to classify, describe, and map ecologically distinct landscape units of this area. Environmental, vegetation, and floristic data were gathered from reconnaissance surveys and 50 permanent sampling plots, providing the basis for a classification of plant communities. The community classification was then synthesized with information on geology, geomorphology, soils, and land use history to produce an ecological land unit classification following methods developed by the Forest Service. The Laurel Fork area straddles the boundary between two major ecoregional units, the Allegheny Mountains and the Northern Ridge and Valley. The Allegheny Mountains barely enter Virginia and support northern land types of relatively limited extent in the Commonwealth, while oak-ericad land types prevail over the Ridge and Valley region. The final classification described 20 Landtype Phases, each more or less equating to a plant association and its habitat. These units were mapped using field data and aerial photographic overlays. This study provides practical tools for ecosystem-based land management, as well as methodologies which can be applied to classify and map similar terrain in the George Washington and Jefferson National Forests and beyond.

RECOVERY OF UNIONID MUSSELS IN THE NORTH FORK HOLSTON RIVER DOWNSTREAM OF SALTVILLE, VA. William F. Henley and Richard J. Neves. Dept. of Fisheries and Wildlife Sciences, Virginia Tech, Blacksburg, VA 24061-0321. The freshwater mussel fauna of the North Fork Holston River (NFHR) downstream of Saltville, VA declined from at least 24 species, as observed in 1918 to 1 in 1974 possibly due to mercury pollution. To determine the degree of recovery of mussels in the NFHR downstream of Saltville, VA 19 sites were surveyed using a snorkeling catch-per-unit-effort (CPUE) method. At sites where investigator CPUE values (no./h) equaled or exceeded 5 mussels/h, a CPUE survey was conducted along transect lines. If investigator CPUE values equaled 10/h, a quadrat survey was also conducted on transects. Nine species of mussels were observed in the NFHR, and reproduction, as indicated by the presence of juveniles, was noted at 5 sites. The number of mussels collected at sites, random CPUE (no./h), transect CPUE (no./h), and density (no./0.25m<sup>2</sup>) was generally inversely correlated to total mercury content, but not methylmercury content, as measured in *Corbicula fluminea* from proximate NFHRM sites. Random and transect CPUE (no./h) were found to be poor predictors of site densities (no./0.25m<sup>2</sup>) and population estimates. Translocation recommendations for the NFHR downstream of Saltville, VA were made based on multiple species aggregation, occurrence of multiple age classes for multiple species, reproduction, and the distribution of total mercury for NFHRM 56.4, 53.2, and 13.5.

PLOVER PARADISE: BARRIER ISLAND NESTING SURVEYS. Teta Kain, 7083 Caffee Creek Lane, Gloucester, Va. 23061. The barrier islands of Virginia comprise the most extensive and suitable habitat for nesting activities of both the Piping (*Charadrius melodus*) and Wilson's (*C. wilsonia*) plovers in Virginia. From the time that the Piping Plover was listed as a threatened species in 1986, the Va. Dept. of Game and Inland Fisheries have monitored nesting success of these two species. Populations of both species have dipped precipitously over the years, due to a number of factors. Mammalian and avian predators, human disturbance to nesting birds, and nesting habitat loss have all been major contributors to the species' decline. The areas of suitable habitat on Cedar and Metompkin islands are examined and methods of monitoring are explained. An overview of other avian species that nest on the islands is also presented.

AN UPDATE OF RANEY'S 1950 ACCOUNT OF FRESHWATER FISHES OF THE JAMES RIVER BASIN. Eugene G. Maurakis, Museum Scientist Dept., Science Museum of Virginia, Richmond, VA 23220, and William S. Woolcott, Biology Dept., University of Richmond, Richmond, VA 23173. Objectives are to provide a current list (and prevailing nomenclature) of freshwater fishes in the James River basin, and update discussions on the origin and relationships of the James River ichthyofauna, and the distributions of fishes within the system. The James River drainage contains 108 freshwater species (59 genera) in 21 families of fishes (81 native and 27 introduced species), including three endemics, two species (*Notropis semperasper* and *Etheostoma longimanum*), and one subspecies (*Percina notogramma montuosa*). The Piedmont contains the highest number (85) of species followed by Coastal Plain (75) and Montane (67). The high number of native species in the James River is attributed to acquisition of species from different origins and by different mechanisms. Phylogenetic relationships of native fishes by family are required to test earlier hypotheses that the James River drainage is more closely related to northern drainages (i.e., York and northward) than to southern ones (i.e., Roanoke and southward).

