ABSTRACTS OF PAPERS
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Aeronautical and Aerospace Sciences

EXPLOSIVE FRACTURING OF FIGHTER AIRCRAFT CANOPIES TO ALLOW THROUGH-CANOPY CREW ESCAPE. Laurence J. Bement, NASA Langley Research Center, Hampton, VA. Many challenges exist in providing for crew escape from fighter aircraft. The need for resistance to bird strikes and flat-panel stealth technology has driven designers to increase the thickness of impact-resistant canopies. The mass of these advanced canopies has exceeded the capabilities for jettison within the current goal of 0.3 second to allow unrestricted crew ejection. Through-canopy crew ejection, the approach used on the Harrier (AV-8B), eliminates the need for delays in initiating crew escape to wait for canopy jettison. A new approach has been developed by a NASA Langley Research Center/McDonnell Douglas team to explosively fracture these high-strength canopies without any debris or sound impact on the crewmembers. Small (less than 0.1-inch thick) explosive cords are installed in the outer surface of the canopy, and on initiation, induce precisely controlled fracture lines into the canopy. When struck by the ejection seat, the canopy would open like "French doors" to allow uninhibited crew egress. The potential savings in system weight, complexity and cost are enormous over that provided by canopy jettison, while increasing the crew escape envelope.

THE BLENDED-WING-BODY ADVANCED TECHNOLOGY CONCEPT. Jeanette Elliott and James R. Elliott*, Systems Analysis Branch, and H. Keith Henry*, Office of Public Affairs, NASA Langley Research Ctr., Hampton, Va. 23681. NASA, Industry, and academia are currently working together on new solutions to tomorrow's aviation challenges. These challenges include the predicted tripling of passenger air travel from 1995 to 2015 and pressures on the aircraft industry to produce lower ticket prices while remaining economically viable. Future aircraft will also be required to meet increasingly stringent noise, emissions, and safety requirements. The use of revolutionary technologies and aircraft concepts may enable future aircraft to meet these challenges. One revolutionary concept currently under study is the Blended-Wing-Body. This thick "flying wing" would carry 800 passengers more than 7,000 miles in a double-deck compartment that blends into the wing - almost twice the capacity of a Boeing 747-400. By integrating the engines, wings and body into a single lifting surface, the overall efficiency will be maximized. Using 2015 technology, advances in structures, aerodynamics and other technologies will be combined to dramatically increase the performance over current aircraft. To develop the technologies for the Blended-Wing-Body, McDonnell Douglas, Stanford University, the University of Southern California, the University of Florida, Clark Atlanta University, and NASA Langley and Lewis Research Centers are conducting computational analyses and performing structural and wind tunnel tests. Remotely-piloted models will then demonstrate stability & control and ride quality. Applications envisioned for the Blended-Wing-Body include commercial, cargo, and long-range military transports. In addition, advances made in the pursuit of the Blended-Wing-Body will provide new technologies for all future aircraft, thereby helping the U.S. aircraft industry to successfully compete in the 21st Century.

OPTIMUM DESIGN OF STIFFENED COMPOSITE PANELS WITH REALISTIC IMPERFECTIONS. Mohamed A. Elseifi, Z. Gürdal*, & E. Nikolaidis*, Dept. of Aerospace Engineering, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Thin walled stiffened composite panels, which are among the most utilized structural elements in engineering, possess the unfortunate property of being highly sensitive to geometrical imperfections. The experimental buckling load sometimes amounts to no more than one-tenth of the buckling load of a perfect panel. Existing codes are able to predict the buckling load of a structure with specified initial imperfection. However, due to the very nature of the manufacturing process, it is hard to imagine that one manufacturing process could ever produce two identical panels. Thus, it is imperative to consider the effects of uncertainty in panel imperfections on the panel load carrying response. The long term goal of this study is to incorporate the effects of imperfections into the formulation of optimum design of compressively loaded stiffened composite panels. The main emphasis will be to investigate the existence of a relationship between the values of the different design parameters defining the panel (e.g. laminate stacking sequence and stiffener spacing) and the geometric imperfections resulting in the manufacturing process. Establishing a relationship between the design parameters and the imperfection-model parameters will allow the prediction of the imperfection effects on the panel behavior, thus allowing the formulation of more realistic design constraints. Currently a convex model for the imperfections has been developed to replace the probabilistic approach typically used in the study of imperfection sensitive structures. Several Central Composite Design (CCD) response surfaces have been developed to check the validity of the predictions of the convex model.

UNSTEADY AERODYNAMIC MODELING, Y. Fan* and F. H. Lutze, Dept. Of Aerospace and Ocean Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0203. A model for predicting longitudinal force and moment time histories during dynamic maneuvers is presented. The model is a state-space representation of the aerodynamics and is valid up to and beyond the stall angle of attack. A first order differential equation of an internal variable is driven by a function of an effective angle of attack and is used to model the state associated with physical characteristics such as flow separation and/or vortex bursting. The effective angle of attack depends on the current angle of attack as well as the angle of attack rate and pitch rate. The stability derivatives which appear in the standard aerodynamic representation are assumed to be quadratic functions of the state variable. This model is applied to an airfoil, a delta wing and an aircraft fighter configuration performing rapid pitch up, pitch down, and sinusoidal pitch motions. Results indicate that the model gives good agreement with observed experiments. In addition using the model in a simulation of standard forced oscillation tests yield frequency and amplitude dependent results consistent with that observed in wind tunnel tests.

DESIGN OF SEMI-SPAN MODEL STANDOFF MOUNTING GEOMETRIES. William E. Milholen II , National Research Council, NASA Langley Research Center, MS 286, Hampton, VA, 23681-0001. A semi-span model test technique has been proposed for the NASA Langley Research Center's National Transonic Facility for the testing of advanced aircraft at flight Reynolds numbers. One area of particular concern is the loss of symmetry about the model centerplane due to the presence of the boundary layer on the wind-tunnel sidewall. The use of active control techniques to minimize the influence of the sidewall boundary layer is not practicable in the National Transonic Facility due to the high cost of developing and operating the control devices at cryogenic conditions. An economic alternative to active control techniques is the use of an optimally designed semi-span model standoff geometry. An efficient computational method is developed for designing semi-span model standoff geometries which would passively minimize the influence of the wind-tunnel sidewall boundary layer. The resulting semi-span model test technique would not rely on costly active sidewall boundary-layer control techniques, and thus would be practicable to enable implementation of a high Reynolds number semi-span model test capability in the National Transonic Facility.

ELECTROMECHANICAL CHARACTERIZATION OF A NEW CLASS OF PIEZOELECTRIC DEVICES. Karla Mossi, Mech. Eng. Dept., Old Dominion University, Norfolk, VA, 23529, Dr. Greg Selby*, Mech. Eng. Dept., Old Dominion University, Norfolk, VA, 23529, and Dr. R. G. Bryant*, NASA LaRC, Hampton VA, 23681. Tests were conducted on 13 different configurations of a new class of piezoelectric devices. These configurations consisted of a combination of 1, 3, 5, 7, and 9 layers of 1-mil thick aluminum as backing material, with and without a top layer of 1-mil aluminum. Additional configurations included backing layers of 5-mil aluminum, 1- and 3-mil stainless steel, and 2-mil beryllium-copper. All of these configurations used the same poled ceramic wafer (PZT-5A) with dimensions of 5.08 x 3.81 x 0.018 cm. The above configurations were tested at two stages of the manufacturing process: before and after re-poling. Poling was accomplished by applying a DC field of 400 V for 5 minutes. The parameters measured included frequency, driving voltage, displacement, capacitance, and radius of curvature. These parameters were measured under no load. An optic sensor recorded the displacement at a fixed voltage(100-400 Vpp), over a predetermined range of frequencies (1-1000 Hz). These displacement measurements were performed using a computer that controlled the process of activating and measuring the displacement of the device.

A NONLINEAR LIFTING LINE METHOD FOR CONCEPTUAL AIRCRAFT DESIGN. D. Bruce Owens, National Research Council, NASA Langley Research Center, Hampton, VA 23681-0001. Highly accurate aerodynamic modeling techniques for the analysis of the nonlinear aerodynamics of complex configurations have matured in terms of efficiency and robustness. As computers become more powerful in speed and memory, these techniques are transcending the phases of aircraft design. Even so, these techniques are still too time consuming, both in geometry input and run time, to be practically used in the initial stage of aircraft design. Unfortunately, most methods that can be used in the conceptual design phase do not predict nonlinear aerodynamics. A nonlinear lifting line method based on Weissinger's lifting line model can provide a means to predict the nonlinear aerodynamics with good accuracy in the time constraints of the conceptual design phase. This method has predicted the stall angle of attack and maximum lift coefficient for a wing using a NACA 0012 airfoil section to within 2% of experimental data. It requires only the planform shape and the airfoil(s) lift data. In order to make use of this tool in the conceptual design phase, the method incorporates characteristics of a design oriented analysis technique. It provides adequate accuracy, computational efficiency, precision for speed tradeoff, minimal time for geometric input and modification, sensitivity-based scaling, and coupling to other methods.

ANISOTROPY IN WAKE TURBULENCE AND ITS AEROACOUSTIC IMPLICATIONS. Christian w. Wenger, Dept. of Aerospace and Ocean Eng., Va. Polytechnic Institute and State Univ., Blacksburg, VA, 24061. Wavenumber frequency spectra are important for predicting the broadband noise produced by an airfoil passing through a turbulent flow. For given locations within a flow, they may be calculated from a series of two-point, three component measurements taken over a range of probe separations keeping one probe fixed. This is accomplished by taking the double Fourier transform with respect to time and with respect to probe separation. In practice, the cross-spectra for each two-point measurement are first computed, followed by the transformation with respect to probe separation for each frequency. The dominating features of the flows can be seen in the cross-spectra and subsequent wavenumber frequency spectra. The anisotropy of large scale eddies results in significant deviations of the spectra from the von Karman spectrum, which has typically been used for broadband noise prediction. Specifically, the measured wavenumber frequency spectra show that the streamwise and spanwise length scales of the upwash velocity component are not equal. If the length scales of the von Karman spectrum are adjusted to match those of the measured spectra, directionality predictions more closely resemble the directionality based on the measured wavenumber frequency spectra.

OPTIMIZATION OF PRESSURE SENSITIVE PAINT MEASUREMENTS. Jeremy P. West, D. M. Oglesby*, Dept. of Chem. and Biochem., Old Dominion Univ., Norfolk, Va. 23529, & B. T. Upchurch*, NASA Langley Research Ctr., Hampton, Va. 23681. The recent application of pressure sensitive luminescent paints for model surface pressure measurements in wind tunnel testing is based on the quenching of luminescence by oxygen. Thus their utility for measuring pressure is dependent on the partial pressure of oxygen. Wind tunnel tests have traditionally operated in an air environment, in which relative error in pressure reaches a minimum near 1.5 PSIA total. Tests do not always occur in this pressure region, so data is often taken at pressures where error is high. By adjusting the oxygen concentration in the test chamber, we can change the total pressure at which error is minimum. This will allow us to operate under optimal conditions, regardless of a test's specific pressure region.

Agriculture, Forestry and Aquaculture Science

POTENTIAL OF CASTOR PRODUCTION IN VIRGINIA. HARBANS L. BHARDWAJ. Agricultural Research Station, Virginia State University, Petersburg, Va 23806. Castor (*Ricinus communis* L.) oil and its derivatives are used by US industry in a wide range of products. Since early 1970s, when castor production ceased in USA, the industry needs for castor oil have been met entirely by imported castor oil. Efforts to develop lesquerella, a wild plant whose seed contain oil that is similar to castor oil, as an alternate oilseed crop for Virginia from 1991-1993 were unsuccessful due to unsatisfactory seed germination/stand establishment and biomass production. Since 1994, The New Crops Program of Virginia State University has been conducting breeding and agronomic research with castor. A world collection of 286 castor accessions has been evaluated and potential genotypes with seed yield above 2000 kg/ha have been identified. A preliminary experiment indicated that castor when planted late to facilitate its rotation with winter wheat can produce seed yield of 1000-1200 kg/ha. The oil content in castor produced in Virginia has varied from about 20 to 50 percent depending upon season and genotype as compared to a mean oil content of about 45% from castor seed produced in Texas/Oklahoma. The oil content in Hale seed produced in Oklahoma and Virginia during 1995 was similar (43 vs. 46 percent, respectively). The fertilizer needs and row-spacing for castor production in Virginia have been identified. Based on the yield level and oil content, commercial castor production in Virginia is possible.

CHARACTER MARKED FURNITURE: POTENTIAL FOR LUMBER YIELD INCREASE. Urs Buehlmann, Dept. of Wood Science and Forest Products, Va. Polytechnique Inst. & State Univ. Backsburg, VA 24061, J. K. Wiedenbeck*, and D. E. Kline*. Currently, character-marks (commonly referred to as "wood defects") are typically not accepted in furniture dimension parts. However, their inclusion in parts is an effective way to increase lumber rough mill yield, and is an option to overcome the declining quality of today's lumber supply. The purpose of this study was to establish the theoretical achievable yield increase due to the inclusion of character-marks in dimension parts. This research used rough mill simulation software, lumber contained in the 1992 Data Bank for Red Oak Lumber, and seven cutting bills from the furniture industry to simulate the cut-up of lumber in a real rough mill. Results show that for No. 2A Common lumber, the inclusion of character-marks in dimension parts on both faces of up to two inches in diameter increases yield by 12.4 percent, on average. For 1 Common lumber the average yield increase observed is 5.6 percent. Yield increases were about half when character-marks were only allowed on one face or when the allowable character-mark size was reduced to 1 inch in diameter. The study also revealed how other factors such as part quality, lumber grade, cutting bill, and processing options interact with character-mark size to influence yield.

THE HEALTH CONDITION OF CAGE REARED RAINBOW TROUT IN VIRGINIA. D. Crosby, Cooperative Extension, VA State Univ., Petersburg, VA 23806. Rainbow trout reared at 250 fish per cage were evaluated for basic fish health problems from November 95 to May 96. Parasitic and bacteria examinations were performed every six weeks for each of the three sample cages. Serum blood chemistry was performed to establish the baseline parameters for total protein, glucose, and calcium. No significant differences for blood chemistry were found between the sample cages. The mean baseline parameters for total protein, glucose, and calcium were 2.9 g/dl, 180.8 mg/dl, and 11.2 mg/dl, respectively. Protozoan parasites, Trichophrya and Trichodina and monogenes were found in low numbers. The prevalence of monogenes increased to a 90% infestation rate but rapidly fell to less than 20% at the end of the study. No bacteria was recovered from the trout during the study. Overall, no significant health problems were found with raising rainbow trout in cages during the winter months in Virginia.

DERIVATION OF MONOPLOID POTATO FAMILIES THROUGH PSEUDOGAMY AND ANDROGENESIS. Rebecca J. Cutright & Richard E. Veilleux*, Dept. of Horticulture, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Monoploid potato can be derived either paternally through anther or microspore culture or maternally through the use of a haploid-inducing pollinator. Our objectives were to derive monoploid populations from each of three selections utilizing each method in order to compare segregation of molecular markers in populations derived by the two alternative mechanisms. A haploid-inducing pollinator was crossed to two selections of *Solanum phureja* (PP5 and BARD 1-3) and one selection from a *S. chacoense X S. phureja* cross (CP2). A total of 185 fruit was obtained from PP5, 35 from CP2, and 398 from BARD 1-3. Percent fruit set was 85% on PP5, 10.8% on CP2, and 64.5% on BARD 1-3. Fruit derived from PP5 contained a mean of 205 seeds of which 0.6% lacked the dominant embryo spot marker carried by IVP101. BARD 1-3 produced a mean of 86.9 spotless seeds per fruit of which 3.5% were spotless. About 48% of the spotless seeds from PP5 and 19.6% from BARD1-3 germinated. Percent spotless seeds generating monoploids from PP5 and BARD 1-3 were 14.4 and 0.93, respectively. In anther culture, BARD 1-3 yielded 1.67 embryos whereas CP2 and PP5 yielded 0.16 embryos per anther. Approximately 25% of CP2, 13.7% of PP5, and 3.7% of BARD 1-3 embryos regenerated. Of the regenerants from PP5 and BARD 1-3, 51% and 44% were monoploid, respectively. (Supported by the Biological Sciences Initiative & Fralin Biotechnology Ctr. of Va. Polytechnic Inst. & State Univ.)

MULTIPLE ANTHELMINTIC RESISTANCE IN GOATS RAISED FOR MEAT PRODUCTION IN VIRGINIA. PART II. T.A. Gipson, Agric. Res. Station, Va. State Univ., Petersburg, VA 23806 and A.M. Zajac*, Va. Polytechnic Inst. & State Univ., Blacksburg VA 24061. Anthelmintic resistance has been documented in the research goat herd at Virginia State University. The objectives of this study were to determine the level of anthelmintic resistance in the research herd after discontinued use of the anthelmintic and to investigate more efficacious methods for anthelmintic administration. Previously, a fecal egg count reduction test (FECRT) was conducted using ivermectin and levamisole, anthelmintic resistance detected and use of these anthelmintics discontinued. A second FECRT was conducted after one year to assess the level of resistance to these anthelmintics. Minor modification for the ivermectin FECRT was an increased dosage of .4mg/kg bodyweight instead of .3 mg/kg used for the previous year's FECRT. Resistance to both anthelmintics was still evident; however, both anthelmintics showed improved performance. Ivermectin gave an 85% reduction in fecal egg counts and levamisole a 79% reduction. Resistance to fenbendazole had also been detected in the research herd and a modified mode of administration was investigated to determine if efficacy could be improved. The modification to the FECRT was as follows: animals were mustered in late afternoon and randomly divided into control and treatment groups, the treatment group was dewormed with fenbendazole at 10 mg/kg bodyweight, penned overnight with access to water but not feed, dewormed again early the next morning at 10 mg/kg and then turned out to pasture later in the morning Under this system, fenbendazole gave a 96% reduction in fecal egg counts; indicating no resistance. Resistance to ivermectin and levamisole continued even though ivermectin dosage had been increased; however, under the modified mode of administration efficacy for fenbendazole significantly improved.