ESTABLISHING AMPHIBIAN MONITORING SITES ON THREE MILITARY BASES AND TWO NATIONAL PARKS IN VIRGINIA. Joseph C. Mitchell, Dept. of Biol. & School of Continuing Studies, University of Richmond, Richmond, VA 23173. The causes of amphibian decline worldwide are many and varied, but stem from the fact that these animals have dual life histories, aquatic and terrestrial. Two environmental factors apparently contribute to amphibian decline in the mid-Atlantic region, habitat loss and acid precipitation. Long-term monitoring sites were established in Ft. Belvoir, Quantico Marine Corps Base and Prince William Forest Park, Ft. A.P. Hill, and Shenandoah National Park in 1995. Seven wetland sites were selected for study in the military bases, as were three streams in Shenandoah National Park. I used two monitoring protocols in the military bases, nighttime frog call surveys and larval surveys. Time constrained searches and linear transects with  $m^2$  quadrants were used in the mountain streams. Results to date reveal healthy populations of all species expected for the sites. Nighttime call surveys combined with larval surveys provide the most complete assessments of amphibian communities. Populations of salamanders in a stream with the lowest pH had the highest species diversity compared to other streams with higher pH values. Such information on amphibian communities provides robust assessments of the quality of wetland habitats that can be used by resource managers to make informed decisions about activities that may affect these animals. [Funding provided by the Legacy Resource Management Program of the US Dept. of Defense]

EFFECTS OF TIMBER HARVESTING ON PEAKS OF OTTER SALAMANDER (*PLETHODON HUBRICHTI*) POPULATIONS. Joseph C. Mitchell, Dept. of Biol., Univ. of Richmond, Richmond, VA 23173, Jill A. Wicknick\*, and Carl D. Anthony\*, Dept. of Biol., Univ. of Southwestern Louisiana, Lafayette, LA 70402. The Peaks of Otter salamander is endemic to a small portion of the Blue Ridge Mountains of Virginia above 443 m elevation. Much of its range lies within a high timber producing region in the George Washington-Jefferson National Forest. We studied 23 sites that received either different types of forest management (clearcuts, shelterwood cuts) or were not recently logged. Densities were determined by counting the number of surface active salamanders in 1x50 m transects at night in wet weather. Densities are highest in areas supporting mature hardwoods. Populations were reduced by 45-47% in clearcuts and 10-66% in shelterwood cuts, as compared to mature sites. Variation in shelterwood cut densities were due to the number of canopy trees left standing. We obtained data on prey consumed by stomach flushing. We identified 949 prey from the stomachs of 80 salamanders from 20 sites. Ants and collembolans made up 54.5% of all prey items. Salamanders in mature sites consumed significantly more soft-bodied prey than in recent clearcuts and shelterwood cuts. Numbers of hard-bodied prey did not differ among sites. Timber harvesting practices may not eliminate this species but may diminish population densities and diet quality.

BEHAVIORAL PLASTICITY IN EGG CAPSULE DEPOSITION OF THE MUD SNAIL *ILYANASSA OBSOLETA*. Ronald S. Mollick, Dept. of Biol., Christopher Newport Univ., Newport News, Va. 23606.

*Ilyanassa obsoleta* is abundant in both subtidal and intertidal regions of the York River. I hypothesized that egg capsule deposition by intertidal snails would be interrupted and reduced on collecting devices by falling tides in the field and on aquarium walls by tidal simulations in the laboratory. In the field, egg capsule collection devices were placed in intertidal and subtidal areas in the spring of 1986 and 1987. Capsule number, condition, and specific location on the device was noted after four weeks. In addition, snail density near each device was assessed. In the laboratory, sets of 30 snails were placed in aquaria that simulated either an intertidal or subtidal regime in the spring of each year and egg capsule number and location were assessed after four weeks. Field results showed that snails preferred to deposit capsules subtidally and in areas on the sampling devices which were closest to the substrate. This paralleled laboratory results. Collectively the behavioral plasticity of the snail allowed it to adjust egg capsule deposition behavior so as to maximize apparent survival of embryos.

MORPHOLOGICAL CHANGE IN GROWTH OF THE *TRICERATOPS* NASAL HORN.

Christopher M. Morrow and John W. Happ, Natural Sciences and Mathematics Div., Shenandoah Univ., Winchester, VA 22601. An ontogenetic series of *Triceratops* nasal horncores from the Hell Creek Formation are analyzed to clarify mode of growth. Morphologies of a rare juvenile horn and a rare subadult horn are described for the first time. Comparisons are made with adult nasal horncores. *Triceratops* nasal horncores are identified by laterally compressed conical shape and epinasal ossification within the arch of an arcing vessel trace whose apex bisects the frontal surface. The small juvenile horn maintains a cancellous surface with only few vessel traces and beginning signs of epinasal ossification. The subadult horn has developed a layer of compact bone over a spongy interior, deep vessel traces, and more pronounced epinasal ossification. At bottom of both horns, a rugose basal suture is clear and distinct and shows major and minor foramina as well as a positive medial V-groove that fits between paired nasals. Neither juvenile horn nor subadult horn were permanently attached to a skull. The ossification process that permanently locks the horn to the nasals begins after the horn is of mature size. Discovery of basal sutures in juvenile and subadult horns confirms that the *Triceratops* nasal horn develops from a separate center of ossification rather than from an outgrowth of the paired nasals as in other Ceratopsidae. A bivariate log-log plot of basal length versus basal width of nasal horncores indicates positive allometry. The rate of rostrocaudal growth exceeds that of lateral growth.

THE WATER SHREW, *Sorex palustris*, AND ITS HABITAT IN VIRGINIA. John F. Pagels, Leonard A. Smock, and Stephen H. Sklarew\*, Dept. of Biology, Virginia Commonwealth Univ., Richmond, VA 23284. The water shrew was first collected in Virginia in Bath County in 1972 and placed on Virginia's list of endangered species in 1990. As part of a recovery effort, additional habitat has been identified and surveyed, and the water shrew has been found at four additional localities, all in Highland County. All five sites are small, headwater streams at an altitude above 900 m. Forest types were northern hardwood or northern hardwood and conifer. The streams are characterized by a steep slope and a resulting geomorphology of primarily riffles with occasional pools. The streams present a heterogeneous environment in terms of water depth, water velocity, substrate particle size and the presence of woody debris. Channel bank areas, the critical habitat for the water shrew, are stable, vegetated, frequently undercut and in direct contact with the stream water, providing the shrews with direct, protected access to the stream. The streams harbor a diverse and abundant aquatic macroinvertebrate community, the primary food of the shrews. (Supported by funds to J. Pagels from the Nongame and Endangered Species Program of the Virginia Department of Game and Inland Fisheries)

FLORISTIC DIVERSITY OF SEASONAL PONDS NEAR GRAFTON, YORK COUNTY, VIRGINIA. Thomas J. Rawinski and Tresha S. White\*, Va. Dept. of Conservation and Recreation, Div. of Natural Heritage, Main Street Station, 1500 E. Main St., Suite 312, Richmond, Va. 23219. Virginia's most significant Coastal Plain seasonal ponds occur near Grafton in York County. The purpose of our study was to document vegetation patterns within and among ponds, leading to a better understanding of the ecological factors influencing floristic diversity and rare species distributions. Transects consisting of permanent, contiguous 100 m<sup>2</sup> plots were established across 35 ponds. Vascular plant species richness among 170 plots ranged from one to 39 taxa. Richness per pond ranged from 17 to 54 taxa, and the total flora consisted of 124 taxa. Five major plant communities were classified, each reflecting particular hydrologic conditions. Floristic diversity in a pond was largely a function of the number of communities present. Virginia's only known extant populations of *Fimbristylis perpusilla* and *Litsea aestivalis* occur here. Ponds disturbed by logging or mowing contained 20 plant species rarely if ever found in undisturbed ponds. In 1995 only five of the 35 ponds retained water past 28 June. Water levels are presently very high, and resampling in 1996 may document longer periods of inundation and changes in community composition.

ARE PITCHER PLANTS A COMPETITIVE THREAT TO THE NEW JERSEY RUSH, *Juncus caesariensis* Coville? Philip M. Sheridan, Dept. of Biol., Virginia Commonwealth Univ., Richmond, VA 23284. The VA Dept. Of Conservation and Recreation has suggested that a competitive interaction may occur between out-planted *Sarracenia* pitcher plants and the New Jersey Rush. For interspecific competition to occur there must be a shared, limiting resource and reduction of fitness in the presence of the presumed competitor. Light and nutrient appear to be the main limiting resources to these herbaceous species. Light is limited by shrub encroachment and not an interaction between the two species. Two introductions of *Sarracenia purpurea* to New Jersey Rush bogs in Caroline County, Virginia have resulted in increased fitness of both species. These results may be explained by a commensal relationship in which *Sarracenia* supply limiting nitrogen and phosphorus through prey capture in the insectivorous leaves.



THE USE OF NATIVE WETLAND PLANTS IN HIGHWAY LANDSCAPES. Philip M. Sheridan, Dept. of Biol., Virginia Commonwealth Univ., Richmond, VA 23284. The main function of highways is to transport goods and people from place to place. During the 1960's this concept was enlarged to include beautification. Today highways may also encompass biodiversity and be used as refuges and green corridors for native species. In 1983 I hypothesized that the addition of *Sarracenia*, *Drosera*, *Vaccinium* and *Calopogon* to an exit ramp sphagnum seepage community near Fredericksburg, Virginia would fulfill this role. All species have survived, flourished and spread and have received acclaim from both the state highway department and interested naturalists. Amending of similar sites in the coastal plain of Virginia may enhance the aesthetic aspects of our highways, educate the public to the value of under-utilized native species and serve as backup sites for propagated rare plant species.

PREDATORY IMPACT OF A WOLF SPIDER ON THE NORTHEASTERN BEACH TIGER BEETLE. Tammy Stockett and Barry Knisley, Dept. of Biol., Randolph-Macon Col., Ashland, VA 23005. Predation by the beach wolf spider, *Arctosa littoralis* on the Federally Threatened Northeastern beach tiger beetle, *Cicindela dorsalis dorsalis* was studied at Flag Ponds Nature Park, Calvert County, MD. Twelve night surveys (June through August) were conducted on alternate 50 meter sections of the 1500 meter shoreline to count numbers of spiders and beetles and to record all predation events by the spiders. Beetles and spiders commonly co-occurred on the beach from mid-June through August, with populations of both peaking in mid-July. Spiders were more abundant on the middle beach and least abundant on the north beach (a newly developed spit); beetles were most abundant on the south beach. Observed predation events by *A. littoralis* included 18 amphipods, 12 ants, 12 *C. dorsalis*, and 13 other arthropods during the 12 twice-nightly surveys. In laboratory feeding trials, spiders fed readily on crickets and beetles, but rarely on amphipods. We calculated an estimate (based on observed predation events and numbers of spiders and beetles active each night) of at least 500 adults of *C. d. dorsalis* eaten by spiders during the summer at this site.