GROWTH CURVE ANALYSIS FROM BIRTH TO YEARLING OF DIFFERENT BREED-TYPES OF GOATS RAISED FOR MEAT PRODUCTION. T.A. Gipson, Agric. Res. Station, Va. State Univ., Petersburg, VA 23806. Nonlinear functions have often been employed to model the growth curve in domestic livestock. The objective of this study was to evaluate the effect of breed of growing young male goats on the parameters of the Gompertz function. Body weights on seven Myotonic, seven Nubian, five Pygmy and seven Spanish were used to estimate individually the parameters of the Gompertz function. Weight records for each animals included birth, weaning (at 8 wk), 17 weekly peripubertal and seven biweekly weights preceding yearling age (a total of 26 weights). All animals were castrated shortly after puberty. Breed significantly ($p<.05$) affected all parameters of the Gompertz function. The asymptote or asymptotic mature weigh, A, was significantly heavier for Myotonic, Nubian and Spanish (42.5, 49.8 and 49.7 kg, respectively) than for Pygmy (20.2 kg). The constant of integration, b, was significantly greater for Myotonic, Nubian and Spanish (2.7, 2.4 and 2.4, respectively) than for Pygmy (3.5). The rate parameter, k, was significantly smaller for Myotonic, Nubian and Spanish (.0050, .0058 and .0053 d^{-1}, respectively) than for Pygmy (.0075 d^{-1}). Myotonic, Nubian and Spanish tended to have the same shape and scale of the growth curve; however Pygmy tended to have a smaller mature weight and to reach peak growth earlier than the other breeds.

EVALUATION OF RAPESEED GREENS FOR NUTRITIONAL QUALITY. Anwar A. Hamama and Harbans L. Bhardwaj. Agricultural Research Station, Virginia State University, Petersburg, Va 23806. Canola (*Brassica sp.*) is being evaluated as an alternate oilseed cash crop for Virginia farmers due to its superior oil quality and consumer demand. During 1995/96 season, it was observed that nutritional quality of pre-bloom foliage from canola plants also compared well with that from mustard and turnip. The pre-bloom foliage from four canola cultivars (Falcon, Dixie, Jetton, and HN120-91) was evaluated again for moisture, fresh yield, dry matter yield, oil content, and fatty acid profiles. Generally, the growing season did not affect yield and quality of canola foliage. However, foliage from 1996/97 had significantly higher saturated fatty acids (21.4 vs. 14.18 %)and 18:1 fatty acid (8.26 vs. 3.28 %) and significantly lower total mono-saturated fatty acids (12.05 vs. 23.24 %) as compared to that from 1995/96. The canola foliage had 3.3 % oil in comparison to 2% oil in mustard and 3% oil in turnip greens. During 1996/97, it has been observed that pre-bloom harvested canola plants can regrow and produce seed. These results indicate that canola foliage may have potential as food and feed and may also serve as a dual-purpose crop as a source of edible greens and oil.

EFFECTS OF 7 SILVICULTURAL TREATMENTS ON TERRESTRIAL SALAMANDERS IN A SOUTHERN APPALACHIAN HARDWOOD FOREST. Douglas N. Harpole and Carola A. Haas, Dept. of Fisheries and Wildlife Sciences, Virginia Tech, Blacksburg, VA, 20261-0321. Previous studies have shown that terrestrial salamander populations decline after clearcut timber harvesting. However, few studies have compared the effects of other forest regeneration methods. We compared the species richness and relative abundance of terrestrial salamanders before and after application of 7 oak regeneration treatments in a low-elevation southern Appalachian hardwood forest in southwest Virginia. Treatments included understory removal, group selection, 2 shelterwoods, leavetree, clearcut, and a control. Results from one harvested site show a slight decline in species richness after harvest. There was a significant decline in salamander relative abundance after harvest on the group selection ($p=0.01$), sheiterwoods ($p=0.01$, $p=0.001$), leavetree ($p=0.02$), and clearcut treatments ($p=0.001$). There was no significant difference in relative abundance during the same period on the control ($p=0.81$) or understory removal ($p=0.94$) treatments.

PURIFICATION AND CHARACTERIZATION OF SOYBEAN PHYTASE. Carla E. Hegeman and Elizabeth A. Grabau, Dept. of Plant Path., Phys., and Weed Sci., Va. Tech., Blacksburg, Va. 24061-0346. Much of the phosphorus in soybean [*Glycine max* (L.) Merr.] meal is stored as phytate (*myo*-inositol hexaphosphate). Non-ruminant animals are unable to efficiently utilize phosphorus in phytate. To meet nutritional requirements, soy-based diets are supplemented with phosphorus, increasing feed costs. In addition, excreted phytate is applied to croplands in manure, and can contribute to environmental phosphorus pollution. Phytase is an enzyme that breaks down phytate, liberating inorganic phosphate. Commercial fungal phytase has been added to feed to degrade phytate, eliminating the need for phosphorus supplementation. Phytase occurs naturally in soybean seeds, but high levels of activity are not detectable until seed germination. Our goal is to isolate and characterize soybean phytase. We have purified a major form of soybean phytase from cotyledons of 10-day old germinating seedlings by sequential ammonium sulfate precipitation, heat treatment, cation exchange, lectin affinity, and anion exchange chromatography. A partial amino acid sequence was obtained by automated Edman degradation. Our sequence showed little similarity to proteins in the Swiss & PIR & Translated protein database. Using amino acid sequence data from soybean phytase, we will generate probes for screening a cDNA library from germinating soybean cotyledons.

HEMIPTERAN THREAT TO SEED QUALITY OF SPECIALTY SOYBEANS. M. Kraemer, C. Sudderth*, and J. McConnell*, Agricultural Research Station, Virginia State University, Petersburg, Va. 23806. Soybean for human consumption requires a good appearance and taste. Although corn earworm (*Helicoverpa zea*) is the major threat to yield in the Eastern Coastal Plain region, hemipterans are probably the most significant threat to seed quality. Hemipterans feed on developing seeds by piercing the pod with stylet shaped mouthparts, resulting in seeds with shrunken areas, often discolored by decay organisms. A complex of stink bugs (brown, green and southern green) and an ant mimic (*Alydus pilosulus*) were responsible for most hemipteran damage in our plots near Petersburg. Seed and pod damage was quantified over two seasons for 28 vegetable soybean genotypes in maturity groups III through VII. Soybeans were planted in 2m rows using a randomized complete block design. At seed maturity, plants from the middle 1m of each row were hand harvested and shelled. Hemipteran damage was classified as light, moderate, or heavy for each of 300 randomly selected seeds per sample. Damage averaged 18%, including 3.7% and 3.5% with moderate and heavy damage, respectively. Significant differences (P=0.05) in mean damage were found between accessions, ranging from 6% in "Shangrao wan gingsi" to 61% in "Kanrich".

EFFECT OF INTENSIVE ROTATIONAL GRAZING BY BEEF CATTLE ON POTATO LEAFHOPPER POPULATIONS IN ALFALFA / FESCUE PASTURE. Curt Laub, Roger R. Youngman*, Thomas P. Kuhar, & Julie M. Smith*, Dept. of Entomology, VPI & SU, Blacksburg, VA 24061-0319. Results of potato leafhopper, *Empoasca fabae* (PLH) scouting of alfalfa from 1994 and 1995 suggested that intensive rotational grazing by cattle may help to reduce PLH population numbers, particularly early in the season. Based on these preliminary data, we initiated a study in 1996 to examine the effect of rotational cattle grazing on PLH population dynamics. Results showed that grazing reduced overall PLH populations compared to non-grazed areas. Reduced populations may be due 1) the destruction of eggs and nymphs, resulting in fewer adults emerging, and /or 2) movement of adults away from grazed areas.

ASSOCIATION BETWEEN YIELD, YIELD COMPONENTS, AND NUTRITIONAL VALUES OF SOYBEAN. Tadesse Mebrahtu and A. Elmi*. Virginia State Univ. Petersburg, Va. 23806. Soybean with Japanese pedigree harvested immature and shelled during processing to use as a vegetable or is served steaming hot in the pod as snack food is termed as vegetable soybean. The objectives of this experiment were to identify genotypes with high yield and nutritive values and to determine the association of yield and agronomic traits with selected nutritional values. Thirty-one vegetable soybeans were evaluated at Virginia State University Research farm in Petersburg, Virginia for agronomic values (green pod and biomass yield, plant height, hundred pod weight, and pod dimensions) and nutritive values (protein, lipid, and oleic, linoleic and linolenic fatty acids). Significant differences for all parameters measured were observed among the genotypes tested. These results suggest that genetic variation exist among the tested genotypes. Associations of pod yield with biomass yield, hundred pod weight, pod length and pod width were significant and positive but negatively correlated with plant height. No significant associations between pod yield and nutritive values were observed. Hundred pod weight or pod length could be used as selection criteria in identifying genotypes with high pod yield potential.

HYPERCHOLESTEROLEMIA CHANGES STEROL AND HYDROCARBONS CONCENTRATIONS IN BLOOD AND TISSUES. Ali Mohamed, Agri. Res. Station, Virginia State University, Petersburg, VA 23806. High intakes of cholesterol have been implicated in causation of hypercholesterolemia and atherosclerosis since early studies showed that feeding cholesterol to experimental animals induced marked elevation of serum cholesterol and cholesterol deposist in the arterial wall. Other factors affect plasma cholesterol level are diet, environment, number of diseases, and smoking. The present sudy was conducted to determine the effect of hypercholesterolemia on the concentration and pattern of sterols and hydrocarbons in serum and tissues. Hypercholesterolemia was induced in rats by daily oral administration of a mixture of cholesterol (600 mg), cholic acid (300 mg), and methyl thiouracil (90 mg)/Kg body wt. for a period of 13 weeks. A control group of untreated animals was maintained under the same environmental conditions. The treated rats were characterized by significant increase in serum cholesterol and triglycerides. Quantitative and qualitative changes in sterols (cholestenol and lanosterol) and hydrocarbons (farnesol and squalene) in serum and tissues samples from aorta, liver, and brain were documented. Significant ($p<0.05$) reduction in these intermediate compounds in all tested tissues and serum was observed. The results also indicated that rats had a greater resistance to high dietary cholesterol level in the first two weeks of the induction period, but there after resistance was significantly reduced. Aorta and liver showed greater changes in sterols and hydrocarbons in treated animals compared to the control group.

BIOCHEMICAL STUDIES ON GREEN IMMATURE SOYBEAN. Ali I. Mohamed, Agri. Res. Station, Virginia State University, Petersburg, VA 23806. Green soybeans are a popular vegetable and snack food in the Orient. Because of their excellent nutritional characteristics and the potential for export to Asian countries, green soybean are gaining popularity as a crop in the United States. The quality properties of vegetables are a function of development time. Color, texture, and size are usually reach a peak during plant and seed development and then start to deteriorate. Therefore, it is important to harvest at the appropriate time to maximize the value of the crop. The large seeded vegetable soybean (dry wt.> 25 g/100 seeds) is becoming popular as roasted soynuts in Asia and among the oriental population in the U.S. However, there is a need for developing cultivars adapted to the U.S. environments. The objective of this study was to determine the GXE effects on the nutritional quality of immature green soybean. A total of 12 large-seeded soybean genotypes were planted in four locations (AL, GA, MD, and VA). The immature pods were harvested, and seeds were collected and stored frozen. Total protein, oil, total soluble sugars, phytate, moisture contents, and fatty acid pattern were determined. The analysis of variance of the data indicated that the effects of genotypes was highly significant for oil, soluble sugars, and phytate. No significant difference in protein among genotypes was found. The mean protein, and oil percentages were 32.8 and 8.6, respectively. Mean sugar and phytate percentages were 11.7 and 1.11 mg/g meal, respectively. Highly significant and negative correlations (r=-0.31**, -0.4**, -0.4**, and -0.32**) were found between location, oil, sugars, and moisture content, respectively.

HYBRID STRIPED BASS MARKETING IN VIRGINIA - CASE STUDIES. Brian L. Nerrie, Cooperative Extension, Virginia State University, Petersburg, VA 23806. The production process of aquaculture, the farming of animals and plants in the aquatic environment, requires product distribution and marketing as a final step. This final step brings the desired return to the farmer, but is often the limiting factor in the production process. Even though hybrid striped bass aquaculture in Virginia is relatively new, successful distribution and marketing systems have been established. Other production inputs required for successful hybrid striped bass marketing are also in place. They include seed stock, farming equipment, feed supplies, fish health diagnostic labs, management ability, and capital. Marketing efforts vary depending on the size of enterprise. Limited scale operations (cage and/or pond culture) used direct marketing techniques to supply local upscale restaurants or fee fishing facilities. Restaurants paid more than $10.00/kg for whole, iced hybrids (>500 g). Large scale commercial operations used existing seafood distribution systems to supply traditional seafood markets. Farmers received more than $6.60/kg for whole, iced, boxed hybrids (>570 g).

WINTER FEEDING OF CATFISH IN VIRGINIA PONDS. Scott H. Newton, Cooperative Extension, Virginia State University, Petersburg, Va. 23806. Aquaculture production of channel catfish (*Ictalurus punctatus*) requires feeding year-round, especially in regions with shorter warmwater production seasons. Since the early 1980s, it has been shown by the author and others that winter feeding of fingerling and juvenile size catfish is beneficial, in the Southern region of the USA. However, this practice is relatively new to producers in the Mid-Atlantic region of the United States In the fall, 1996, three ponds of small catfish averaging 340 pounds per 1000 fish and three ponds of large catfish averaging 620 pounds per 1000 fish were placed on a winter feeding program. A lower protein ration (28%) was used during winter because it has been shown to be adequate and is less expensive. From November to May, fish were fed a total of 54 days on a schedule based upon water temperature. Small catfish had an average weight gain of 13.5% while the larger catfish gained an average of 7.4% during winter. Catfish that are fed usually gain weight and are less susceptible to spring disease problems than fish that have not been fed during winter.

OBSERVATIONS ON CAGE CULTURE OF BROOK TROUT IN VIRGINIA PONDS. Scott H. Newton, Cooperative Extension, Virginia State University, Petersburg, VA. 23806. Brook trout (*Salvelinus fontinalis*), the only native species of freshwater trout, are raised primarily for stream stocking and fee-fishing operations. Since 1990, annual production has ranged from 130,000 to 140,000 pounds. Winter cage culture potential of brook trout was investigated at the VSU Aquaculture Pond Complex during 1996 and 1997 winter seasons. Fish stocking and harvest sizes were similar for both seasons, however, survival in 1996 was 93% compared with 77% for 1997. The 1997 production period (132 days) was 42 days shorter than the 1996 season (174 days). After two seasons of cage brook trout culture, preliminary recommendations are presented for industry consideration: 1) brook trout appear to be a suitable species for winter season cage culture, 2) brook trout could be used to diversify a winter rainbow trout cage operation, 3) brook trout are more temperature sensitive, but feed much more actively at cooler temperatures (9 -11C) than rainbow trout, and 4) brook trout harvest and transportation for live sales should be done below 15C

CULTURE OF JUVENILE FRESHWATER MUSSELS IN A RECIRCULATING SYSTEM. Francis X. O'Beirn and Richard J. Neves, Dept. of Fisheries and Wildlife Sciences, Virginia Tech, Blacksburg, VA 24061. Aquaculture of endangered and threatened freshwater mussel species has been recommended as a conservation tool. A recirculating system was constructed with a total water capacity of 400L, within which 13cm diameter petri dishes were located. Each dish was stocked with 100 juvenile rainbow mussels, *Villosa iris*. The water was exchanged in each system on a weekly basis and the animals were fed *Neochloris oleoabundans* daily. A trial was initiated; whereby, the animals were raised with and without sediment. Animals at the start of this trial had mean sizes of 2.73 and 2.72 mm for the sediment and no-sediment treatments, respectively. After 16 weeks, the animals with sediment were significantly larger (5.67mm vs. 4.50mm) and had greater survival (85% vs. 74%) than those cultured without sediment . It appears that the system and protocols employed in these studies have major applications in the large scale culture of freshwater unionids. Also, the growth and survival obtained for the rainbow mussel suggests that the succesful transfer of these methodologies to endangered species of mussels can be achieved.

PRELIMINARY IN VITRO FEED STUDIES WITH ANGUILLA ROSTRATA ELVERS. Albert O. Reid and Brian L. Nerrie, Cooperative Extension, Virginia State University, Petersburg, VA 23806. Interest in eel farming in Virginia is expanding. Determining the proper nutritional requirements of juvenile American eels will be crucial to the establishment of Virginia's eel farming industry. This study evaluates the effects of diets containing two protein:lipid ratios on growth rates of juvenile American eels. Glass eels air shipped from Maine were raised to 0.5 g. Eels were randomly selected and stocked in six 30-liter aquaria (N=8 per aquarium). Diet 1 consisted of a 45% protein eel supplement + 20% menhaden oil. Diet 2 consisted of a 45% protein eel supplement + 10% menhaden oil. Diets were bound into a water stable paste using gelatin. Eels were fed daily at a rate equal to 10% of initial biomass. Water quality (dissolved oxygen, temperature, ammonia and nitrite) was monitored daily and maintained by water exchange (10% daily). Preliminary results indicate eels fed diet 1 (feed conversion = 7.3:1) grew faster (Δ0.34g) than eels fed diet 2 (feed conversion = 23.1:1, Δ0.18g) .

MODELING THINNING EFFECTS ON RING SPECIFIC GRAVITY OF LOBLOLLY PINE (*Pinus taeda* L.) Gudave Tasissa, & Harold E. Burkhart, Dept. of For., Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061-0324. Stem analysis data obtained from trees in permanent sample plots of a thinning study were used to evaluate the effects of thinning on ring specific gravity of loblolly pine and to develop a ring specific gravity prediction model. The thinning study is distributed throughout the native range of loblolly pine spanning four broad physiographic regions: Atlantic-Coastal Plain, Gulf-Coastal Plain, Piedmont and Highlands, and consisted of two treatments and a control. Thinning effects on ring specific gravity were not significant because thinning did not significantly change the proportion of latewood in a growth ring. Regional variation in specific gravity was significant with the Gulf-Coastal Plain having the highest specific gravity followed by the Atlantic-Coastal Plain. No significant difference was found between ring specific gravity of the Piedmont and Highlands. Ring specific gravity is predicted as a function of ring position in tree, a tree's competitive position, percent latewood in a ring and ring width. As the data included several within-tree observations which tended to be correlated, direct covariance modeling with a continuous time autoregressive structure was used to addresses biases in the standard error of estimates and hypothesis tests. (Supported by the Loblolly Pine Growth and Yield Research Cooperative maintained at Va. Polytechnic Inst. & state Univ.)

PUBESCENT CHANGES IN FOLLICULAR POPULATIONS IN THE OVARY OF THE SPANISH GOAT. S. Wildeus[1] and J. Jones*, [1]Agricultural Res. Station, Va. State Univ., Petersburg, VA 23806. The pattern of sexual development impacts reproductive management strategies, and seasonal effects on reproductive function appear to be more pronounced in pubertal than mature female goats. Spanish goats are considered seasonal breeders and this experiment evaluated seasonal effects on ovarian development in postpubertal Spanish does. Thirty-five spring-born doelings were maintained as one group following weaning and fed to grow at a moderate rate. Starting at 6 mo of age (August) ovaries were collected at monthly intervals from five randomly selected animals. Weight and dimensions of each ovary were recorded and surface structures counted as corpora lutea, and large (>5 mm), medium (2-5 mm), and small (<2 mm) follicles. Data were analyzed on a whole animal basis and differences between age groups were determined. Body weight increased ($P<0.001$) from 15.9 kg at 6 mo to 23.6 kg at 11 mo of age. In contrast, total ovarian weight increased ($P<0.01$) from 0.98 g at 6 mo (August) to 2.35 at 8 mo (October), than decreased again to 1.81 g at 11 mo (January). Ovarian dimensions were not significantly different between age groups (mean length: 15.5 mm, mean width: 10.5 mm, and mean depth: 8.2 mm). The number of corpora lutea was higher ($P<.05$) at 8 mo (October: 2.0) than 6 mo (August: 0.8) and 7 mo (September: 0.4) and declined after the October peak. Large and medium follicles increased ($P<0.05$) from 6 mo (August: 1.2 and 2.0, respectively) to 7 mo (September: 3.0 and 5.8, respectively) and fluctuated thereafter. Small follicles were similar between age groups (overall mean: 25.1). These data indicate that ovarian growth and structures developed differently from overall body growth in postpubertal Spanish does. Data further suggest that these fluctuations in follicular development are related to the seasonal variation in reproductive activity that have been of observed in mature does of this breed.

EJACULATE CHARACTERISTICS OF BOER AND BOER CROSS GOATS RECEIVING FOUR LEVELS OF COTTONSEED IN THEIR DIETS. S. Wildeus[1] and J.-M. Luginbuhl[2]*, [1]Agricultural Res. Station, Va. State Univ., Petersburg, VA 23806 and [2]Dept. of Crop Science, N.C. State Univ., Raleigh, NC 27695. Gossypol can impair male reproductive function in a number of species. This experiment evaluated the effect moderate dietary inclusion of whole cottonseed (WCS), a ready source of free gossypol, on semen quality in young male goats (*Capra hircus*). Thirty-six Boer and ½ Boer postweaning buck kids were allocated to receive four levels of WCS in their diets (0, 8, 16, and 24%). The treatments provided an estimated mean daily intake of 0 to 75 mg/kg body weight/day free gossypol, based on a 0.68% gossypol content of WCS. After a 105 d feeding period, scrotal circumference was recorded and semen was collected by electroejculation. Semen samples were scored for volume and initial motility. Sperm concentration, morphology and mortality was determined in PBS-glutaraldehyde-fixed subsamples and eosin-nigrosin stained smears. Differences between WCS levels on scrotal circumference and ejaculate characteristics were determined by analysis of variance after arcsine conversion of percentages. Scrotal circumference was similar in the four treatment groups (23.7 cm), but the scrotal circumference to body weight ratio was higher in bucks receiving the highest level of WCS compared to the control group (0.40 vs. 0.33; $P<0.05$). Ejaculate characteristics did not differ ($P>0.1$) between dietary treatments, with a mean volume of 1.81 ml, a mean sperm concentration of 0.42×10^9/ml, a motility of 68.2%, and 58.3% live sperm. Sperm morphology was also not affected by dietary treatments and mean percentages of spermatozoa with abnormal heads, tails and cytoplasmic droplets of 2.9, 7.9 and 5.6%, respectively. The data indicate that WCS, when fed at levels of up to 24% of total diet, apparently had no effect on ejaculate characteristics in these young male goats.

REPRODUCTIVE PERFORMANCE OF THE KINDER GOAT UNDER COMMERCIAL PRODUCTION CONDITIONS. S. Wildeus[1] and P. Showalter[2]*, [1]Agricultural Res. Station, Va. State Univ., Petersburg, VA 23806 and [2]Zederkamm Farm, Snohomish, WA 98296. The Kinder goat is a more recently established dual purpose (meat & milk) breed that is derived from crosses of the Nubian and Pygmy breeds. There are more than 1000 animals registered in the U.S. and Canada. This is a first study that summarizes reproductive performance data collected for this breed between 1989 and 1997 in a commercial herd (119 doe and 298 kid records). Animals were intensively managed on pasture, supplemented with hay (orchard grass and alfalfa) and concentrate (16% crude protein pre-mix, sunflower and flax seed, mineral) throughout the year dependent on stage of production and sex of animal. Animals were dewormed and vaccinated on a routine basis. Records were collected on dam and sire identification, breeding and kidding dates, litter size and birth weights, and selected body weights. Data were analyzed for effects of dam, sire, doe age, litter size (birth type), sex of animal, and month of year on production characteristics. Average litter size at birth was 2.51, and affected by doe age ($P<0.001$; range 1.93 at 1 yr to 3.46 at 4 yr) and months of breeding ($P<0.05$; range 0.87 in July to 2.75 in August through September). Litter size was also affected ($P<0.05$) by a dam x sire interaction. Average litter birth weight was 6.04 kg, and also affected by doe age ($P<0.001$; range 4.34 kg at 1 yr to 8.45 kg at 5 yr), but not dam and sire effects. Litter birth weight increased ($P<0.001$) from 2.65 kg in single litters to 11.20 kg sixtuplets. Average gestation length was 147.8 d and not affected by doe age, litter size or dam. Birth weight was similar for male and female kid (2.34 vs. 2.19 kg, respectively), but higher in single, twins and triplets (2. 52 - 2.74 kg) than in quads, quints and sixtuplets (1.81 to 2.11 kg). These data indicate a high reproductive potential of this breed under optimum production conditions.

Archaeology

BURIAL CAVES IN SOUTHWEST VIRGINIA: PREHISTORIC DISTRIBUTION, LOOTER DESTRUCTION, AND CURRENT POLITICS. Michael B. Barber, George Washington & Jefferson National Forests, 5162 Valleypointe Parkway, Roanoke, Va. 24019. The Marginella Bead Cave Project was organized to locate and record burial caves within a southwest Virginia context. Of the 42 known burial caves within the Commonwealth, 24 were visited and 18 first recorded during the project. The distribution of the resources was examined with a high correlation found between burial cave location and Mississippian influences. Looter activity was documented with all but one of the known burial caves in Virginia severely damaged by felonious "excavations." Three caves were described in some detail in order to provide examples of the resources base, extent of looter impacts, and current management trends. Finally, the role of state agencies in cave protection was considered.

A JASPER QUARRY WORKSHOP AND FOOD PROCESSING STATION IN ROCKBRIDGE COUNTY, VIRGINIA. Eugene B. Barfield, Archaeology, George Washington and Jefferson National Forests, Roanoke, VA, 24019 & Kimberly N. Lowe, Science Museum of Western Virginia, Center in the Square, Roanoke, VA, 24011. Jasper has been a lithic source prized sporadically, through time, by Native Americans. A high quality source with an interesting geological history and prehistoric usage was discovered in 1993 along the western slopes of the Blue Ridge Mountains in Rockbridge County, Virginia. This lithic lies along a fault in a small valley, spawned from a boulder field of Antietam/Erwin quartzite in a National Forest Wilderness area. The high quality quartzite source, only 10,000 feet from the jasper quarry, was also utilized by the Native Americans. A quartzite reduction station along with several hunting camps in the vicinity of the jasper quarry offer temporal comparisons of usage of these two dissimilar lithics. Excavated areas of the jasper reduction station/base camp have artifacts continuously deposited to depths of three feet. For at least 10,000 years Native Americans have harvested this rich environmental envelope along the Blue Ridge. The geology and usage of this jasper breccia will be discussed.

FUELING THE FURNACES: COLLIERS AND THEIR WORKING HOMES. James M. Hepner, George Washington and Jefferson National Forests, Roanoke, Va. 24019. Colliers preformed a skilled job integral to the iron industry period in Virginia but, often at great risk and distances from the furnaces or their preferred domicil. During the time they spent away on their jobs, many lived in small round wood with mud chinking huts(Colliers Huts). Six of these huts have now been recorded. Much of the previous work has centered on the colliers pits and it is now time to go back into the anthropology and see how it ties into the archaeology. The construction and use of these huts is discussed as well as the relationship of the collier to the furnaces and local communities, and the environmental impact from their extensive and intensive usage of what is now a large portion Federal Forest Service lands in Virginia.

DAN RIVER CULTURE AND ITS EXPANSION WEST OF THE BLUE RIDGE.Howard A. MacCord. The Dan River Culture evolved and flourished in the Roanoke River drainage from Early Woodland to Historic times. Around AD 1400 it expanded west of the Blue Ridge into the valleys of the James and New Rivers, and into the headwaters of the Roanoke River. The Culture is distinguished by various traits, including sand-tempered ceramics, circular habitations enclosed in a circular, palisaded village. Burials are in individual graves in a flexed position, usually with head to the east. Many shell ornaments demonstrate extensive trade with coastal groups. The subsistence base was agricultural, supplemented by hunting, fishing, and gathering. Historic records identify tribes east of the Blue Ridge, but those to the west remain unidentified so far. A major site of the Culture was on New River in Wythe County - the Martin Site. Testing there in the early 1970s proved the validity of the Dan River expansion. Other sites of the Culture are known, and some mixing with earlier occupants of the region is shown. Reasons for the expansion are unknown, as is the ultimate fate of the Indian groups involved. No Indians were reported in the western areas when first EuroAmerican explorers visited the region in the late 17th Century.

CHALCEDONY: A COMPARATIVE STUDY OF LITHIC ASSOCIATION AMONG WOODLAND SITES BETWEEN THE BLUE RIDGE AND THE UPPER JAMES RIVER. Mark A. Martin and Joel C. Hardison, George Washington & Jefferson National Forests, 5162 Valleypointe Parkway, Roanoke, Va. 24019. In the fall of 1996, emergency salvage excavations were conducted through the Threatened Sites Program of the Va. Department of Historic Resources and the Roanoke Chapter of the ASV at 44Bo2, a Late Woodland village site in Botetourt County. The site, also known as the Mt. Joy site, is located within the floodplain of the James River approximately 1 mile south of the town of Buchanan, adjacent to the confluence of the James River and Looney Creek. Excavations revealed an unpalisaded village with central plaza and several features including trash pits, hearths and post molds. The largest number of diagnostic artifacts recovered from the site includes Hamilton and Madison projectile points and Dan River Series ceramics. Tentative dates for the main occupation of the site range from the early to mid 15th century. Preliminary lithic analysis of the artifacts reveals substantial reliance on the lithic resource chalcedony. During the analysis, similarities were noticed between the chalcedony found at 44Bo2 and the cores and debris found at 44Bo401, a chalcedony quarry located 3/4 mile northeast of the village. A comparative analysis was conducted on artifacts recovered from both sites.

VIEWS ACROSS THE VALLEY: SETTLING THE BLUE RIDGE AND ALLEGHENIES OR "HOLLERS" IN THE MOUNTAINS: A COMPLEX OVERSITE.Robert P. Meyer Jr., George Washington & Jefferson National Forests, 5162 Valleypointe Parkway, Roanoke, Va. 24019. The mountainous regions of western Virginia, (to include the Blue Ridge, Ridge and Valley and the Appalachian Plateau) have long been a mystery and a challenge to those individuals bent on navigating through them, settling within or around them, or simply attempting to understand their role from a cultural point of view. This paper will concentrate on the two separate provinces of the Blue Ridge and Ridge and Valley, but will allude occasionally to the Appalachian Plateau and even acknowledge the existence of the Piedmont and Tidewater provinces albeit grudgingly. The crux of this presentation is rooted in the upper hollows of the western mountainous regions and attempts to explain the magnitude of effort expended and the changes imparted on the landscape by the occupants and forbearers of said hollows and the effect of industrial progress on their continued habitation.

A REVIEW OF LITHIC RESOURCES UTILIZED BY NATIVE AMERICAN KNAPPERS IN WESTERN VIRGINIA.George A. Tolley, George Washington & Jefferson National Forests, 5162 Valleypointe Parkway, Roanoke, Va. 24019. Lithic resources have been the most abundant and most resistant remnant left within the landscape by prehistoric populations. Lithics used by western Virginia Native Americans in their tool kit include a variety of sources. These lithic sources can be broken down into three broad categories: clastic sedimentary or meta-sedimentary materials, igneous or meta-igneous rocks, and non-clastic or cryptocrystallines. The most common types within each category include: quartzite, ferruginous quartzite, and silicified siltstone under the clastic materials; greenstone and rhyolite under the meta-igneous rocks; and chert, jasper, and chalcedony under the non-clastic category. This paper addresses the formation of these lithic resources and discusses their occurrence within the western portion of the state. These resources are addressed from their primary source since erosive forces have transported many of these materials a considerable distance from their source. The concept of using lithic materials to help discover the territory included within Native Americans' seasonal rounds is also briefly explored in this paper.

Astronomy, Mathematics and Physics

ON THE ANALYSIS OF A POPULATION MODEL WITH NONLINEAR HARVESTING, Brian Bradie, Dept. of Mathematics, Christopher Newport Univ., Newport News, VA 23606-2998. The dynamics of the logistic equation with nonlinear harvesting,

$$\frac{dN}{dT} = RN\left(1 - \frac{N}{K}\right) - H(N),$$

are investigated. The harvesting term, $H(N)$, is assumed to satisfy the following conditions:

$$H(0) = 0,$$
$$H'(N) > 0, H''(N) < 0 \quad \forall N,$$
$$\lim_{N \to \infty} H(N) = H.$$

It is shown that, under these conditions, this model exhibits a transcritical bifurcation of the trivial solution and either one or two saddle-node bifurcations. Formulas for the transcritical and saddle-node bifurcation curves are determined, as are the conditions under which the second saddle-node bifurcation will occur. These results are demonstrated for several specific functions, $H(N)$.

OPTIMAL MANIFOLD DESIGN. Winston K. Harris, Dept. Of Phys., James Madison Univ., Harrisonburg, Va. 22801.A current problem in automotive design is the design of the intake manifold. The manufacturer wishes to incorporate a strong power plant with the given automobile while maintaining low exhaust emissions. Many features of intake manifold design have been explored experimentally, and evidence suggests that having a longer intake port improves power output while reducing emissions. However, manufacturers are frequently limited by the amount of tubing that can be used in the given manifold due to a spatial constraint, and bending the tubing can cause excess turbulence in the manifold. So the problem is once the desired length is determined, the angles which the tubing must be bent, must be optimized in order to minimize turbulence in the air column based on the volume constraint in the engine compartment. Using mathematical manipulation software, it is possible to find the bending angles for the tubing which maximizes air flow by minimizing turbulence. Ultimately the design will increase power and reduce emissions.

BOUNDARY ELEMENT METHOD FOR THE CALCULATION OF ELECTROMAGNETIC BAND STRUCTURE. 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. In a solid-state material whose dielectric constant is fabricated to be spatially periodic in one-, two-, or three dimensions, the electromagnetic modes (photons) exhibit bands and gaps in a fashion analogous to that exhibited by wavelike electrons in crystals. We have developed a boundary element method (BEM) for calculating the photon modes of periodic structures whose unit cells consist of piecewise homogeneous dielectric materials of arbitrary shapes. In this case, the BEM involves transforming the full set of Maxwell's equations with boundary conditions in d independent variables into an integral equation in $d-1$ variables. These integrals are then discretized so that the equations can be solved numerically using standard techniques of linear algebra. This method generally provides improved calculational efficiency as compared to alternative approaches, and it is more effective in treating high-frequency modes. Illustrative examples are given here for several two-dimensional systems. (Supported in part by the U. S. Office of Naval Research.)

INCORPORATING A LASER INTO AN EXPERIMENTAL SYSTEM FOR THE CLAS DETECTORS AT JEFFERSON LAB. Daniel P. Lasher, Dept. of Physics, James Madison University, Harrisonburg, Virginia, 22801. I will discuss some of the concerns when determining the type of laser we wanted to use for the calibration of the Photomultiplier Tubes at Jefferson Lab. These include pressure, flow rate, non toxic, nonflammable, easy to work with gas, remote controlled valve and feedback from a pressure switch.

NEAR-FIELD SCANNING OPTICAL MICROSCOPY STUDIES OF Cu(In,Ga)Se_2 SOLAR CELLS. A. A. McDaniel and J. W. P. Hsu*, Dept. of Physics, Univ. of VA, Charlottesville, VA 22903, and A. M. Gabor*, Energy Photovoltaics, Princeton, NJ 08543. Thin film devices are among the most promising candidates for affordable solar cells. In order to understand what is necessary to reliably produce good cells, devices must first be fully characterized. Using near-field scanning optical microscopy (NSOM), we study the spatial variations in photoresponse of two Cu(In,Ga)Se_2 (CIGS) solar cells. The cells are imaged on both the surface and the cross-section. Surface images show how the microstructure of the sample affects photoresponse. Cross-section images reveal the depth and nonuniformities of the p-n junction.

COMPUTER CONTROLS OF THE CALIBRATION OF A LARGE CALORIMETER AT CEBAF. Walter P. Opaska, (Dr. Kevin L Giovanetti), Department of Physics.James Madison University, Harrisonburg,VA. At the Continuous Electron Beam Accelerator Facility (CEBAF) in Newport News, Virginia, a large calorimeter is being built. The calorimeter will be part of a detector system that identifies particles that emerge from a target after an interaction with a high energy electron from an incident beam: These particles will emit photons (light) as they pass through the layers of lead and scintillation material of the calorimeter. This light is converted into electrical signals in the photomultiplier tube. This is then used to calculate, for example, the particle's energy. A calibration system for the calorimeter is being built at JMU. The control system consists of stepper motors that regulate the delivery of a laser pulse to the photomultiplier tubes of the calorimeter. This light pulse is used to calibrate the photomultiplier tubes. My presentation will center on the mechanism that is being used to control the calibration system. The computer management of the system is a suite of C++ commands. It will allow users to control the system with a Graphical user interface (GUI). The GUI is written in the script language Tcl/Tk. The calibration system will be integrated with the control system for the calorimeter to allow easy operation and maintenance of the complete system.

THE CLAS DETECTOR: READY TO GO. A PICTORIAL TOUR OF THE DETECTOR AND THE INSTALLATION. Christopher C. Overall. Dept. of Physics. James Madison University. We will take the audience on a pictorial tour of CEBAF. The tour will give a brief overview of the initial construction of Halls A, B and C and then will focus on the installation of the CLAS detector in Hall B. The ingenuity involved in the construction will be discussed and there will be a brief description of the individual components of the detector.

CALCULATING EPHEMERIDES USING THE PARKER-SOCHACKI ALGORITHM. Joseph W. Rudmin, Dept. of Physics, James Madison Univ., Harrisonburg, VA 22807. The Parker-Sochacki Algorithm, a powerful new approach to solving initial value problems, has been used to solve the general n-body problem of particles orbiting under mutual gravitational attraction. The algorithm permits the rapid and precise calculation of the coefficients of the Taylor Series to large order. The algorithm has been implemented using a compiled Basic code on a PC-platform. It has been found to be both fast and accurate. Using extended-precision (20-digit) arithmetic, the algorithm conserves angular momentum and energy to one part in ten to the eleventh for 200-day projections of the solar system. 200-day projections have been computed for both 200 km and 15 km precision and tests of speed versus polynomial order and step-size have been conducted. The algorithm will be explained and results of the computation will be presented.