HISTORICAL REVIEW AND DISTRIBUTIONAL STATUS OF CANEBRAKE RATTLE-SNAKE AND ITS HABITAT ON THE JAMES-YORK PENINSULA OF VIRGINIA. Robert A. S. Wright, Vanasse Hangen Brustlin, Inc., 7188 Chapman Drive, Hayes, VA. 23072.

Since February 1994, research has been undertaken to document the historical range for canebrake rattlesnake on the James-York Peninsula within portions of York County, and the Cities of Hampton and Newport News. Extant populations have been correctly identified as "in critical need of protection" in this region. The future for the canebrake, while "bleak", is not entirely without hope, according to my research. Utilizing some novel as well as standard investigative techniques, more than fifty new reports (photographs, skins, eyewitness accounts, public records etc.) document a more conclusive distributional range of sixty square miles on the Peninsula. The causes of habitat loss are quantified and discussed in this presentation; maps are shown to depict areas for future conservation efforts.

THE MEASUREMENT OF WATERFOWL DIVERSITY: A GUILD VERSUS A TAXONOMIC APPROACH. J. C. Wilgenbusch, Dept. of Biol., George Mason Univ., Fairfax, VA 22030. The relationship between species and guild diversity was examined for waterfowl utilizing a freshwater tidal embayment of the Potomac River in southern Fairfax County, Virginia. From 1985 to present, waterfowl at four transects were counted twice each Fall, Winter, Spring, and Summer. Birds were identified to species and assigned to one of six feeding guilds. Cumulatively, over 50,000 individuals birds were counted representing 29 genera and 47 species. Three species, two genera, and two guilds represent 56, 66, and 81 percent respectively of the total number of individual birds counted. The relationship between guild diversity and species diversity varied more seasonally than spatially. The number of species per guild dramatically increased due to seasonal migration, however each transect was differentially influenced by the seasonal influx. Although guild diversity and species diversity were highly correlated, as the number of species per guild increased the reliability of guild diversity as a surrogate for predicting species diversity decreased.

THE INFLUENCE OF WATER AVAILABILITY DURING INCUBATION OF *CHELYDRA SERPENTINA* ON POST-HATCHING GROWTH AND SURVIVORSHIP. J. C. Wilgenbusch, Dept. of Biol., George Mason Univ., Fairfax, VA 22030. The availability of water during incubation may have profound influences on the life history of reptiles with flexible shelled eggs. Other than the risk of lethal dehydration, *Chelydra serpentina* incubated on a dry substrate emerge from the egg significantly smaller than do hatchlings incubated on a wet substrate. Body size at hatching may influence the fitness of an individual either directly (differential survivorship) or indirectly (differential growth). The fitness consequences of variable body size due to the availability of water during incubation are dependent upon the magnitude and the persistence of the size differential caused by the availability of water during incubation. Wet and dry incubated *Chelydra serpentina* hatchlings were randomly assigned to a group or a solitary tank. Approximately 150 days after hatching, the average body size of dry and wet independently housed turtles coalesced. Survivorship among turtles housed in the group tanks was not related to incubation condition, rather survivorship was more closely related to clutch. These results indicate that the availability of water during incubation only temporarily influences the body size of independently housed hatchling *Chelydra serpentina* and that size differences due to the availability of water during incubation are less important than clutch related differences for survival in a group tank.

## Psychology

AMERICAN VERSUS AFRICAN DIFFERENCES IN MATERNAL PERCEPTIONS OF CHILDRENS' PHYSICAL VERSUS EMOTIONAL WELL-BEING. R. Bhandari & J. Pickens, Department of Psychology, James Madison University, Harrisonburg, VA 22807. A survey assessed maternal perceptions of childrens' physical and emotional well-being, and was administered to 60 mothers in the United States and 55 mothers in Tanzania. Mothers in Tanzania rated physical factors about their children (nutrition, weight, height) as more important than emotional factors, compared with American mothers. The importance of play was rated similarly by mothers in both countries. Regression analysis showed that socio-economic status accounted for 9.3% of variation in physical well-being scores, 6.7% in temperament scores and 9.4% in mood scores. Significant differences in Tanzanian versus American mothers' rankings of emotional state, social interaction and physical activity of their child were observed. More American mothers ranked "emotional state of their child" as most important and "physical activity" as least important, compared with Tanzanian mothers who rated "physical activity" as most important and who tended to rate "social interactions" as least important. Future considerations for cross-cultural research on parenting were discussed.

VIOLENCE IN ROMANTIC RELATIONSHIPS. Jennifer Bonney & Barbara Winstead\* Dept. of Psychology, Old Dominion Univ., Norfolk, Va. 23529. The study investigated verbal and physical violence in relationships. 212 participants. The Conflict Tactics Scale, Hendrick's Relationship Assessment Scale, Accommodation Scale were administered. Participants were classified into the Exit, Voice, Loyalty, or Neglect style of accommodation. Those classified as Exit reported higher levels of self-generated verbal abuse than the Neglect participants. The Never, Mild, and Moderate levels of self and partner-generated verbal and physical abuse were significantly related. No gender differences for self-generated verbal or physical abuse or partner-generated verbal abuse; however, females reported lower levels than males of partner-generated physical abuse. Higher levels of relationship satisfaction were significantly related to lower levels of partner-generated verbal abuse. Those classified as Voice or Loyalty reported higher levels of satisfaction than those classified as Exit.