DEVELOPMENT OF A REMOTE COMPUTER CONTROL SYSTEM FOR THE CALIBRATION OF PHOTOMULTIPLIER TUBES IN CALORIMETERS AT THE THOMAS JEFFERSON NATIONAL ACCELERATOR. Justin H. Voshell, (Dr. Kevin Giovanetti), Department of Physics, James Madison University, Harrisonburg, VA. The Thomas Jefferson National Accelerator Facility (TJNAF) is the nation's newest accelerator, capable of delivering a continuous electron beam of 4 GeV. The accelerator's most unique detector is the Large Acceptance Spectrometer, which employs a variety of techniques to identity particles ejected from the target. One of these is the Hall B Forward Calorimeter, which uses layers of lead and scintillator in conjunction with banks of photomultiplier tubes to determine the energy of the particles. These tubes must be frequently calibrated to continually collect reliable data. A system was needed to perform this calibration. This calibration system contained a number of unique features. These included the coordination of twelve stepper motors, the implementation of Hall effect safety limit switches, the design of control circuitry, and the development of a computer interface to control this system from a remote location over the local network through a VME crate. My presentation will discuss the ways the system has been designed and constructed at James Madison University, and will highlight various techniques used to seamlessly integrate the system into the TJNAF control system.

Biology

BACTERIA ASSOCIATED WITH THE LARVAE OF THE ASIAN TIGER MOSQUITO, *AEDES ALBOPICTUS* (DIPTERA). Margaret L. Allen, Dept. of Biology, Old Dominion Univ., Norfolk, Va. 23529. The objective of this study was to examine bacterial associates of larvae of a natural population of *Aedes albopictus* in Chesapeake, Va. Oviposition traps were placed in six random locations for two experiments. In the first experiment, larvae reared in autoclaved leaf litter were significantly more successful than those reared in natural leaf litter. Larval success is defined here as adult emergence. In the second experiment (an unreplicated pilot study), larvae were reared in antibiotic-treated (equal portions of ampicillin and tetracycline) leaf litter. Mosquito larvae were less successful at doses over 0.2 g/l, but bacterial counts were not decreased in the container water. Antibiotic treatments significantly decreased the pH in container traps. SEM examination of *Aedes albopictus* larval guts revealed no bacteria. Abiotic changes mediated by bacteria in containers may impact the success of larval mosquitoes in completing metamorphosis.

POPULATION DYNAMICS OF *ORYZOMYS PALUSTRIS* AND *MICROTUS PENNSYLVANICUS* IN TWO VIRGINIA TIDAL MARSHES. Christopher P. Bloch and Robert K. Rose, Dept. of Biological Sciences, Old Dominion Univ., Norfolk, VA 23529-0266. A two-year mark/recapture study was conducted to compare the population dynamics of marsh rice rats (*Oryzomys palustris*) and meadow voles (*Microtus pennsylvanicus*) at two tidal marsh sites on the Eastern Shore of Virginia. Population densities were consistently lower at one site, possibly because it had less dense vegetative cover. No discernable pattern of population dynamics was observed there, possibly due to low sample sizes. At the second site, densities of both species rose through the spring until late autumn and declined over the winter in both years. There was significant correlation (Spearman's coefficient; $p<0.0021$) between rice rat density and meadow vole density at this site. Responses to extreme abiotic conditions such as harsh winters are believed to cause this pattern, though other possible explanations are still under investigation.

THE ROLE OF KEY INNOVATION IN THE ADAPTIVE RADIATION OF SPIDERS. Jason E. Bond and Brent D. Opell*, Dept. of Biology Virginia Tech., Blacksburg, VA 24061. We combine statistical and phylogenetic approaches to test the hypothesis that adaptive radiation and key innovation has contributed to the diversity of the order Araneae. The number of unbalanced araneid clades (those whose species numbers differ by 90% or more) exceeds the number predicted by a null Markovian model. The current phylogeny of spider families contains 74 bifurcating nodes, of which 31 are unbalanced. As this is significantly more than the 14.8 expected unbalanced nodes, some of the diversity within the Araneae can be attributed to some deterministic cause (e.g., adaptive radiation). One of the more highly unbalanced (97%) bifurcations divides the orb-weaving spiders into the Deinopoidea and the larger Araneoidea. A simple statistical model shows that the inequality in diversity between the Deinopoidea and the Araneoidea is significant, and that it is associated with the replacement of primitive cribellar capture thread by viscous adhesive thread and a change from horizontal to vertical orb-web orientation. These changes improve an orb-web's ability to intercept and retain prey and expand the adaptive zone that orb-weaving spiders can occupy and are considered to be "key innovations".

ANALYSIS OF FLAVONOID METABOLISM IN ARABIDOPSIS. Ian Burbulis, and Brenda Shirley. Department of Biology, Virginia Tech.Blacksburg, VA 24061. One of the hallmarks of the living cell is the ability to catalyze thousands of specific chemical reactions in a spatially- and temporally-regulated fashion. Although the *in-vitro* kinetic and catalytic properties of hundreds of enzymes have been characterized over the past several decades, our knowledge of how cells spatially organize all these catalysts in the bulk cytosol remains unclear. Two-hybrid analysis has identified interactions between the *Arabidopsis* chalcone synthase (CHS), chalcone isomerase (CHI), and dihydroflavonol reductase (DFR), the first, second, and fourth flavonoid biosynthetic enzymes, respectively. When CHS, CHI, or DFR are fused to the DNA-binding domain of GAL4, these proteins specifically interact with DFR, CHS, or CHI trans-activation fusions, respectively. Furthermore, affinity chromatography techniques have shown that immobilized CHI is capable of selectively purifying CHS, CHI, and DFR from *E. coli* cell lysates via specific protein-protein interactions. This work extends previous immunocytochemical and cell fractionation studies suggesting that the flavonoid biosynthetic pathway exists as an enzyme complex associated with the endoplasmic reticulum. This model explains how the cell directs the timing, abundance, ratio, and subcellular deposition of diverse flavonoid end-products by channeling intermediates through dedicated biochemical circuits.

SOIL MICROARTHROPOD COMMUNITY CHANGES IN RESPONSE TO CLEARCUT LOGGING OPERATIONS IN SOUTHWEST VIRGINIA. S. J. Cooney, J.R. Heckman, and J. Cairns, Jr., Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. In order to establish its goals, restoration ecology has focused on the development of indices to quantify the adequate recovery of an ecological system. Since predisturbance conditions are rarely known in sufficient detail, these goals are, by definition, somewhat arbitrary. However, by comparing a recovering system with one of similar structure to the site's predisturbance condition, one can readily draw systematic comparisons with certain structural and functional endpoints. One such structural measure, the soil microarthropod community, can be separated into two main categories: subsurface soil inhabitants, and surface leaf litter dwellers. By observing the general trends in soil microarthropod distribution and abundance, one can extrapolate these findings and make some assumptions about the nature of the disturbance, like its severity or potential to recur. This project investigated soil microarthropod communities as a structural measurement of relative disturbance. The comparison was made between a clearcut and burned forest plot, and relating it to an adjacent undisturbed tract. Results indicated significant differences ($p<0.01$) in community structure with taxa richness being greater on the undisturbed site. Neelidae was the dominant family in the uncut samples, while Onychiuridae rose from 45.5/ sample in the uncut to 120.75/sample to be the dominant on the cut site. Comparisons of the two most abundant orders in soil (Acarina [mites] and Collembola [springtails]) showed a change from 1.86:1 (springtail:mite) in the undisturbed site to 3.04:1 in the disturbed site. It is concluded that measurements of soil microarthropod communities, including taxa richness, average abundance per sample, and springtail:mite comparisons provide useful data for monitoring ecosystem recovery.

SEASONAL PATTERNS OF NITROGEN FIXATION IN THE SUBTERRANEAN TERMITE RETICULITERMES (ISOPTERA: RHINOTERMITIDAE) OVER THREE YEARS IN COASTAL VIRGINIA. A. D. Curtis and D. A. Waller, Dept. of Biological Sciences, Old Dominion Univ., Norfolk, VA, 23529. Termites host symbiotic nitrogen-fixing bacteria and participate in biogeochemical cycling of nitrogen in terrestrial ecosystems. We examined nitrogenase activity and colony dynamics of *Reticulitermes flavipes* (Kollar) and *Reticulitermes virginicus* (Banks) for three years from June, 1993, to April, 1996, in a forest ecosystem in Virginia. Termite nitrogenase activity was highest in fall and spring (≈ 3 μg N_2 fixed • termite fresh mass $(g)^{-1}$ • day^{-1}) and lowest in winter and summer (≈ 0.8 μg N_2 fixed • termite fresh mass $(g)^{-1}$ • day^{-1}). The nitrogenase activity of worker termites was significantly higher than all other castes, and workers comprised the largest proportion of all the castes throughout the study period ($\approx$ 90%). The localized input of fixed-nitrogen by termites may reach 15.3 mg N • log^{-1} • day^{-1} and 5.6 g N • log^{-1} • yr^{-1}.

CHARACTERIZATION OF THE EFFECTS OF CALCIUM AND CALMODULIN ON THE MICROTUBULE MOTOR PROTEIN KCBP. B. E. Deavours & R. A. Walker*, Dept. of Biol., Va. Tech, Blacksburg, Va. 24061 & A. S. N. Reddy* Dept. of Biol. Colorado State Univ. As one of the major components of the eukaryotic cytoskeleton, microtubules (MTs) play essential roles in organelle transport, organization of the cytosol and cell division. Many of the functions of MTs are performed by MT-dependent motor proteins that use the energy of ATP hydrolysis to "walk" along MT tracks and in doing so transport a wide variety of cargo within cells. Recently, a new member of the MT-motor family from *Arabidopsis thaliana* , KCBP (kinesin calmodulin-binding protein) was identified by virtue of its ability to bind to calmodulin, suggesting that the activity of this protein is regulated *in vivo* by calcium and calmodulin. We have expressed the motor domain of KCBP in *E. coli* and have examined its enzymatic and MT binding properties. Consistent with its putative identification as a motor protein, KCBP was found to bind MTs in an ATP-dependent manner and exhibited MT-stimulated rates of ATP hydrolysis. Ca^{2+}/calmodulin was found to inhibit the binding of KCBP to MTs under conditions which ordinarily induce a tight association. In addition, Ca^{2+}/calmodulin inhibited the MT-stimulated, but not basal rates of ATP hydrolysis of KCBP. These results suggest that Ca^{2+}/calmodulin may serve to regulate the activity of KCBP *in vivo* by regulating its activity and association with MTs. Characterization of the regulation of KCBP will not only further define the role which this motor protein plays in plant cells, but will help to elucidate the mechanism by which a cell can temporally and spatially control a multitude of proteins in a specific and organized fashion.

ATTRIBUTES OF SMALL MAMMAL COMMUNITIES IN INTENSIVELY MANAGED PINE PLANTATIONS. James D. Dolan and Robert K. Rose. Old Dominion University, Norfolk, VA 23529. Small mammal community attributes were obtained using Fitch (live) and pitfall trapping techniques on 0.25 ha grids encompassing five pine stand age classes. *Cryptotis* and *Sorex* (shrews) were captured only by pitfall trapping, while *Sigmodon* (a large rodent) was captured only with Fitch traps. Six other species were captured primarily by Fitch traps. Pitfall and Fitch trap techniques must be used in conjunction with one another to obtain the most accurate description of a small mammal community. Relative small mammal densities and biomass decrease with increasing stand age until year 8, after which they remain constant until the habitat is altered by management practices, such as thinning, which gives rise to increasing densities and biomasses. Species diversity remained relatively constant from early successional stages until year 24, after which diversity increased. Slash and burn site preparation provided a for higher level of species diversity, relative density, and biomass during early successional stages than the cut-and-rake technique.

ANNUAL REPRODUCTIVE CYCLE OF ORYZOMYS PALUSTRIS IN A VIRGINIA TIDAL MARSH. E. A. Dreelin and R. K. Rose, Dept. of Biol. Sciences, Old Dominion Univ., Norfolk, VA 23529-0266. The objectives of this study were to determine when the marsh rice rat (Oryzomys palustris) begins and ends reproduction during the year, if there are seasonal changes in litter size, and the weight at which sexual maturity is reached. Monthly samples were collected from May 1995 to May 1996 in Northampton Co., VA. Rice rats were trapped using Fitch live traps, euthanized in the field, and brought to the lab for necropsy to assess reproductive condition. Data collected in January and February 1982 were included in the analysis to compensate for small sample sizes. Potential breeders did not reproduce throughout the year (X^2= 86.9, $p<0.001$). Rice rats in breeding condition were found from March to November; none of the rice rats trapped in December, January, or February were in breeding condition. Pregnant females were found from April to October. The mean litter size was 4.63 ± 0.34; changes in litter size during the breeding season were not observed. Rice rats reached sexual maturity at 30-40g.

MITOCHONDRIAL DNA VARIATION AND POPULATION DIVERGENCE IN THE PUPFISHES OF DEATH VALLEY. David Duvernell, Dept. of Biology, Virginia Tech., Blacksburg, Va. 24061. The pupfishes of Death Valley (*Cyprinodon nevadensis* complex) are a classic example of rapid (post Pleistocene) allopatric differentiation; several populations exhibit striking morphological, physiological, and behavioral divergence. However, genetic changes accompanying or causing this differentiation have been poorly resolved and/or difficult to detect. In order to investigate the historical phylogeography of the system and infer genetically effective population sizes, mtDNA control region sequence variation was assessed within and among populations. In total, eleven haplotypes were identified among 278 individuals from sixteen populations; pairwise sequence divergences ranged from 0.23 to 2.14%. Genetic diversity within populations was generally low (1-3 haplotypes per population) suggesting relatively small effective population sizes. Most variation occurred among populations, resulting in extensive population structure and differentiation. Several populations, particularly in the Ash Meadows region, exhibited relatively divergent but inter-related haplotypes. The distribution of haplotypes has resulted, in part, from ancestral lineage sorting. However, the presence of highly divergent haplotypes in some populations may only be explained by secondary contact events. This pattern suggests that the isolation of contemporary populations has not been unidirectional, but rather, has been a dynamic process.

EFFECTS OF IL-15 ON THE CYTOTOXICITY OF LAK CELLS AGAINST ME-180 CERVICAL CARCINOMA CELLS. John Dye and Rosemary Barra, Dept of Biological Sciences, Mary Washington College, Fredericksburg, Va 22401. IL-15 is a novel new cytokine thought to have the ability to induce a change in a class of lymphocytes known as NK cells. This change is the differentiation of the NK cells into LAK cells which are known to be cytotoxic to abnormal cells such as transformed cells. ME-180 cells were treated with two sets of lymphocytes, one set had been incubated with 25 ng/ml IL-15 for 24 hours, the other had not been retreated with the cytokine. Results based on the neutral red assay indicate that the ME-180 cells incubated with IL-15 treated lymphocytes had a higher level of cytotoxicity than did Me-180 cells incubated with untreated lymphocytes.

TICKS OF THE DISMAL SWAMP OF VIRGINIA. Ralph P. Eckerlin, Natural Sciences Div., Northern Virginia Comnty. Col., Annandale, VA 22003. Eight collections of ticks were made from the clothing and bodies of humans in the Dismal Swamp of Virginia during the last week of April or the first week of May from 1984 to 1997. Some limited flagging to detect questing ticks along a trail, and trapping of small mammals to secure ticks were also done. A total of 190 ticks, all nymphs and adults was obtained from humans. Amblyomma americanum was the most common and made up 86% of the total. Dermacentor variabilis (9%) and Ixodes scapularis (5%) were less abundant. All 3 species are important vectors of tick borne disease to humans. Flagging with a meter square cloth over a 100m grassy trail in 2 consecutive years (1996-97) yielded 62 questing ticks, all nymphs and adults, in proportions not significantly different from that found on humans. The 34 ticks removed from 6 Peromyscus leucopus and 1 Mus musculus were all larvae and nymphs of the same 3 species plus a single Amblyomma maculatum, a tick considered rare in VA. Flagging indicated 190-430 questing ticks per km of trail with considerable variation from year to year. The species composition of the tick community did not change over the 13 year observation period.

VITELLOGENIN INDUCTION AND QUANTIFICATION IN XENOPUS LAEVIS EXPOSED TO METHOXYCHLOR. Belinda O. Escanio, Dept. of Biology, Randolph-Macon Woman's College, Lynchburg,Va. 24503. Environmental estrogens, such as pesticides, have detrimental effects on the reproductive success of wildlife since they disrupt reproductive and developmental processes. Because of rampant concern that estrogenic chemicals may be adversely affecting the health of humans and wildlife, reliable methods for detecting estrogenic chemicals are needed. The enzyme-linked immunosorbant assay has recently been utilized to screen certain chemicals for estrogencity. ELISA allows for the quantification of vitellogenin, a lipoprotein, which is induced with exposure to estrogenic substances. In this experiment, male frogs were exposed to methoxychlor and 17B-estradiol. Vitellogenin was quantified using ELISA. Contrary to recent research which considers methoxychlor to have estrogenic activity, results indicated that there was no significant vitellogenin production at the sublethal levels of methoxychlor used.

HURRICANE IMPACT ON THE COTTON STAINER INSECTS (*DYSDERCUS ANDREAE*) OF ST. THOMAS, USVI. Harold J. Grau, Dept. of Biol., Chem., & Env. Sci., Christopher Newport University, Newport News, Va. 23606. Cotton stainers are pan-tropical hemipterous insects that feed primarily on Malvaceous plants. I have studied the *D. andreae* populations of St. Thomas since 1992, collecting data on body sizes and population densities and distributions. In September of 1995, and again in July of 1996, the island suffered direct hits by tropical hurricanes. As might be expected, the populations of *D. andreae* exhibited severe reductions in densities and distribution, being totally eliminated from several locations. However, one population seemed to experience considerable population growth following the second hurricane event. Average body sizes of post-hurricane populations were not smaller than those before the hurricanes; in fact, in most cases, the insects were significantly larger in 1996 (post hurricane) than in 1994. However, comparisons with records from 1992 and 1993 show fewer differences with those from 1996; for some unknown reason, insect body sizes were smaller in 1994. (check out the stainer web site! http://users.cnu.edu/~hgrau/)

RESTORATION OF DEGRADED LAND: A COMPARISON OF STRUCTURAL AND FUNCTIONAL MEASUREMENTS OF RECOVERY. J.R. Heckman and J. Cairns, Jr., Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The main goals of this study were to document the structural and functional recovery of differently restored areas, to understand better the relationship between the two, and to determine which types of measurements are best for assessing restoration success. To address these questions, an experimental system was created through topsoil removal and subsequent restoration in a blocked, completely randomized design using two levels of soil amendment (with or without 10 kg of leaf mulch per m^2) and three levels of seeding treatment (no seed, a standard reclamation mix, and an alternative, wildflower dominated reclamation mix). Vegetation structure in amended sites, as measured by total vegetation cover and species richness, recovered to levels similar to references within the two years of the study. Plant community composition did not develop similarity to references in any experimental treatments. Both soil amendment and seeding type affected cellulose decomposition rates, with amended plots showing higher decomposition rates than unamended, and seeded plots exhibiting higher rates than unseeded. Enzyme activities were largely determined by soil amendment, but the reference plots consistently had higher enzymatic activity. Amended sites exhibited significant increases over time in soil respiration, reaching or surpassing the rates observed in reference areas. Methane oxidation rates were generally increased in disturbed plots compared to undisturbed references due to increased atmospheric diffusion into the soil. Amended areas exhibited depressed rates relative to unamended, and seeding level had no significant effect on methane oxidation. Over all measurements, restoration of ecosystem function was most facilitated by the addition of the soil amendment. Seeding treatment significantly altered the resultant plant community, which may have substantial, long-term consequences for succession.