#### EFFECTS OF PARENTING STRESS ON PARENT-CHILD INTERACTION QUALITY DURING THE MARSCHAK INTERACTION METHOD: A TASK ANALYSIS

S. Coffey and J. Pickens. Dept. of Psychology, James Madison Univ., Harrisonburg, VA 22807  
This research investigated the effects of parenting stress on the interactions between parents and their children during the Marschak Interaction Method (MIM). During the MIM, parents are asked to perform a series of eight tasks with their children. This study examined interaction quality ratings on two individual MIM tasks - the "Parent Separation" task and the "Child Looks in the Mirror" task - and how behavior on these individual tasks were related to interaction quality ratings for the entire MIM. This study also assessed if interaction quality ratings differed between dyads where parents reported more versus less parenting stress on the Parental Stress Index (PSI). Coding schemes were developed to rate parent-child interaction behavior quality for the overall MIM and individual task performances. The results indicated that individual task ratings were positively correlated with ratings on the overall MIM. Dyads where the parent reported less parenting stress received more optimal ratings on each of the two tasks than dyads where the parent reported more parenting stress.

THE EFFECTS OF TARGET AGE, SUBJECT AGE, AND MEMORY TYPE ON ATTRIBUTIONS FOR MEMORY FAILURE. Michael Drew, Jennifer Harryn\*, Jennifer Ziembra\*, Kelly Spickard\*, Jason Young\*, and Jane M. Berry\*, Dept. of Psychology, Univ. of Richmond, Richmond, VA 23173. This experiment investigated the influence of target age, subject age, and memory type (short-term, long-term, and very long-term) on attributions for other people's memory failures. 50 young (mean age= 20.64) and 49 old subjects (mean age= 70.71) read vignettes describing memory failures of old or young target persons. Subjects judged causes of failures by assigning percentage amounts to "lack of ability," "lack of effort," "task difficulty," and "other." MANOVA indicated that young subjects were significantly more likely to attribute failures to task difficulty and confirmed the double standard of failure attribution: Relative to failures of young targets, failures of old targets were more likely to be attributed to ability and less likely to be attributed to effort. As factor analysis indicated that memory type was not a salient attributional factor, results do not support Parr and Siegert's (1993) conclusion that the double standard is mediated by memory type.

THE ACT OF REQUESTING PERFORMANCE FEEDBACK: ADDITIONAL CONSIDERATIONS OF THE MOTIVATORS AND DETERRENENTS. Bryan C. Hayes and Debra A. Major\*, Dept of Psych, Old Dominion Univ., Norfolk, Va. 23529. The benefits of feedback have been established for many years with feedback considered essential to performance, adaptation to new environments, and is arguably one of the basic components of motivation. However, organizational members often perceive that they receive less performance feedback than is needed. Viewing feedback as a valuable resource to the individual, empirical evidence demonstrates that individuals do actively seek feedback and has linked this behavior to acquisition of knowledge and important outcomes to both the individual and organization. Several researchers have offered empirically supported models of the factors believed to determine when a person will and will not ask for performance feedback. Motivation to seek feedback comes from the benefits that the feedback information provides. However, certain situational factors (e.g., presence of third party observers) make overt request for feedback a risky act. These situational factors make certain behaviors appear risky and potentially damaging to impressions. This paper builds on existing models that predict when and how feedback seeking behavior (FSB) will take place. A model is developed that includes influence processes missing in the existing models.

THE EFFECT OF UNRECOGNIZED MEAN SUBGROUP DIFFERENCES ON CORRELATION COEFFICIENTS. C. Anthony Macera and Robert M. McIntyre, Dept. of Psych., Old Dominion Univ., Norfolk, VA 23529. During correlational studies, data are often pooled from two or more subgroups to increase the sample size of the predictor, the criterion, or both. When the predictor and/or criterion are treated as though they were composed of homogeneous subgroups, yet the subgroups actually contain mean differences, inaccurate conclusions can be made from the results. This paper addresses the problem as described by McIntyre (1990, *Jnl. Applied Psych.*, 75(1),91-94), which explains how correlation coefficients can be obtained which are spuriously high or spuriously low when such differences are not taken into account. Here, original data from 6 previously conducted studies are reanalyzed to determine the differences in correlation coefficients obtained by using the Pearson  $r$  and by another formula which makes statistical adjustments for the mean differences across subgroups. No significant differences between the results of the 2 methods were found for the examined studies. It is expected that such differences will appear as more studies are reanalyzed.

EFFECT OF LESIONS OF THE AREA POSTREMA ON INGESTIVE BEHAVIORS AND REPRODUCTIVE ACTIVITY OF GROWTH-RESTRICTED PREPUBERTAL FEMALE RATS. J.A. Olejniczak, H. l'Anson and L.E. Jarrard, Depts. of Biology and Psychology, Washington and Lee University, Lexington, VA 24450. Lesions of the area postrema (AP), a circumventricular organ located on the dorsal surface of the medulla, cause hypophagia and body weight loss in adult rats. The AP also appears to detect brain glucose availability and has been implicated in the metabolic regulation of estrous cyclicity. We investigated the effects of the AP lesion on ingestive behavior and onset of puberty in food restricted female rats with delayed puberty. Female rats (n=12) were placed on a restricted diet to maintain a weight of 80-90 g. On day 54-55 of age, the AP was lesioned using gentle aspiration (n=5) or sham lesioned (n=7). Sham and AP lesioned rats showed a similar pattern of body weight changes following surgery. AP lesioned rats consumed more water (AP: 17.0 +/- 3.1 ml/day, SHAM: 9.7 +/- 0.2 ml/day) compared to Sham lesioned rats, but did not require more food to maintain their pre-lesion body weight. All rats remained acyclic. These results suggest that the AP may play a role in controlling ingestive behavior in the rat, but may not be the only CNS structure which is important in this regard. In addition, since these growth-restricted rats did not begin cycling following AP-lesion, these results do not support the hypothesis that the AP provides an inhibitory signal to reproductive activity during times of decreased food availability. (Supported by NIH HD-07433).

EFFECTS OF CLOTHING ON PERCEPTIONS OF SOCIAL POWER: ADDING A JACKET TO A SKIRT-AND-BLOUSE. W. Bryan Pennington, Jr., Laurie L. Kerr, Christine E. Nelms, Rachel L. Hoaglund, and James P. O'Brien, Social Sciences Div., Tidewater Cmnty. Col., Virginia Beach VA 23456. Temple & Loewen (1993) found that subjects, asked to imagine a "large office complex" setting, rated faceless line-drawings of a woman dressed in a jacket higher in total, expert, and legitimate power than those without a jacket on an expanded version of the Attributed Power Index (API). This modified replication presented 6 classes of community colleges students with an actual woman dressed in a skirt-and-blouse (NJ; n=56) or with a jacket and skirt-and-blouse (J; n=57). All subjects were asked to line up in order of birth-month and -day, without speaking, and to complete the API; errors were also recorded. With  $df=111$ , t-tests were not statistically significant for total score or any of the five API scales for types of social power. Compliance analyses are unavailable at this time. Whether Temple & Loewen's results apply to real situations, including the "large office complex" imagined by their subjects, is unresolved.

TEACHER'S AND CHILDREN'S RESPONSES TO COMPUTER ASSISTED INSTRUCTION J. Pickens and C. Wallack', Dept. of Psychology, James Madison Univ., Harrisonburg, VA 22807. College students preparing for careers as teachers in early childhood and secondary education participated in a course on Computer Assisted Instruction (CAI) at James Madison University. Twenty-four student-teachers practiced using 12 different educational software products. These student-teachers then instructed 62 children (ranging in age 3 to 11 years) in the use of these educational programs and observed them. The student-teachers generally rated CAI as enjoyed by children, more engaging than text-books, and developmentally appropriate for a wide range of students. Differences were noted across CAI programs in the difficulty children had learning the rules of the games and in learning to use the keyboard or mouse to play these educational games. For over 200 evaluations completed on 12 software products, student-teachers reported significant differences across programs in ease of use, flexibility, pacing, the reinforcing quality of graphics and sounds, and whether they would use the CAI products in their own classrooms. These results suggest that future educators rate CAI positively, but that training is necessary for educators to effectively differentiate and select products and then incorporate CAI in their classrooms.

THE ROLE OF IMAGE GENERATION ON THE RECOLLECTION OF THE SERIAL ORDER OF ODORS. Suzanne M. Sharp, Allison Foote\*, & David G. Elmes, Dept. of Psychology, Washington and Lee Univ., Lexington, VA 24450-0303. The effects of odor imagery on the memory for common odors was examined in two experiments. In the first experiment, the subjects either sniffed a substance, imagined the visual characteristics of it, or imagined its odor. After a filler task, old/new recognition was tested for either the target odor or the name of the odor. Source recognition was also assessed by having subjects indicate the encoding condition for the items labeled old. Odor imagery did not enhance the hit rate or the source recognition. In the second experiment, some subjects generated a context for several odors, while yoked subjects received the generated descriptions. Half of all subjects expected a memory test, and the remainder did not. Serial order recognition was tested twice with a week between tests. Retention fell during the test interval, but it was not influenced by either generation or knowledge of the upcoming test. The present data agree with earlier results that seem to indicate that odor memory is not strongly influenced by top-down processing.

ACQUISITION OF A CONCURRENT OLFACTORY DISCRIMINATION TASK IN RATS: EFFECTS OF ENTORRHINAL CORTEX LESIONS. E. W. Smith, C. M. Sturge, S. Dallvechia, and L. E. Jarrard, Dept. of Psychol., Washington & Lee Univ., Lexington, VA. 24450. Our previous research has shown that rats are able to learn a complex, 8-pair, concurrent, olfactory discrimination task. Pairs of olfactory stimuli (e.g., oregano vs. cumin) are repeatedly presented where one odor in each pair is consistently reinforced. It is well known that the entorhinal cortex receives direct projections from the olfactory bulb, and it has been reported that this structure plays an important role in the processing of olfactory stimuli. In the research to be reported the entorhinal cortex was removed selectively, and the rats were trained on the concurrent, olfactory discrimination task. The results indicated that rats with the entorhinal cortex removed learned the complex task at the same rate as controls. These results will be discussed as they relate to previous research and the reports that the entorhinal cortex plays a vital role in the processing and storage of olfactory information.