THE EFFECT OF ANT PROXIMITY ON EXPLORATORY BEHAVIOR OF THE SUBTERRANEAN TERMITE *RETICULITERMES* (ISOPTERA: RHINOTERMITIDAE) . L. Hembree & D. Waller, Biol. Dept., Old Dominion Univ., Norfolk, Va. 23527. Two ant species, *Crematogaster* sp. and *Lasius* sp., were tested as possible biological control agents for the subterranean termite *Reticulitermes*. Termites were placed in a central chamber with two attached side chambers to allow foraging. Ants were placed in a chamber that was connected by tubing plugged with plastic stoppers to one of the side chambers. Holes in the stoppers allowed the passage and detection of semiochemicals by the termites. Five replicates were done for each ant species and each replicate used termites from a different colony. After seven days, the number of termites in the chambers near and far from the ants was tallied, and a Student t-test was used to analyze the data. The results were not significant for either ant species. These ants may not be the most effective biological control agents for *Reticulitermes*, or perhaps *Reticulitermes* has not evolved a response to ants.

STRESS-INDUCED THERMOGENESIS IN WILD AND DOMESTIC HOUSE MICE (Mus musculus). Claire Holland,Dept. of Biol., Randolph-Macon Woman's Col., Lynchburg, Va., 24503. Brown adipose tissue (BAT) is used by small mammals to generate much of the heat necessary to maintain body temperature at low air temperatures. Cold-acclimation, diet, photoperiod, and some forms of stress have been shown to stimulate BAT production through the sympathetic nervous system. In my experiments, I have tested the hypothesis that there would be significant differences in the responses of wild and domestic strains of house mice (Mus musculus) to the stimuli of stress and cold. This was done through cold-acclimation at 5 C and the use of vibration as a stress stimulus in groups of wild and domestic house mice. The thermogenic capacity of the wild house mice increased in response to stress, while the domestic house mice were unaffected. The response of the wild house mice to cold was also significantly greater than that of the domestic hosue mice. The significant differences that exist in the thermogenic responses of domestic and wild type strains of Mus musculus may be due in part to body mass and acclimation temperature differences, but are also likely due to very real differences in physiologies. Positive responses to stress raise questions about how captivity stress might influence studies of wild rodents.

COMPARISON OF GROWTH RATES OF MICROPOGONIAS UNDULATUS RECRUITING TO OREGON AND OCRACOKE INLETS. Sumalee Hoskin, Dr. Cynthia Jones*. Old Dominion University, Applied Marine Research Laboratory, Norfolk VA, 23529, & William Hettler*, NMFS, Southeast Fisheries Science Center Beaufort, NC, 28516. Atlantic croaker are estuarine dependent fish that spawn off shore and the resulting larvae recruit inshore to juvenile nursery grounds. Separate spawning stocks of croaker, north and south of Cape Hatteras in the Mid-Atlantic, have been hypothesized. Stocks are commonly delineated using the life history parameter, growth rate. Thus, we wanted to determine if growth rates differed between larvae ingressing through inlets north and south of Cape Hatteras. Oregon Inlet to the north of Hatteras, and Ocracoke Inlet to the south were compared using variations in the size, abundance, entrance times, and growth rates of larvae recruiting from October 1994 to April 1995. Larval growth was modeled using a Laird-Gompertz growth model. Preliminary results show a difference in growth rate of larval croaker north and south of Cape Hatteras. These results support the hypothesis there may be two separate spawning locations and perhaps even separate spawning stocks of Atlantic croaker.

MATING BEHAVIOR AND MALE CHOICE BY THE LIZARD, *Anolis carolinensis*. T.A. Jenssen & S.C. Nunez*; Biology Dept., Virginia Tech, Blacksburg, VA 24061-0406. During 56 days in the field (Augusta, GA), 7 free-ranging males were each observed continuously for 8 full days. They had 2-6 resident females with whom a total of 397 encounters were recorded (approx. 7/day/♂). Half of the heterosexual contacts were broken off at long distance (>1 m), and 199 progressed to close contacts (from several body lengths apart to touching). One fourth of the close contacts (33/123) were female-initiated, and 62% (123) involved receptive females (i.e., passive and neck bending). Within close contacts, males appeared to be controlling mating because males: 1) used a differential display rate toward non-receptive and receptive females, suggesting they could distinguish relative female receptivity while still approaching; 2) bypassed 69% (85/123) of receptive females (i.e., copulatory opportunities); and 3) thus, copulated sparingly (approx. 1.4 times/day), and only when courtship was male-initiated. Larger males (who also had larger territories and more females) courted less per female, but with longer duration and longer coital durations than smaller males. Male coital frequency, however, had no correlates with measured variables; all females were mated with no significant bias to male or female attributes.

NCD TAIL DOMAIN BINDING TO MICROTUBULES. A. Karabay, R.A. Walker, Dept. of Biol., Virginia Polytech. Inst. and State Univ., Blacksburg, Va. 24061. Non-claret disjunctional (ncd) is a kinesin related microtubule motor protein that is required for proper chromosome distribution in meiosis and early mitosis in Drosophila oocytes and early embryos. Ncd has two microtubule (MT) binding sites: an ATP-independent-N-terminal tail, and an ATP-dependent-C-terminal motor domain binding sites, and it moves towards the minus end of MTs. Through the action of these binding sites ncd cross-links and bundles MTs. To understand the role of ncd motor protein in spindle assembly and formation in the process of chromosome segregation, the tail domain proteins were expressed as C-terminal fusions to thioredoxin (Trx), and ATP independent interactions of ncd with MTs were characterized. Based on sedimentation and blot overlay assays Trx alone, and Trx-NT1 (amino acids 27-63), Trx-NT7 (amino acids 100-187), and Trx-NT8 (amino acids 115-187) did not bind MTs, whereas Trx-NT2 (amino acids 27-119), Trx-NT3 (amino acids 27-149), Trx-NT4 (amino acids 27-187), Trx-NT5 (amino acids 62-187), and Trx-NT6 (amino acids 83-187) bound MTs. The ncd tail domain proteins that bound MTs also showed MT bundling activity. Based on these results, ncd amino acids 1-63 and 100-204 are not required for ATP-independent binding of ncd to MTs, while the sequence from amino acid 83 to 100 contains a MT binding site. (Supported by Virginia Polytech. Inst. and State Univ. and NIH Grant GM 52340.)

TESTING FOR NATURAL SELECTION ON CODON USAGE IN *DROSOPHILA SIMULANS*. Richard M. Kliman, Dept. of Biol., Radford Univ., Radford, Va. 24142. Synonymous codons (encoding the same amino acid) are used quite unequally in fruit flies, and this is thought to reflect, in part, a long history of natural selection on codon usage. To test specifically for recent selection on codon usage in *D. simulans*, synonymous codon polymorphisms were identified for each of nine genes by comparing DNA sequences of multiple gene copies. The ancestral character states at polymorphic sites were inferred from an outgroup (*D. melanogaster*) sequence; sites were then designated ancestrally "preferred" or "unpreferred" on the basis of previous studies on *Drosophila* codon usage. D_{pref} and D_{unpref} are the mean number of derived states at ancestrally preferred and unpreferred sites, respectively. *B*, the test statistic, equals D_{unpref} minus D_{pref}, and should be positive if selection is acting. For each gene, a computer simulation of coalescence and mutation (assuming a Wright-Fisher/"infinite sites" neutral model) generated 10^5 random data sets with the same number of gene copies and polymorphic sites; statistical significance was based on the proportion of simulated data sets that gave values of *B* equal to or greater than that calculated for the actual data. The test, assuming either independent assortment among or complete linkage of sites, was significant for three genes (*per*, *Adh* and *Est-6*) and nearly significant for a fourth (*Zw*). This supports the hypothesis that selection recently influenced codon usage in this species. (Supported by the Jeffress Memorial Trust and the Radford Univ. Col. of Arts and Sciences.)

SHELL COMPETITION AMONG *COENOBITA CLYPEATUS* INDIVIDUALS WITH EMPHASIS ON GROWTH RATE AND BEHAVIOR. Krisha Loftus, Elsa Q. Falls, & Arthur F. Conway, Dept. of Biol., Randolph-Macon Col., Ashland, VA 23005. Shell exchange behavior in the terrestrial hermit crab *Coenobita clypeatus* may consist of forceful eviction, peaceful evacuation, or mass exchange and has been hypothesized to benefit the exchanging individuals through increased growth. In this experiment, placing crabs in shells larger or smaller than their original shells had no significant effect on growth while crabs were housed individually or in groups of four. Housing crabs in pairs significantly increased forceful eviction and resulting mortality compared to crabs housed individually or in groups of four; however, group size had no significant effect on growth rate. These results do not support the hypothesis that small shell size will limit growth while large shell size will promote growth; they suggest that growth rate may be determined by factors intrinsic to the crabs when they are maintained under conditions of readily available food and water.

A BEHAVIORAL PROFILE OF FREE-RANGING JUVENILE MALE AND FEMALE GREEN ANOLES. Matthew B. Lovern, Dept. of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. During June-August of 1995 and July of 1996, 20 male and 17 female green anoles (Anolis carolinensis) were observed at a field site in Augusta, GA to produce a behavioral profile for unmanipulated, free-ranging individuals. All individuals were observed once for 30-60 min. Juveniles did not differ intersexually in perch height, perch diameter, body color, or home range size. However, as males developed, they perched higher, spent more time green, and occupied larger home ranges; the same trends did not hold for juveniles females. Additionally, males ate more often than females throughout ontogeny. Finally, with respect to social behavior, both sexes gave each of the species-specific headbobbing displays previously known for this species, but there were no intersexual differences in either display structure or rate. These data are compared with and interpreted in light of adult behavioral profiles measured in this same population, both to better understand selective pressures facing juveniles, and to provide a foundation for experimental work on the various (e.g., endocrinological, experiential) factors influencing the ontogenetic trajectory of behavior from neonate to adult.

INDUCTION OF APOPTOSIS AND p53 EXPRESSION IN ME-180 CELLS. Kristy Markos and Rosemary Barra, Dept. of Biological Sciences, Mary Washington College, Fredericksburg, VA 22401. The p53 tumor suppressor gene is an important regulatory gene for the process of cell division. Under normal conditions, p53 functions to halt the cell cycle in the G2 phase allowing for DNA damage to be repaired. In cases of extreme, irreparable damage, p53 induces programmed cell death known as apoptosis. ME-180 cells were treated with three chemotherapeutic agents, cis-platinum, doxorubicin and hydroxyurea to induce DNA damage. p53 expression was identified using electrophoresis and immunoblot procedures. Results indicate a low p53 expression in untreated ME-180 cells whose level of expression is increased by all three drugs. This increase in p53 expression is shown to lead to an increase in apoptosis due to irreparable DNA damage.

DO TERMITES USE CHEMICAL CUES TO FIND FOOD? N. Matkins & D. Waller, Biol. Dept., Old Dominion Univ., Norfolk, Va. 23527. Subterranean termites feed on surface and buried wood, but little is known about how termites locate food sources. We examined whether termites followed chemical cues in both laboratory and field experiments. In the lab, significantly greater numbers of *Reticulitermes* spp. (Isoptera: Rhinotermitidae) termites foraged in areas with 1% w/v solutions of sugar and sugar plus yeast. However, in the field termites did not respond to these solutions. Perhaps microbial activity affected the solution chemistry, or perhaps termites were more attracted to the natural food sources.

THE EFFECT OF SOIL DISTURBANCE ON EXPLORATORY BEHAVIOR IN THE SUBTERRANEAN TERMITE *RETICULITERMES* (ISOPERA: RHINOTERMITIDAE). J. Mathew & D. Waller, Biol. Dept., Old Dominion Univ., Norfolk, Va. 23527. Subterranean termites forage throughout the soil. We examined whether soil disturbance would deter termites from foraging. Four colonies of *Reticulitermes* spp. were each divided into two sets of 200 workers and four soldiers. Each set was placed in a chamber and allowed to forage into a connected chamber. After one week, termites in connecting chambers were removed and frozen (one set) or reintroduced (second set). The "disturbed" chamber was reattached to the original chamber and a third "undisturbed" chamber was attached to the opposite side. After one week, termites in all three chambers were counted. Manipulation (freezing vs. reintroduction) did not significantly affect termite numbers; therefore prior experience had no effect on exploratory behavior. However, significantly fewer termites entered the undisturbed chambers, indicating an effect of disturbance.

ONCOGENE EXPRESSION IN ME-180 AND C-4I CERVICAL CARCINOMA CELLS. Arash Momeni and Rosemary Barra, Dept. of Biological Sciences, Mary Washington College, Fredericksburg, VA. 22401. Oncogenes are an important class of genes that enhance cellular division and proliferation. When activated, they promote genetic replication during the S phase of the cell cycle. Recently, extensive research into the nature and causes of malignant tumors has targeted oncogenes. Furthermore, malignant tumor metastasis has been associated with oncogene expression. The degree of *ras* and *myc* oncogene expression in ME-180 metastatic and C4I non-metastatic cell lines was investigated. Results indicate greater oncogene expression in the metastatic ME-180 cell line than in the non-metastatic cell line.

BACTERIAL DEGRADATION OF HALOACETIC ACIDS IN DRINKING WATER, Carly Moritz, and Andrew Gordon, Dept. of Biological Sci., R.L. Williams, Dept. of Chem./Biochem., Old Dominion Univ., Norfolk, Va. 23529 and Sherry Williams, Newport News Waterworks, Newport News, Va. Haloacetic acids (HAAs) are disinfection by-products formed in the chlorination of drinking water. These compounds are of concern with regard to the safety and quality of the drinking water in all distribution systems and will be regulated in the near future. The levels of these HAAs has been presumed to be the highest at what are termed Maximum Residence Time Locations (MRTLs) due to the time in contact with the chlorinated water in the distribution system. Recent studies from the Newport News Waterworks and these ODU laboratories have found that there is an apparent bacterial degradation occurring at these MRTLs due to the presence of an active biofilm and that the levels of HAAs are unexpectedly low. Studies in these laboratories have shown that a bacteria is capable of utilizing a haloacid dehalogenase enzyme to effectively degrade the HAAs. Bench studies using two bacteria, which are able to carry out this degradation, will be described together with a suggested mechanism to explain this bacterial degradation.

RESPONSE OF THE SUBTERRANEAN TERMITE *RETICULITERMES* (ISOPTERA: RHINOTERMITIDAE) TO TWO CONCENTRATIONS OF THE DYE MARKER NILE BLUE. M. Norris & D. Waller, Biol. Dept., Old Dominion Univ., Norfolk, Va. 23527. Subterranean termite colonies are located deep in the soil and are difficult to study. Mark-release-recapture studies with ingestible dyes have been used to estimate termite numbers. These techniques assume that there is no mortality resulting from the dye. We examined the response of *R. flavipes* and *R. virginicus* to both short and long-term exposure to 0.1% and 1% w/w Nile Blue dye, which is commonly used with these species. Both *R. flavipes* and *R. virginicus* experienced significant mortality after 24-26 days at the higher concentration, and *R. virginicus* had decreased survivorship on the lower concentration of dye. The hindgut protozoans, which digest the cellulosic diet of termites, showed a variable response to the dye.

ECOLOGY OF STROUBLES CREEK: RESEARCH AND ENVIRONMENTAL EDUCATION M.S. Rosenzweig, D.A. Deshler*, M. Harpin*, J. Hudson*, G. Line*, and M. Booth*, SEEDS - Seek Education, Explore, DiScover, PO Box 824, Blacksburg VA 24053. Stroubles Creek, a small tributary of the New River drains most of Blacksburg. Along its course, the environment of the creek is impacted by continuing urbanization. SEEDS has worked with the town of Blacksburg to "Adopt" a portion of Stroubles Creek and has worked with students from Virginia Tech's Biology dept. on a monitoring and education project that will lead to restoring biological integrity to portions of the stream. During the first year of the study we have collected data on water chemistry, riparian vegetation, and hydrology/drainage. In addition, During our research, we have studied geographic and cultural history and value of the stream to the community, both in terms of its natural resources and its value in Blacksburg's hydrologic cycle. We have developed educational activities that have been offered to the public schools. The Virginia Tech students have done two "walking presentations" along the stream to high school students and members of the community to increase community awareness of the importance of Stroubles Creek. This project stands to benefit the citizens of Blacksburg as a long-term study to help understand and monitor the biological diversity of the town's most important stream.

THE USE OF PHAGE DISPLAY TECHNOLOGY IN DEVELOPING ANTIBODIES AGAINST PLANT PROTEINS. Michael Santos, and Brenda Shirley*. Department of Biology, Virginia Tech.Blacksburg, VA 24061. A new method for producing antibodies employs filamentous phage that express antibody fragments as fusions to the gene III coat protein. Major advantages of this method over conventional antibody production include the complete by-passing of immunizations, the speed of the enrichment process for high-affinity antigen binders, and the ease of expressing soluble antibodies by simply using appropriate *E. coli* hosts. The method involves a process that closely mimics the natural immune system's antigen-driven selection of B cells. We have attempted to isolate phage antibodies in the Fab format against plant chalcone synthase (CHS) and chalcone isomerase (CHI), two key enzymes in the flavonoid biosynthetic pathway, that were over-expressed as glutathione-S-transferase (GST) protein fusions. Using ELISA assays, five CHI-specific binders were identified after three rounds of panning. No high-affinity binders, however, were isolated for CHS, possibly because much less antigen was available due to inefficient expression of the GST fusion. We are performing another series of selections using the Nissim SCFV library and CHS/CHI expressed as thioredoxin protein fusions. Antibodies and antibody genes resulting from the search will be used to further characterize these flavonoid enzymes.

ANALYSIS OF NOVEL CHALCONE SYNTHASE MUTANTS IN *ARABIDOPSIS*. David E. Saslowsky & Brenda W. Shirley*, Dept. of Biol., Va. Tech, Blacksburg, VA 24061-0406. Mutants have been powerful tools in the characterization of the flavonoid biosynthetic pathway in petunia, snapdragon, maize, and *Arabidopsis* because disruption of flavonoid biosynthesis is non-lethal and results in visually distinguishable phenotypes such as altered flower or seed color. Flavonoids, important secondary metabolites in plants, play various roles in addition to pigmentation, including protection from ultraviolet-B (UV-B) radiation and signaling between plants and microbes. In some plants, flavonoids are also required to maintain male fertility. The first enzyme in the flavonoid pathway, chalcone synthase (CHS), is encoded by a single-copy gene in *Arabidopsis* and mutants at this locus are termed *transparent testa 4* (*tt4*). *tt4* mutants are deficient in flavonoid biosynthesis and produce yellow seed instead of brown (wild type). Five novel CHS mutants have been isolated as second-site suppressors of the UV-hypersensitive phenotype of chalcone isomerase (CHI) mutants (L.G. Landry, T-M Ou-Lee, and R.L. Last, unpublished data). These alleles are currently being characterized at the DNA and protein levels in our laboratory. The addition of these new alleles to the two previously described for *tt4* creates an allelic series that will help elucidate structural and regulatory roles of CHS. In future experiments, this allelic series will be used to examine interactions of CHS with other flavonoid enzymes as well as subcellular localization and organization of flavonoid metabolism.

EFFECTS OF SOMATOTROPIN TREATMENT AND EXERCISE ON MALE CD-1 MICE. E. R. Scott and A. F. Conway, Dept. of Biol., Randolph-Macon Coll. Somatotropin is used by athletes to enhance their performance but the effects of this practice have not been widely studied. This experiment investigated the effects of somatotropin in combination with exercise on strength, body weight, food consumption, water consumption, and organ weights in CD-1 male mice. The mice were injected with 0.5 mg of porcine somatotropin dissolved in 0.025 M sodium bicarbonate every other day for fourteen days. A control group was injected with 0.025 M sodium bicarbonate on the same schedule. Half the mice in each group were exercised on a treadmill for twenty minutes a day, five days each week. Grip strength was measured every third day using a Thornton 0-1000 gram force transducer. No significant changes in body weight, food consumption, water consumption, or organ weights were observed as a result of either somatotropin treatment or exercise. Grip strength in mice which received somatotropin increased more than in control mice but the difference was not statistically significant. These results indicate that somatotropin treatment caused no measurable adverse physical changes but also failed to significantly enhance physical performance when used alone or in combination with exercise.

TESTOSTERONE, DOMINANCE, AND SPATIAL RELATIONSHIPS OF *PEROMYSCUS LEUCOPUS* IN RELATION TO BREEDING SEASONS. E. A. Serabian and J. A. Cranford, Department of Biology, Virginia Tech, Blacksburg, Va, 24060. Population densities of *P. leucopus* fluctuate seasonally and yearly. Breeding peaks usually occur in Spring and Fall, while lows occur in Summer In order to examine the roles of males in seasonal breeding, testosterone (T) levels, male-male behavior and spatial relationships were evaluated between June 1995 and October 1996. Natural T levels of free-living males were determined using live-trapping, blood sampling and RIA. Behavior and dominance rank were evaluated by staged, pairwise encounters. Adult males on experimental sites were given T implants in order to produce a high T male to contrast variations in T in control males. T implanted males had higher T levels than controls ($P<0.05$). Natural T levels varied between years and seasons. Peaks occurred from mid-Mar to mid-Jun and from mid-Jul to early-Sep. Lows were observed from mid-Jun to mid-Jul and also in late Sep. T levels in 1995 were significantly lower than 1996 with subordinant males having low T levels and dominant males having higher T ($P<0.05$). In 1996, the Spring and Fall breeding season were characterized as having overall higher T levels, dominant males had low T while subordinate males had high T ($P<0.05$). During Summer, the reverse was true with dominant males having higher T and subordinant males having low T. Overall T is lower at this time, however, not as low as in 1995. Behaviorally, males exhibited aggression during Spring and Summer seasons, but not Fall. Differences between T implanted males and controls lie in the rank of rank that is aggressive during summer. Dominant T implanted males were aggressive, while subordinant control males were aggressive. Summer breeding lows still occurred on all sites. The distance between males and females was greater during Summer than during peak breeding times. A significant correlation was observed between distance between males and females on T -implanted sites, but not on control sites. Stable dominance heirarchies appear to be in place in Spring and Fall, whereas Summer is a time of instability and reorganization of social structure probably due to higher densities, high aggression, and lower T levels. T implants may not have been effective in overcoming the Summer breeding low because although T levels were higher, dominance heirarchies could just be established with higher basal T levels. This probably occurred because control males from T implanted sites (males caught prior to T implantation) had higher T levels also. Another possibility is that males with higher T were seen as subordinant by breeding females which would explain the greater distance measured between females and high T males.

THE ROAD WARRIORS: CORRIDOR USE BY THE RED IMPORTED FIRE ANT. Judith H. Stiles & R. H. Jones, Dept. of Biol., Va. Tech, Blacksburg, Va. 24061. For early-successional species, road and powerline corridors through forests provide refugia and source populations for invading adjacent forest gaps. Within an 800 km^2 forest matrix in South Carolina, we measured five corridor types, ranging from narrow to wide and from infrequently to frequently disturbed, to determine if corridor width, disturbance frequency or spatial arrangement of various corridor features influence the density or spatial pattern of mounds of the red imported fire ant, *Solenopsis invicta* Buren. We mapped mounds, road edges and forest edges within ten 500 meter segments of each corridor type. Mound density was greatest in open dirt road corridors (86.5 mounds/ha), intermediate in paved and gravel road corridors (68.0 and 63.0 mounds/ha), and lowest in powerline cuts and closed-forest canopy dirt road corridors (27.6 and 8.8 mounds/ha). Mean mound volume was greater in powerline cuts than in paved roads (14.6 and 9.6 L) and was inversely related to disturbance frequency. Mounds were located significantly closer to road or forest edges than expected. In all corridor types except dirt roads, mounds were more common toward northern edges, and more so as the orientation of the road changed from north/south to east/west. These data suggest that mound density is not affected by corridor width as much as disturbance frequency, and that fire ant distribution in corridors is not as uniform as it is in pastures.

MICROHABITAT PARTITIONING IN POST-BREEDING ANOLIS CAROLINENSIS LIZARDS. Kendall G. Taney, Dept. of Biol., VPI&SU, Blacksburg, Va. 24061, & T. A. Jenssen, Dept. of Biol., VPI&SU, Blacksburg, Va. 24061. Many sexually size dimorphic *Anolis* lizards partition their physical habitat by age and sex classes. The competition avoidance hypothesis is a possible explanation for this phenomenon. Observations were made on a thriving population of *Anolis carolinensis* living along the Augusta canal. A walking census was performed to locate subjects along a two kilometer tow path along the canal. Lizards were placed into five classes based on snout-vent length estimates, with each class increasing in size. We also recorded the height, diameter, and vegetation type on which each lizard was perching. Results showed that as size class increased from 1-5, the respective mean variables for all three habitat variables also increased. Size class 5 was always separated significantly from the other size classes. It was also found that there was no intersexual divergence of perch location for class 5. The competition avoidance theory was not supported in this study, but the ecomorphology theory seemed to fit best with the results.

RESPONSE OF THE SUBTERRANEAN TERMITE *RETICULITERMES FLAVIPES* (ISOPTERA: RHINOTERMITIDAE) TO BAIT TOXICANTS. B. Titiz & D. Waller, Biol. Dept., Old Dominion Univ., Norfolk, Va. 23527. Current efforts in termite control involve attracting termites to palatable baits with slow acting toxicants that will eventually eliminate the colony. We examined the response of *Reticulitermes flavipes* to either untreated wood or wood treated with insect growth regulator #1 or insect growth regulator #2. Termite survivorship was significantly decreased by the treated wood, although wood consumption did not vary among treatments. Numbers of large protozoans, but not small protozoans, declined on diets of treated wood, but the gut fauna was not completely eliminated. These growth regulators show promise as slow acting toxicants for the control of subterranean termites.

THE ANNUAL REPRODUCTIVE CYCLE OF THE MEADOW VOLE IN A VIRGINIA SALT MARSH. A Michelle Watson and Robert K. Rose, Dept. of Biol., Old dominion Univ., Norfolk, Va. 23529. The meadow vole, Microtus pennsylvanicus, shows considerable variation in its breeding period. Monthly samples were necropsied to determine the details of the reproductive status of meadow voles, on the Eastern Shore of Virginia. Preliminary data show that meadow voles in this region maybe breeding year round. These data will later be combined with data collected by R.K. Rose, in Piedmont Virginia,to further clarify the reproductive cycle of meadow voles in Southeastern Virginia.

THYROID HORMONES IN AVIAN EGGS: PRESENCE, MANIPULATION, AND INFLUENCE ON EMBRYONIC DEVELOPMENT. C. M. Wilson[1] and F. M. Anne McNabb[2]. [1]Dept. of Biology, Hampden-Sydney Col., Hampden-Sydney, VA 23943 and [2]Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Maternal thyroid hormones are deposited in avian eggs, primarily in the yolk. Euthyroid Japanese quail hens lay eggs with yolk thyroxine (T4) concentrations low relative to plasma T4 concentrations, and yolk triiodothyronine (T3) concentrations comparable to plasma T3 concentrations. Hen thyroid status was manipulated to alter the amount of thyroid hormones deposited in egg yolk. Hens made hyperthyroid by twice daily oral dosing with either 1x or 3x the normal thyroid secretion rate of T4 show a significant increase in plasma T4 and deposition of thyroid hormones in yolk, relative to thyroid status. Both euthyroid and hyperthyroid hens appear to regulate the deposition of thyroid hormones in yolk at each level of thyroid status. Hens dosed twice daily with 1μg T3 show a small (significant) increase in plasma T3, a small (significant) decrease in plasma T4, but no difference in yolk T4 or T3 content when compared to controls. Hens administered the goitrogen methimazole to obtain low thyroid hormone eggs maintain a euthyroid state but cease egg laying. Pelvic cartilage, a thyroid hormone-responsive tissue, from embryos of eggs from hens given either the highest T4 dose or the T3 dose show significant increases in wet weight and alkaline phosphatase activity, indicating acceleration of both growth and differentiation in an embryonic tissue.

EFFECTS OF FUNGI ON ESTABLISHMENT OF OAK, LOBLOLLY AND DOGWOOD SEEDLINGS. Lee West and Robert H. Jones, Dept. of Biol., VA Tech, Blacksburg, VA. Establishment of tree seedlings in forest understories is a key process in forest succession. To determine the influence of soil fungi and overstory composition this process, we planted seedlings of *Quercus alba, Cornus florida* and *Pinus taeda* in two closed canopy forest types - naturally regenerated hardwood and planted pine - with two replicates for each type. A fungicide treatment was applied to half of the seedlings in each forest. An ergosterol assay and visual assessment of mycorrhizal colonization are being developed to measure the fungicide effects. During the first year of the two year study, no fungicide treatment effect was detected for seedling survival or diameter growth in any of the species. Forest type had no apparent effect on survival but did show an effect ($p<.05$) on diameter growth for *P. taeda* and *C. florida*. Species differences were significant for both percent survival and diameter growth. Survival was 77%, 70% and 48% and mean diameter growth (mm) 2.7, 1.2 and 3.3 for *Q. alba, P. taeda* and *C. florida* respectively. Thus, early results indicate little or no net effect of the soil fungi community on tree seedling establishment, but modest effects of overstory composition.

DEVELOPMENTAL PATTERNS OF THYROID HORMONE CONTENT IN EMBRYONIC QUAIL TISSUES. A. E. Wolf and F. M. A. McNabb, Dept. of Biol., VA Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The patterns of thyroid hormone (TH) content were described for whole embryos and hatchlings, and liver and brain during embryonic and perihatch development in Japanese quail. Tissue THs were extracted using a chloroform/methanol extraction procedure. Recovery of THs by this extraction procedure was consistent in different tissues and in whole embryos and hatchlings. Validation studies for both T_4 and T_3 RIAs, using diluted and spiked tissue extracts, indicated consistent measurement of hormone concentrations over the ranges of the hormone assays. The patterns of T_4 and T_3 content in whole embryos and hatchlings (less than 24 hrs old) were low until mid incubation, then increased essentially exponentially during the perihatch period. Liver T_4 content did not differ significantly between days 12 to after hatch, but tended to be higher during the perihatch period. Liver T_3 content increased dramatically in embryos that had pipped into the air cell. These T_4 and T_3 patterns are similar to those in quail plasma. Brain T_4 content did not change significantly from day 12 through the time when embryos pipped into the air cell, indicating that brain T_4 is regulated although there are large changes in T_4 plasma concentrations during late embryonic development. Brain T_3 content was low during incubation, then peaked during the perihatch period. This peak in brain T_3 content is consistent with previous studies indicating the initiation of 5'-deiodination pathways in brain that convert T_4 to T_3 at this stage.

Biomedical and General Engineering

ISSUES RELATING TO THE ADVISING OF ENGINEERING FRESHMEN AT VIRGINIA TECH, Michael H. Gregg, Division of Engineering Fundamentals, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061-0218. Educators generally agree on the important role an advisor takes in the success of her/his students. The Accreditation Board for Engineering and Technology (ABET) mandates that 'the engineering faculty must assume the responsibility of assuring that the students receive proper curricular and career advising". This paper addresses some of the issues confronting the freshman advisor in Virginia Tech's College of Engineering.

THE ECP SURFACE AND ITS OFFSPRING. William P. Harrison, Div. Of Engineering Fundamentals, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The Egyptian Chord Profile (ECP) is represented mathematically by one branch of the normalized general quadratic equation in an X-Z plane, where X is the horizontal, chordwise coordinate, and Z is the vertical, thickness coordinate. When a constant extrusion of width W is applied to this profile in the spanwise Y direction, a so-called ECP Surface is produced. This is a generalized, external wing-like surface from which a number of specialized surfaces, called offspring, can be formed. One such offspring is formed by drilling a round, horizontal hole through the ECP Surface at midspan, after which the surface is tapered in the spanwise direction on each side of the hole. This design enables a thin, non-elastic endless sheet of width W to feed continuously in the positive X direction over the flat bottom portion of the ECP Surface, move over and around its leading edge, and then wrap into the cylindrical hole, producing a hollow tube of material suitable for packaging certain industrial products shaped as circular cylinders of a specified diameter.

WEAR RESULTS OF AN ADVANCED POLYMERIC MATERIAL FOR USE IN TOTAL KNEE REPLACEMENTS. Lisa A. Scott and Ramamurthy Prabhakaran*, Dept. of Mech. Engrg, Old Dominion Univ., Norfolk, VA 23529 and Robert G. Bryant*, Polymers & Composites Branch, NASA LaRC, Hampton, VA 23681. The wear rate of a high performance polymeric material (LaRC™-SI) along with particulate composites containing 15-30% (w) of graphite, PTFE, X-903 crystalline polyimide powder and Al_2O_3 was investigated against a titanium (Ti, 6Al-4V) countersurface. The results were compared to a reference material, Ultra High Molecular Weight PolyEthylene (UHMWPE), since it is the most common bearing material used in total knee replacements (TKR). UHMWPE exhibited a lower wear rate (2×10^{-7}) than the polyimide and particulate composites which ranged from 2×10^{-5} to 6×10^{-7}. A slight weight gain at the beginning of the test was observed for UHMWPE. Results found using scanning electron microscopy with energy dispersive X-ray detector indicated titanium present on the surface of the worn UHMWPE specimen. Electron spectroscopy for chemical analysis revealed the titanium to be in an oxide form which most likely accounts for the slight weight gain observed at the beginning of the test. It was also found that there was a high surface attraction between the titanium and the LaRC™-SI. This was evidenced by the formation of surface striations on the titanium plate. Due to the nature of the attraction between the polyimide and the titanium surface, the wear results for the polyimide and particulate composites are not directly comparable to UHMWPE.

Botany

BEECH FORESTS OF THE MID-ATLANTIC STATES. H. S. Adams, Div. of Arts & Sci., D. S. Lancaster Cmnty. Col., Clifton Forge, VA 24422, S. L. Stephenson, Dept. of Biol., Fairmont State Col., Fairmont, WV 26554, and S. A. Ware, Dept. of Biol., Col. of William and Mary, Williamsburg, VA 23187. Quantitative data on composition and structure of vegetation were collected from fifty forest stands having a major component (IV ≥17.5) of beech. Three stands were located in western Virginia (Giles County), fourteen in West Virginia (Cranberry Glades and the Fernow Experimental Forest and adjacent portions of the Otter Creek Wilderness Area), seven in southwestern Virginia (Mount Rogers and White Top Mountain), twelve in eastern Virginia (central Coastal Plain), and fourteen in the western part of the Great Smoky Mountains. In all, forty-eight species of trees were tallied. Basal area of trees (m^2/ha) in sampled stands ranged from 16.3 to 58.2 (western Virginia and GSM, respectively), whereas density of trees (N/ha) ranged from 198 (GSM) to 1,820 (GSM). Average density was least in eastern Virginia (369) and most in western Virginia (680). Average richness and diversity of tree species was least in GSM (5 and 1.294, respectively) and greatest in eastern Virginia (14 and 2.014, respectively). On average, beech was leading dominant in all five regions. Second leading dominants varied among regions: red oak (West Virginia and western Virginia); sugar maple (southwestern Virginia); silverbell (GSM); and white oak (eastern Virginia). Results of DECORANA separated the stands along the regional lines studied and would seem to parallel that of the three population types of beech: gray beech (GSM), red beech (West Virginia and western Virginia), and white beech (eastern Virginia).

THE PINE/HARDWOOD ECOTONE: A FOUR-YEAR STUDY BY THE GOVERNOR'S SCHOOL AT DABNEY S. LANCASTER COMMUNITY COLLEGE. H. S. Adams, D. S. Lancaster Cmnty. Col., Clifton Forge, VA 24422, E. J. DeGroot, Alleghany H. S., Low Moor, VA 24457, and E. G. Haverlack, USDA For. Serv., Covington, VA 24426. Two transects of five permanently marked contiguous ten by ten meter plots extending from hardwood-dominated regions, across relatively abrupt ecotones, into pine-dominated regions were established in central Alleghany County, Virginia, by Governor's School participants in 1993. These transects were resampled in 1994, 1995, and 1996. At both the pine and hardwood ends of the transects, basal area of pines (*Pinus* spp.) and hardwoods steadily increased during the four years of investigation. The density of hardwoods increased by 10.0 percent at the pine end of the transects and decreased by 3.4 percent at the hardwood end, whereas the pine density remained unchanged. Importance values for both pines and hardwoods changed very little at the two ends of the transects. Major decline in pine basal area and density occurred in the ecotone during the same period (67.4 percent and 47.0 percent, respectively). However, most of this reduction occurred between 1993 and 1994. Concurrently, basal area of hardwoods increased by 8.6 percent and density declined by 1.6 percent. Importance value for pines decreased by 17.9 percent as hardwood importance increased by the same amount. These values now are comparable to those at the hardwood end of the transects, suggesting shifting of the ecotone toward the pine ends. Decline of the pines was due to infestation and damage by the southern pine bark beetle (*Dendroctonus frontalis*). (Supported in part by a grant from the Virginia Department of Education.)