ATTACHMENT STYLES AND JEALOUSY IN ROMANTIC RELATIONSHIPS. Melinda Swager and Barbara Winstead, Dept. of Psych., Old Dominion Univ., Norfolk, VA 23529. This study analyzed the relationship between attachment styles and romantic jealousy in adult romantic relationships. Undergraduates completed a series of questions concerning their feelings in their present or past romantic relationships. Students reported one of three attachment styles: secure, avoidant, or anxious-ambivalent. Romantic jealousy was assessed using the Interpersonal Jealousy Scale. In addition, this study differentiated between emotional and sexual jealousy. As predicted, anxious-ambivalents reported higher levels of jealousy than secures. However, avoidants did not differ significantly from the other two styles in their level of jealousy. Males reported feelings of sexual jealousy more often than females; females reported feelings of emotional jealousy more often than males. However, no relationship was found among attachment styles and type of jealousy. Results of this study point to the need for further research distinguishing between the emotional and sexual aspects of jealousy.

THE ROLE OF INTENTION IN LEARNING: AN EEG ANALYSIS. Nicholas Tatar, Julie Ann Olejniczak, Margaret Randol\*, Robert Taylor\*, David G. Elmes, Dept. of Psychology, Washington and Lee University, Lexington, VA 24450-0303, and Thomas P. Urbach, Department of Philosophy, SUNY Binghamton, Binghamton, NY 13902-6000. While ERPs to individual words were being collected, three different groups of subjects studied 120 five-letter words that were presented amidst two filler tasks. The test for retention was a stem completion task, in which stems of the 120 targets and some fillers were presented and the subjects were supposed to complete them. The Inclusion Group was not given memory instructions and was told to complete the stems with the first word that came to mind. The Exclusion Group was not given memory instructions and was told to complete the stem with the first word that came to mind that had not been used in a previous phase of the experiment. The Explicit Group was told about the memory test and was told to use previous words to complete the stems. Most stems were completed by the Explicit Group and fewest by the Exclusion Group. Peak positive ERPs during the test phase occurred between 400 and 600 ms post stimulus. For correct stem completions, the peak ERPs for the Exclusion Group tended to be greater in the right hemisphere than those for the Explicit Group. We have tentative evidence for different neuronal generators for implicit and explicit memory.

ON THE ROLE OF THE HIPPOCAMPUS IN CUED AND CONTEXTUAL APPETITIVE CONDITIONING. T. S. Trigilio, B. Bowring, L. E. Jarrard and T. L. Davidson. Dept. of Psychology, Washington and Lee Univ., Lexington, VA 24450, and Dept. of Psychology, Purdue Univ., Lafayette, IN. Rats were trained in an appetitive classical conditioning task where a tone conditioned stimulus (CS) was followed by an unconditioned stimulus (US) (food). Half of the animals received 3 unsignalled USs and half 0 unsignalled USs. After 15 days of training where activity before and during the CS and before the US in unsignalled trials was recorded, half of the rats in each group had the hippocampus removed and half served as controls. Postsurgery, the rats underwent 14 days of extinction where no food US's were given. The results showed that rats with hippocampal lesions were slower to extinguish the response to the CS but there were no differences between groups in activity that preceded the unsignalled US's. The results indicate that removing the hippocampus impairs the rats' ability to learn inhibition to cues that have undergone both excitatory and inhibitory training.

INFORMATION SEEKING AND ATTRIBUTIONS: PERCEIVED COSTS VERSUS ACTUAL COSTS. Jonathan E. Turner, Bryan C. Hayes, and Debra A. Major, Dept. of Psych., Old Dominion Univ., Norfolk, VA. 23529. The effects of information seeking in the workplace on attributions made about the seeker were investigated using a hypothetical scenario where an individual sought specific types of information from the subject. One hundred sixteen subjects, 29 of which had supervisory experience, responded to a questionnaire assessing perceived organizational commitment of the seeker, use of ingratiation tactics, the seeker's self-interest, ability, organizational potential and allocation of rewards, and the degree to which they would help the seeker. The seeker's characteristics varied by tenure, relative position to the subject, and the type of information being sought. It was found that supervisors perceived the seeker to be more committed and deserving of greater rewards when technical as compared to feedback information was sought. When subjects assumed the role of the seeker's coworker, they perceived the seeker to be more committed and deserving of rewards when feedback information was sought. Main effects for information type sought and tenure were found for ingratiation /rewards and self-interest respectively.