BIOCONTROL OF THE INVASIVE Ailanthus altissima WITH FUNGAL WEAPONRY. G. R. Armel, R. J. Richardson, R. J. Stipes and P. L. Hipkins. Dept. Plant Pathol. Physiol. & Weed Sci., VA Tech, Blacksburg, VA 24061-0331. Biocontrol offers an alternative approach to herbicidal management of undesirable weeds such as Ailanthus altissima ("Tree of Heaven"). This report describes our attempt to find a pathogen to reduce expanding populations. We collected pathological tissues from declining trees along the Blue Ridge Parkway and other roadsides in western Virginia. Biopsy tissues from 50 symptomatic trees yielded Fusarium oxysporum; healthy seedlings root inoculated with macro- and microconidial suspensions developed typical Fusarium wilt symptoms (chlorosis, leaf abscission, vascular discoloration), and the original fungus was re-isolated. Control seedlings, root "inoculated" with water only yielded no symptoms. Healthy seedlings replanted in infested soil also developed Fusarium wilt symptoms, with the original fungus re-isolated from biopsy/necropsy tissues. Studies will be continued in 1997, with surveys and laboratory analyses for the same or other potential pathogens. The endpoint of this research would be to provide a means to deliver inoculum in adequate quantities to manage these weed trees along highways. We thank Dr. Gary J. Griffin for confirming our identificaiton of the pathogen.

STRUCTURE AND ORGANIZATION OF ß-GLUCOSIDASE GENES IN PLANTS. Hema Bandaranayake* and Asim Esen, Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Genomic sequence and organization of the maize ß-glucosidase gene *glu1* has been determined after amplifying it in three overlapping fragments by PCR. The *glu1* gene comprises 12 exons interrupted by 11 introns. The 12 exons code for a 566 amino acid long precursor with a 54-amino acid-long N-terminal extension for plastid targeting and a 512-amino acid long mature protein. The sizes of 12 exons vary from 35 to 334 bp with an average AT content of 51.1%. In contrast, the sizes of 11 introns vary from 78 to 1041 bp with an average AT content of 65.7%. Comparisons of the maize glu1 sequence and organization with those of cassava MebglA, two myrosinase genes (TGG1 and TGG2) from Arabidopsis and an endosperm-specific ß-glucosidase gene (bgQ60) from barley suggest that all of these five genes have descended from a common 13-exon and 12-intron ancestral gene. The current cassava MebglA gene has the organization of the postulated ancestral ß-glucosidase gene. The major mutational events in the evolution of plant ß-glucosidase genes appear to be the loss of ancestral introns 1, 2, and 11 from the barley, 8 from maize, and 5 from *Arabidopsis* genes and the acquisition of a transit peptide coding region for plastid targeting by grass and possibly other monocot ß-glucosidase genes. The data also suggest that these events have occurred in the past 150 to 200 million years after the separation of monocots and dicots.

TEMPORAL AND SPATIAL EXPRESSION OF ß-GLUCOSIDASE (DHURRINASE) ACTIVITY IN *Sorghum bicolor*. Muzaffer Cicek and Asim Esen, Dept. of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061. *Sorghum bicolor* (L.) Moench has two isozymes of the cyanogenic ß-glucosidase dhurrinase: dhurrinase-1 (*Dur1*) and dhurrinase-2 (*Dur2*). A full-length cDNA encoding dhurrinase-1 was isolated from 4 day-old etiolated seedlings and sequenced. The cDNA has a 1695-nucleotide-long open reading frame which codes for a 565-amino acid-long precursor and 514-amino acid-long mature protein, respectively. Deduced amino acid sequence comparisons show 70% identity between maize and sorghum ß-glucosidase precursor proteins. Multiplicity of sorghum ß-glucosidases (dhurrinase) genes and their expression in different plant parts were studied. Southern blotting data indicate that ß-glucosidase is encoded by a small multigene family, having at least two members. Northern blotting data indicate that the mRNA corresponding to the *dur1* cDNA is present at high levels in the node and the upper half of the mesocotyl in etiolated seedlings but at low levels in the root, only in the zone of elongation and root tip region. Light-grown seedling parts have lower levels of mRNA than those of etiolated seedlings. Immunoblotting analysis performed using maize-anti-ß-glucosidase sera detectes two distinct dhurrinases in sorghum (57 and 62 kD). The data indicate that the cloned cDNA corresponds to *Dur1* (57 kD). The distribution of dhurrinase activity in different plant parts supportes the mRNA and immunoreactive protein data, indicating organ specific expression of the *dur1* gene.

THE REPRODUCTIVE BIOLOGY OF ADDISON'S LEATHERFLOWER. Rhonda Edwards and Duncan Porter, Dept. of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061. *Clematis addisonii* Britton (Ranunculaceae) is an herbaceous perennial restricted to a four country region in the Ridge and Valley Province of Virginia. A two year study of the reproductive biology of this species revealed that it is self-compatible and shows no significant reduction in seed set following self-pollination. Field observations of flowers and laboratory observations of *in vivo* pollen tube growth indicate protogynous maturation of sex organs, a condition shown to be an effective outcrossing mechanism in a number of self-compatible species. The secretion of floral nectar throughout both sexual phases attracts pollinators whose activity is necessary for adequate seed set. These findings suggest that, in spite of self compatibility, the potential for outcrossing exists in *Clematis addisonii* as a result of protogyny and the secretion of nectar from the onset of flowering.

GYNOECIUM STRUCTURE IN *PENTHORUM*. W. John Hayden and Jeffrey D. Lewandowski, Dept. of Biol., Univ. Richmond, Richmond, Va. 23173. Gynoecia of *Penthorum sedoides* and *P. chinense* were studied by light and scanning electron microscopy. Gynoecia vary from five, the most common state, to eight carpels; when present, pleiomerous gynoecia occur at the base of the inflorescence. Overall, the gynoecium consists of a proximal multi-locular ovary region that shows no evidence of conduplicate folding and distal, divergent styles with prominent plicate sutures and terminal capitate stigmas. Although the ovary region is half inferior at anthesis, fruits are essentially superior. Fruits dehisce by abscission of the distal portions. The proximal region develops within the floral apex, includes the multiovulate pendulous placentae, is vascularized via the inner of two rings of pedicellar bundles and lacks stomata both externally and on internal septum surfaces. The distal regions, including the styles and stigmas, originate from the surface of the floral apex and resemble leaf primordia in early stages; distal structures are vascularized by the outer ring of pedicellar bundles (as are perianth elements and stamens) and have prominent stomata on external and internal locular surfaces. The manifest morphological and anatomical differences between proximal and distal regions support a stachysporous model of gynoecium structure in the genus *Penthorum*, i.e., stem-borne placentae subtended and enclosed by folded leaves.

DOES THE RHIZOME OF *SAURURUS CERNUUS* UNDERGO SECONDARY GROWTH? W. John Hayden and Leonard S. Machut, Dept. of Biol., Univ. Richmond, Richmond, Va. 23173. *Saururus cernuus* is an herbaceous wetland plant with a sympodial growth system of rhizomes and erect aerial stems. Previous literature is equivocal about the presence or absence of secondary growth in rhizomes of this "paleoherb." Using light and scanning electron microscopy, we studied two rhizomes that were collected in Chesterfield Co., VA. Sections were prepared at regular intervals over the span of two year's growth and, at each point sampled, we recorded the number of mature and immature xylem elements and the radial extent of xylem tissue. With two exceptions, the parameters measured are relatively constant throughout the rhizome. On average, we found fewer than one immature element, four to five mature elements, and xylem radial dimensions of 90 to 110 μm per bundle. At young growing tips, however, immature elements predominate and mature elements are few. Further, rhizome segments distally adjacent to aerial stems have nearly twice the usual number of mature elements per bundle and 40 percent greater radial extent of xylem. Based on qualitative features of bundle anatomy and quantitative data showing no steady increase in xylem tissue with age, we interpret all vascular tissues observed in the *Saururus* rhizomes studied to be of primary origin. Literature reports of secondary growth in *Saururus* rhizomes may be attributable to the more southerly provenance of the samples or to artifactual effects from cultivation.

SEEDLING DEVELOPMENT IN TWO SPECIES OF *CHAMAESYCE* WITH ERECT GROWTH HABITS. W. John Hayden and Olga G. Troyanskaya, Dept. of Biol., Univ. Richmond, Richmond, Va. 23173. Seedlings of *Chamaesyce hypericifolia* (Section Hypericifoliae) and *C. mesembrianthemifolia* (Section Sclerophylleae) were studied with light and scanning electron microscopy to elucidate details of early development for comparison with previously described structures and processes found in prostrate species (Section Chamaesyce). Following expansion of the cotyledons, epicoty development is limited to a pair of "V" leaves inserted superadjacent to and decussate with the cotyledons; no meristematic residue remains at the epicotyl apex following their origin. Growth resumes by means of branches that originate as buds in the cotyledonary axils. In both species studied, one cotyledonary branch dominates the other and attains erect stature; however, the opposite axillary bud and additional supernumerary buds remain detectable at the cotyledonary node even in mature plants. In prostrate species, the basic organography of cotyledons, "V" leaves, and buds is the same. In prostrate species, however, both axillary buds and several additional buds develop into a radiating plexus of horizontal branches. Nodal anatomy is also similar in erect and prostrate species; cotyledons and "V" leaves are both vascularized by trilacunar nodes, and the cotyledonary node is further characterized by split lateral traces. Evidently, the peculiarities of seedling development in *Chamaesyce* predates the divergence of sections Hypericifoliae, Sclerophylleae, and Chamaesyce.

OUR FOOD CROPS: HOW MANY ARE NATIVE TO NORTH AMERICA. Khidir W. Hilu, Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Among the thirty most important crops that feed the world, only the sunflower was domesticated in North America. The top four crops are wheat, corn, rice and barley, which combined account for about 80% of the global yield. None of these crops are native to North America. The soybean was domesticated in China; potato, tomato and peanut in South America, and most temperate fruit crops are Old World in origin. Agriculture has eight centers of origin; six of them in the Old World and two in Central and South America. There has been no significant plant domestication in North America. Areas of plant domestication are centers of genetic diversity which can provide genetic resources for crop improvement. The majority of our crops have very narrow genetic bases and are quite vulnerable to disease and environmental change such as drought. The major advances in plant breeding are occurring in developed countries that lack genetic resources. This situation has resulted in critical conflicts dealing with ownership of these genetic resources. Such issues only highlight the complexity and interdependence of economic systems in the world today.

TEACHING ECONOMIC BOTANY AT THE COLLEGE LEVEL. Khidir W. Hilu, Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Teaching economic botany at any level can be rewarding and exciting for both students and teachers. In such a course, one is dealing with plants and issues that touch everyday life. The issues range from local to global. Several textbooks exist, however, a choice is difficult to make because of the differences in emphasis and the variety of approaches authors take. The objectives of the course go beyond informing the students of economic plants to educating them about important social, economic and environmental issues. The teaching tools include lecturing, displaying plant material, showing audiovisuals such as slides and videos, presenting research lectures, and inviting guest lecturers. Discussions on important global issues and writing assignments can also be introduced to the course. The expected achievements from teaching such a course include broadening students' understanding of the vital importance of plants, expanding the students comprehension of cultural differences through ethnobotany , and raising their awareness of the critical balance that exists between our current need for food and industrial supplies, and the future of our species and planet.

USING THE LICHEN *PARMELIA RUDECTA* TO BIOMONITOR A NEW TECHNOLOGY COAL FIRED POWER PLANT: PRE-IMPACT STUDY. Kerri L. Jones and Dr. Stephen W. Fuller, Dept. of Biol., Mary Washington Col., Fredericksburg, Va. 22401. *Parmelia rudecta* lichens were used as biomonitors of air pollution surrounding a new coal fired power co-generation plant in King George County, Virginia for the year before the plant began production in January 1997. This location is near Stafford County which is designated by the EPA as a non-attainment air pollution zone. Twenty-two test sites were chosen. Eleven sites surrounded the plant and represented the pre-impact area; eleven sites were located upwind from the plant and served as the control area. Each site was composed of one *Quercus velutina* tree greater than 40cm in diameter. Two *P. rudecta* specimens were selected for study at each site. Beginning in January 1996 photographs were taken of the specimens at each tree. Growth was analyzed by measuring the difference between lichen thalli photographs of consecutive seasons. Statistical analysis of growth determined that lichen growth was greatest in both the winter pre-impact and control areas.

ARACHIS HYPOGAEA: A BENEFICENT IMMIGRANT WORTH KEEPING. D. B. Langston, Jr., R. J. Stipes, and P. M. Phipps, Dept. Plant Pathology, Physiology, and Weed Science, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061. Peanut (Arachis hypogaea L.) is an annual herb of the family Fabaceae and is a crop plant of cosmopolitan distribution. The peanut is a well traveled plant as it originated in South America, was taken West to Malaysia, China, Indonesia and Madagascar, and later taken East from South America to Africa via the Spaniards. World production of peanut averages ca. 23 million metric tons grown on ca. 20 million hectares on six continents with India, China, and the United States producing 70%. The peanut was introduced to southern North America during colonial times by the English. Since its introduction, the peanut has risen to the rank of eighth among the primary food crops produced in the United States, contributing approximately 4 billion dollars to the United States economy each year. Southeastern Virginia provides the warm, moist climate and sandy-textured soils essential for profitable commercial peanut production. The reproduction of the peanut is unique in that, upon fertilization, the gynoecium (peg) geotropically grows down into the soil which will give rise to the pods that will only form in the absence of light beneath the soil surface. Peanut is also susceptible to many economically important plant diseases with Sclerotinia blight of peanut, caused by *Sclerotinia minor* Jagger, causing the greatest disease losses in Virginia.

COLLECTING FLORA WITH A CAMERA. Kenneth R. Lawless, Dept. of Materials Science & Engineering, University of Virginia, Charlottesville, VA 22903. The 35mm camera equipped with a macro lens and color film can provide a useful supplement to the usual collection of voucher specimens, and could in many cases provide an alternative means of documentation. Examples of photographic collections from Orchidaceae, Ranunculaceae, Melastomataceae, Gentianaceae, Liliaceae, and other families will be shown, illustrating cases where identification is certain and others where it is ambiguous. Several example will be given where because of size, fragility, or rarity, photographic collection is really essential.

USING THE LICHEN *PARMELIA CAPERATA* TO BIOMONITOR A NEW TECHNOLOGY COAL FIRED POWER PLANT: PRE-IMPACT STUDIES: Susan T. Lee and Stephen W. Fuller, Dept. of Biol., Mary Washington Col., Fredericksburg, Va. 22401. *Parmelia caperata* lichens were used as biomonitors of air pollution to determine the air quality around a new coal fired co-generation power plant, in King George County, Virginia for a full year before the plant began production in January of 1997. Twenty two sites consisting of one *Quercus velutina* tree greater than 40 cm in diameter were selected in relatively open sites, both in the area surrounding the plant stack and extending east northeast approximately 18 kilometers, and in an area upwind of the stack to serve as a control. Three *P.caperata* specimens were selected for study at each tree. Photographs for growth determination were taken each season beginning in January 1996. *P. caperata* growth was analyzed by measuring the difference between lichen photograph slides of each season. *P.caperata* grew 0.94 mm from Spring to Summer , 0.36 mm from Summer to Fall, and 2.18 mm from Fall to Winter in the impact area (1996-97). Growth in the control area was recorded as 0.02 mm from Spring to Summer, 2.19 mm from Summer to Fall , and 2.53 mm from Fall to Winter (1996-97). Statistical analysis of the growth data shows significant differences within and between all seasons in the impact and control areas with the exception of Summer to Fall and Fall to Winter control data. Similarly, no significant difference between the impact and control areas from Fall to Winter was found.

MOLECULAR CHARACTERIZATION OF THE *MAT*K GENE IN THE GRASS FAMILY (POACEAE). Hongping Liang and Khidir W. Hilu, Dept. of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The pattern of variation of the whole *mat*K gene was examined in the grass family using 13 coding region sequences from species representing the seven subfamilies and related *Joinvillea plicata* (Joinvilleaceae). The alignment of 14 sequences of 1632 bps showed that the variable sites distributed roughly throughout the entire gene. The 3' region is more conservative than the 5' region. The variation at nucleotide level and at amino acid level have a similar pattern but differed in magnitude, which can be explained by low variation at the third codon position (42%) as compared to higher variation at the first and second positions (58%). The average transition and transversion ratio of the *mat*K gene is 1.34, ranging from 0.90 to 2.00, and the correlation between the taxonomic level and ratios is not statistically significant. Relative Apparent Synapomorphy Analysis (RASA) of the aligned data indicated a strong phylogenetic signal in this data set (tRASA = 4.27). RASA conducted on different sectors of *mat*K indicated that the "X-domain" region contain significant phylogenetic signals. The phylogenetic analysis of 246 informative sites by PAUP results in a single most parsimonious tree (CI=0.649, RI=0.652). The parsimonious tree based on 3' half of *mat*K has identical topology to the tree based on the entire gene. The seven subfamilies were well resolved in the parsimonious tree and the bambusoid species appeared at the base of the tree. The results are supportive of the use of partial sequencing in systematic studies.

BOTANICAL PEDAGOGY AT THE BLANDY EXPERIMENTAL FARM. Marion B. Lobstein, Associate Professor of Biology, NVCC-Manassas Campus, NVCC-Manassas Campus, 6901 Sudley Rd., Manassas, VA 22110 and Adjunct Professor of Biology, Blandy Experimental Farm, Boyce VA 22620. Blandy Experimental Farm located near Winchester, VA is the field station for the University of Virginia and the location of the Orland E. White Arboretum, the State Arboretum of Virginia. This 700 acre site provides year-round opportunities for botanical and science education. The summer academic program taught in conjunction with UVA's Environmental Science Department offers unique opportunities for field study in botany and ecology. The combination of old fields, numerous woodlots, small ponds, and the Arboretum plantings makes available a unique diversity of habitats for study and research projects at Blandy. The proximity to Shenandoah National Park, Thompson Wildlife Management Area, and other nearby natural areas are additional field study opportunities. Summer internships for graduate and undergraduates are additional research and study opportunities. The newly renovated classroom at Blandy expands opportunities for year-round educational activities with growing collaboration with local school district and other groups to conduct programs in science education. Blandy is part of a nationwide consortium of field stations and works closely with other educational institutions throughout the region. The grounds and Arboretum are open to the public every day of the year and public educational outreach is ongoing.