THE EFFECT OF STUDENT-PAID PORTION OF COLLEGE EXPENSES ON ACADEMIC ACHIEVEMENT AND PERSISTENCE AMONG COMMUNITY COLLEGE STUDENTS. Doris M. Velazquez, Debra L. Vendt, Maria E. Marscheider, Linda E. Miller<sup>1</sup>, and James P. O'Brien, Social Sciences Div., Tidewater Cmnty. Col., Virginia Beach VA 23456 (and <sup>1</sup>SUNY, Old Westbury). Personal contacts with leaders in the field revealed that students' personal financial burden (SB) was considered (1) important, (2) extremely complex, (3) difficult to measure, (4) absent from the research literature, and (5) qualitative measures were recommended. Trials of the qualitative survey indicated that military and veterans (MV) students presented unique problems and a second version for these students was developed (MV data was not analyzed here). It was hypothesized that SB would be positively related to GPA and negatively related to Persistence (P) for community college students (N=79). As existing literature does support,  $r$ 's were significant for the Parental Non-Support measure x GPA,  $r = +.397$ , and x P,  $r = -.308$ , beyond .0005 and .005 levels of significance (1-tailed tests), respectively. More direct SB measures, however, must be rescored since the ranking devices used in these analyses appear to be too coarse, although some reached significance beyond the .05 level. This study apparently represents the first reported treatment of the effects of student-paid vs. parent-paid portions of college costs.

THE RELATIONSHIP BETWEEN PERCEIVED STRESS AND COPING STYLE. Adria N. Villarreal & Elaine M. Justice\*, Dept. of Psych., Old Dominion Univ., Norfolk Va. 23508. Traditional and non-traditional aged students completed the Hassles & Uplifts State Scale as an indication of perceived stress. Coping style was also assessed. Results indicated that traditional-aged students reported a greater frequency, higher cumulated severity, and higher average intensity of both hassles and uplifts than non-traditional aged students. Individuals with a problem-solving coping style differed from those with social support and emotion-focused coping styles. Problem-solvers reported a significantly higher frequency and cumulated severity of both hassles and uplifts. Thus, both age and coping style affected perceived stress.

### Statistics

AN OUTLIER RESISTANT REGRESSION METHOD IN THE PRESENCE OF MODEL MISSPECIFICATION. Christopher A. Assaid & Jeffrey B. Birch. Dept. of Statistics, VPI&SU, Blacksburg, VA 24061. Parametric regression fitting (such as OLS) to a data set requires specification of an underlying model. If the specified model is different from the true model, then the parametric fit suffers to a degree that varies with the extent of model misspecification. Mays and Birch (1995) addressed this problem in the one regressor variable case with a method known as Model Robust Regression (MRR), which is a combination of parametric and nonparametric techniques. This paper was based on the underlying assumption of "well-behaved" (Normal) data. The method seeks to take advantage of the beneficial aspects of the both techniques: the parametric, which makes use of the prior knowledge of the researcher via a specified model, and the nonparametric, which is not restricted by a (possibly misspecified) underlying model.

The method introduced here (termed Outlier Resistant Model Robust Regression (ORMRR)) addresses the situation that arises when one cannot assume well-behaved data that vary according to a Normal distribution. RMRR is a blend of a robust parametric fit, such as M-estimation, with a robust nonparametric fit, such as LOWESS. Some properties of the method will be discussed as well as illustrated with an example.

A SURVIVAL ANALYSIS OF A PROSPECTIVE STUDY COMPARING A NEW PROCEDURE TO THE STANDARD PROCEDURE FOR VARICEAL BLEEDING. Wendy B. London, Dept. of Biostatistics, Medical College of Virginia at Virginia Commonwealth University, Box 32, Richmond, Va. 23298-0032. An application of a Cox proportional hazards model was used to perform a survival analysis. The objective of this analysis was to determine whether or not there was a difference between the survival rates of patients who received the "standard" procedure versus those who received a "new" procedure for bleeding gastrointestinal varices. The analysis also determined the extent to which risk factors affected the survival rates. Two models were developed: Model A included all clinically important risk factors as identified by the clinician, while Model B included only statistically significant variables and was used to make predictions about survival rates. When tested, all time-dependent covariates were found to be not significant; therefore, proportional hazards existed. A sensitivity analysis was performed to check for potential bias introduced by informative censoring. A statistically significant difference between the two procedures was detected, and statements were made regarding the significant risk factors.



A MODEL ROBUST DUAL MODELING APPROACH TO HETEROGENEITY OF VARIANCE IN A REGRESSION SETTING. Tim Robinson & Jeffrey B. Birch, Dept. of Statistics, VPI&SU, Blacksburg, VA 24061. In typical normal theory regression, the assumption of homogeneity of variances is often not appropriate. Instead of treating the variances as a nuisance and transforming away the heterogeneity, the structure of the variances may be of interest and it is desirable to model the variances. Aitkin (1987) proposes a dual model in which a log linear dependence of the variances on a set of explanatory variables is assumed. Aitkin's approach is an iterative one providing estimates for the parameters in the mean and variance models through joint maximum likelihood. Estimation of the mean and variance parameters are interrelated as the responses in the variance model are the squared residuals from the fit to the means model. Our research will consider the impact of model misspecification in one or both of the models in Aitkin's dual model approach. Mays and Birch (1995) have demonstrated an effective semi-parametric method to situations of model misspecification in the one regressor setting. Using their techniques, we develop a dual model similar to Aitkin's but which is robust to misspecification in either or both of the two models. For instance, if the means model is misspecified, we show that the squared residuals from the model robust fit of Mays and Birch is more appropriate for the response data in the variance model than squared residuals from a misspecified parametric model. Examples will be presented to illustrate the new technique, termed here as Dual Model Robust Regression.