A SURVEY OF TRACHELOMONAS SPP. IN LAKE KILBY, SUFFOLK, VIRGINIA. Harold Marshall, Dept. Biol. Sci., Old Dominion Univ., Norfolk, VA 23529-0266. Lake Kilby is a reservoir lake of 222 acres, with a maximum depth of 7.1 m. Results of a one year phytoplankton study revealed 16 identified Trachelomonas species, and others identified to genus, using SEM. Highest concentrations occurred during spring and summer, reaching 83,700 cells/l. Identified species were Trachelomonas acanthostoma, T. acanthophora, T. alisoviana, T. armata v. longa, T. globularis v. boyeri, T. hispida, T. hispida v. coronata, T. inermis, T. intermedia, T. regulosa, T. scabra v. longicollis, T. similus, T. superba, T. varians, T. verrucosa, and T. volvocina. Mean monthly values in the lake: pH 6.0, NO_3 0.6 mg/l, PO_4 0.06 mg/l, and O_2 6.0 mg/l. Supported by the Virginia Dept. of Game and Inland Fisheries.

THE BREEDING SYSTEM OF THE NARROW ENDEMIC WETLAND PLANT, *HELENIUM VIRGINICUM*. N. A. Messmore & J. S. Knox*, Dept. of Biol., Washington & Lee Univ., Lexington, Va. 24450. *Helenium virginicum* is a narrow endemic seasonal wetland plant that is listed as a candidate for endangered or threatened status by the Federal government, and is listed as endangered by the state of Virginia. We investigated the breeding system of this rare plant to gain insight into its limited distribution and abundance. Experiments revealed that, like most members of the Asteraceae, *H. virginicum* is self-incompatible. In a common garden where water and nutrients were not limited, 28 plants from a single *H. virginicum* population each were both selfed and outcrossed from a large pooled sample of pollen. A mean seed set per head of 76.8% was found in outcrossed heads, compared to only 0.8% in selfed heads. Sporophytic self-incompatibility also was determined based on stigmatic pollen tube inhibition. A self-incompatible breeding system may put small populations of *H. virginicum* at risk of local extinction due to the limited availability of compatible mates, and should be considered when designing effective conservation and management strategies. (Supported by R. E. Lee and Glenn Research Grants of W&L Univ.)

ECOLOGY OF ODOROUS COMPOUND-PRODUCING ALGAE IN THE WATER SUPPLY FOR METROPOLITAN BOSTON, MASS. Bruce C. Parker, Dept. of Biol., Va. Tech, Blacksburg, VA 24061, & Myron H. Beaty, Dept. of Biol., Merrimack Col, No. Andover, Mass 01845. Oligomesotrophic Wachusett Reservoir has been plagued with seven plankton algae that impart unpleasant odors and tastes to the tap-water. A nitrogen-fixing *Anabaena* often becomes abundant overnight from May-June and produces earthy and musty compounds. The diatoms *Asterionella formosa* (Jan-Mar) and *Tabellaria fenestrata* (May-July) produce fishy compounds either directly or indirectly. The dinoflagellate, *Ceratium* sp. may dominate in June in association with fishy and septic odors. *Synura petersenii* can dominate especially at some depth in dim light and under low silica conditions in fall and winter, producing cucumber, fishy, etc. odors. *Dinobryon* sp. and *Uroglena volvox* often appear in late spring to fall, producing fishy and other odors. *Synura, Dinobryon*, and *Uroglena* are photosynthetic and heterotrophic. *Synura* can utilize dissolved organic matter, while *Dinobryon* and *Uroglena* are also phagotrophic for small bacteria-sized particles. Understanding the ecology of these nuisance algae and compounds they produce has facilitated the design of a reservoir management and water treatment plan to optimize the availability of potable water until upstream nutrients can be reduced.

THE DARWIN CORRESPONDENCE PROJECT. Duncan M. Porter, Dept. of Biology, Virginia Tech, Blacksburg, VA 24061-0406. In 1974, Frederick H. Burkhardt retired as President of the American Council of Learned Societies and cast about for something to work on in his retirement. He already had served as General Editor of The Papers of William James and decided that editing Charles Darwin's correspondence might prove interesting. He teamed up with the Cambridge zoologist the late Sydney Smith, to begin a search for Darwin's letters. Aided by grants from the National Endowment for the Humanities and the National Science Foundation, Fred and his colleagues discovered far more letters than could fit into the originally-planned five-volume work. The NSF wisely insisted that both sides of the correspondence should be included, and by the time the first volume appeared in 1985, over 14,000 letters had been discovered. Now, we know of about 15,000 letters, and more turn up each year. Also in 1985, a Calendar of the letters was published, with a second edition in 1994. The tenth volume of The Correspondence of Charles Darwin, covering 1862, will be published by the Cambridge University Press in June 1997. Thirty-two volumes in total are planned, three to appear every two years from now on. Most of the research takes place at the Cambridge University Library, where eight people currently are working on the Project. Five work on it in the US at Bennington, VT and Blacksburg. As Senior Editor, I am confident that we will finish in 2011, on schedule.

PLANT DIVERSITY SURVEY OF THE PEAKS OF OTTER BACKCOUNTRY AREA, BLUE RIDGE PARKWAY, VIRGINIA. Gwynn W. Ramsey, Dept. of Biol., Lynchburg College, Lynchburg, VA 24501. A three year study reveals that the vascular flora of the Peaks of Otter, in the Blue Ridge Mountains of central Virginia (Blue Ridge Parkway Mile Post 83.5 - 87.5), is interestingly diverse. Voucher specimens document a vascular flora of 357 genera in 97 plant families with 662 species within the 2500 hectare research area. Largest collections of the Peaks of Otter Flora are represented by the Asteraceae (77 spp.), Poaceae (48 spp.), Rosaceae (36 spp.), Cyperaceae (29 spp.), Liliaceae (29 spp.), Fabaceae (29 spp.) and Lamiaceae (25 spp.). Of the species collected, 121 (18%) are introduced. Eight federally and/or state listed rare taxa were discovered and mapped during the study and eight potential habitats were described and mapped. Kodachrome slides and a videotape help document the study. (Supported by Department of Interior, National Park Service, Blue Ridge Parkway, Cooperative Agreement, #CA 5140-1-9002, SUB A #1)

MECHANISMS OF CRYOPROTECTANT INJURY TO AFRICAN VIOLET TISSUE. Michael H. Renfroe & Jeremy Aldrich*, Dept. of Biol., James Madison Univ., Harrisonburg, Va. 22807. Cryoprotectants may be toxic to cells or may cause dehydration injury to plant tissues. Therefore cryoprotectants should be tested for cytotoxicity and tissue dehydration. We tested sucrose, sorbitol, mannitol, glycerol and dimethylsulfoxide (DMSO) for their potential as cryoprotectant compounds to be used with African violet (*Saintpaulia ionantha*) tissue. Axenic leaf discs were immersed in individual cryoprotectant solutions of various concentrations. Water potential measurements were recorded for each solution. Following exposure to cryoprotectants, discs were placed on a tissue culture medium formulated to initiate adventitious shoots. Leaf disc survival was observed. By observing disc survival and solution water potential, we inferred that sucrose, sorbitol, and mannitol caused dehydration injury to African violet when used at concentrations often found in cryoprotectant solutions. DMSO was cytotoxic at concentrations below which dehydration injury would occur. Glycerol was the only compound tested that did not cause dehydration injury or cytotoxicity at concentrations typically used in cryoprotectant solutions. This investigation helps us to understand the mechanisms of tissue injury associated with various cryoprotectant solutions.

ICE STORM DAMAGE IN A SMALL VALLEY IN SOUTHWESTERN VIRGINIA. Richard W. Rhoades, 611 Rose Ave., Blacksburg, VA 24060. Mixed deciduous forest was sampled two years after a series of ice storms to assess damage to individuals and changes in community composition. Prestorm compositional data were available from 1993. Ice storms occurred in Feb. and Mar. 1994. The same plots were resampled after the storms. Density of overstory trees decreased 19% and density of understory trees, 15%. Basal area (B.A.) of overstory trees declined 6%, but B.A. of understory trees changed little. Little change occurred in sapling density, but B.A. increased 45% indicating response to loss of canopy. The overstory trees scarlet oak and white pine suffered the heaviest damage, 36% of B.A. lost. Among understory trees and saplings the greatest damage was to red maple and white pine with 11% of B.A. lost. Damage was heaviest on the valley floor and adjoining south-facing slope, particularly among overstory and understory trees. Overall damage was moderate, i.e. 15% of individuals were damaged and 10% of B.A. was lost. I expect little change in the vegetation on the two slopes; it will remain a chestnut oak oak community. Vegetation of the valley floor should change slightly with fewer oaks and more species typical of mixed mesophytic forest.

GROWTH OF TREES ON THE VIRGINIA TECH CAMPUS IN RESPONSE TO VARIOUS STRESS FACTORS. Richard W. Rhoades and R. Jay Stipes, Dept. Plant Pathol., Physiol. & Weed Sci., Virginia Tech, Blacksburg, VA 24061-0331. We measured dbh and crown diameter of 9 species of trees from 1993 to 1995, to determine how site stress and other factors affect growth. Growth rates differed significantly amound species. Northern red oak had the highest diam. growth, and Alaskan white cedar had the highest crown growth, and flowering dogwood and black maple had the lowest. Five major factors influenced growth: ice damage, percent roots restricted by pavement, heart rot, chlorosis and Dutch elm disease. Almost half (49%) of trees were injured physically or manifested visible disease. We also compared growth rates of trees in two groups classified by percent of root system paved over, viz., low stress vs. stressed sites. Mean diam. growth was higher on stressed sites, but crown growth was lower on these sites. Growth rates on the two kinds of sites varied with species. Five species had higher diam. growth on stressed sites, and three species had greater diameter growth on low stress sites. Annual rates of diam. growth of campus trees was higher than comparable growth rates of the same species in forests. Based on these results, we were unable to show conclusively that site stress suppressed growth of trees on the campus. Several unmentioned factors are operative.

AN INTRODUCTION TO THE RARE SPECIES *PARONYCHIA VIRGINICA* SPRENG. (CARYOPHYLLACEAE): REPORT OF WORK IN PROGRESS. Wendy L. Rohrer, Dept. of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. *Paronychia virginica* Spreng. (Caryophyllaceae) is a perennial evergreen herb of exposed, relatively xeric habitats. Approximately ten mid-Appalachian populations remain in Virginia, West Virginia, and Maryland and are disjunct from populations located primarily in Texas, Oklahoma, and Arkansas. A study is being conducted by the current author to test the hypothesis that eastern and western populations differ significantly and, therefore, represent at least two distinct taxa. The objectives of the project are as follows: 1) to clarify the systematics of *P. virginica*, 2) to compare the use of allozymes and morphometrics in estimating population structure and dynamics, and 3) to provide useful information for evaluating the vulnerability of eastern populations to extinction. Starch gel electrophoresis was performed and six enzyme systems/nine loci (EST-2, EST-3, LAP, MDH-1, MDH-2, PGI, PGM-1, PGM-2, and SKDH) were identified as scorable and reliable in expressing genetic variability. Data were statistically analyzed using BIOSYS-1. An examination of 56 qualitative and quantitative morphological characters was performed and a data matrix was constructed for use in a phenetic analysis. Results and discussion of the allozyme and morphometric analyses will be communicated in a future publication.

PLANT BIOCHEMICALS AND INSECT RESISTANCE. Frank S. Santamour, Jr., U.S. National Arboretum, ARS, USDA, Washington, DC 20002. The search for the intrinsic chemical compounds that may confer insect resistance in trees is not always successful. An alternative approach is to determine which chemicals are responsible for insect susceptibility. Once the compound(s) are identified, mass screening of individuals of the major tree species, and sexually compatible species, may reveal some plants that have little or none of this chemical. These trees may then form the basis for a selection and breeding program to develop superior trees. One example from our research is the determination that strobic acid in the cortical oleoresin of certain white pines was the principal cause of susceptibility to the white-pine weevil. Another example is the finding that rhododendrin in the inner bark of many white-barked birches was the key to susceptibility to the bronze birch borer. Trials and tribulations are discussed.

THE EPIPHYTIC DIATOM COMMUNITY ON SPECIES OF ISOETES FROM SOUTHEASTERN USA. David Seaborn, L. Musselman, & H.G. Marshall, Dept. Biol. Sci., Old Dominion University, Norfolk, VA 23529-0266. Leaves of Isoetes plants, collected from ponds in Virginia, Georgia, and Florida, were examined with scanning electron microscopy. Pennate diatoms dominated the epiphytic floral community on the leaves of these plants, and were represented by mainly Cocconeis and Navicula spp. The greatest density of the diatoms was located at the tips of the leaves, and decreasing toward their base. Examination of other aquatic macrophytes living in the same locations as these quillworts did not indicate the presence of high numbers of epiphytic diatoms. This suggests a possible substrate selection for Isoetes by these diatoms.

POLYMORPHISM OF ß-GLUCOSIDASE ISOFORMS GLU1 AND GLU2 IN MAIZE (*Zea mays* L.). Mohammad Shahid and Asim Esen, Dept. of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Two isoforms of ß-glucosidase (Glu1 and Glu2) were identified in different parts of maize seedlings as well as in mature plants. All plant parts including root, mesocotyl, node, leaf and coleoptile of a 5-day-old maize seedling have isoform Glu1, while isoform Glu2 occurs in leaves only, starting at day 7. In mature maize plants, isoform Glu2 is present only in the leaf blade, while isoform Glu1 occurs in all other parts like root, stem, leaf sheath, and male and female inflorescences. Seven different maize inbreds were analyzed both for Glu1 and Glu2 allozymes using 15-day-old mesocotyls and leaves. All of these inbreds had different allozymes of isoform Glu1. In contrast, isoform Glu2 whose expression was limited to leaves had only one allozyme, and thus was not polymorphic.

MORPHOLOGICAL VARIATION AND SYSTEMATICS OF EASTERN NORTH AMERICAN BRACKEN FERN. William D. Speer and Khidir W. Hilu, Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The cosmopolitan Pteridium aquilinum (L.) Kuhn is widespread throughout eastern North America, where it is represented primarily by var. latiusculum (Desv.) Underw. and var. pseudocaudatum (Clute) Heller. The taxonomy of Pteridium is contentious and the status of these two groups is uncertain. A numerical study of twelve qualitative and quantitative morphological characters was used to examine the taxonomic relationships of these two taxa. Multivariate analysis of the morphology distinguished the two taxa when the qualitative characters were used alone or in conjunction with some of the quantitative traits. Univariate analysis of all twelve characters revealed that the qualitative characters differed significantly ($P < 0.001$ in each case) between the two taxa, while the quantitative characters did not. Morphological distinctiveness was maintained even in those localities where both taxa were present, with few or no intermediates being found. The morphological data strongly support the current varietal status of these two groups.

PHYTOPLANKTON ABUNDANCE AND BIOMASS IN THE BOTTOM WATERS OF CHESAPEAKE BAY. Jennifer L. Wolny & H.G. Marshall. An 11 year data base was analyzed, using monthly samples taken above and below (bottom waters) the pycnocline, at stations in the lower Chesapeake Bay. Total phytoplankton and autotrophic picoplankton abundances were greater above the pycnocline compared to bottom waters, with the diatom category a major exception. Abundance patterns also tended to increase throughout the water column moving from the Bay mouth northward. Total phytoplankton and autotrophic picoplankton biomass (cell carbon) were less in the bottom waters. Several algal taxons were mentioned as being exceptions to this distribution. Supported by the Virginia Dept. Environmental Quality and EPA.

Chemistry

MECHANISTIC STUDIES ON THE MONOAMINE OXIDASE-B CATALYZED OXIDATION OF 1,4-DISUBSTITUTED-1,2,3,6-TETRAHYDROPYRIDINES. Andrea H. Anderson, Neal Castagnoli, Jr., Dept. of Chemistry, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The 1-methyl-4-substituted-1,2,3,6-tetrahydropyridines constitute an interesting class of tertiary amines which often display better MAO-B substrate properties than the natural substrates such as serotonin and dopamine. Replacement of the N-methyl substituent with a cyclopropyl group converts the 4-phenyl analog into a mechanism based inactivator, behavior which is consistent with the single electron transfer (SET) catalytic pathway proposed by Silverman for MAO-B. In contrast to these results, the 1-cyclopropyl-4-benzyl analog is a mixed substrate/inhibitor of MAO-B. These results suggest that cyclopropylaminyl radical cations, generated by the SET pathway, may not be obligatory intermediates in the MAO-B catalyzed oxidation of these cyclic allylamines. In an attempt to gain further insight into the mechanism associated with the MAO catalyzed oxidation of 1,4-disubstituted tetrahydropyridines, we have undertaken deuterium isotope effect studies on both the substrate

USE OF PC-SPARTAN IN PHYSICAL CHEMISTRY LABORATORY. J. Cox, G. Mahedevan, C. Castevens and D. Shillady, Department of Chemistry, Virginia Commonwealth University, Richmond, VA. PC-SPARTAN has been proposed for use in undergraduate education. This is a report of the use of PC-SPARTAN as a "dry-lab" experiment in CHE L304, Physical Chemistry Laboratory at Virginia Commonwealth University in the Spring of 1997. After a brief presentation of the Variation Principle, students explored use of PC-SPARTAN on a 133 MHz AMD 5X86 with 16 Mb RAM, a CD-ROM and a 1.2 Gb hard drive. Typical examples of plots from an HP 680C inkjet printer are presented along with the finding that the transition state geometry produced by the simple method in PC-SPARTAN is close to that obtained from a more rigorous saddle-point calculation using the GAMESS program on a CONVEX C-210. PC-Spartan V1.1 has very limited import/export features, but the range of graphical presentations is excellent. (3/2,1) SCF calculations for furfural and pyridine (11 atoms) can easily be completed on the 133 MHz 5X86 PC in a three hour laboratory.

DIMERIZATION OF 3-MIETHYLINDOLE WITH ALKYL AND ARYL SULFONIC ACIIDS. Sami Faour and Wayne M. Stalick, Department of Chemistry George Mason University, Fairfax, VA 22030. When 3-methyl indole is reacted with dodecyl benzene sulfonic acid (DBSA) in the presence of a hydrocarbon solvent, two distinctly different compounds are produced. One of these is a white, sharp melting solid and the other is a gum which is relatively insoluble in most solvents. Elemental analysis of the white solid shows that it contains one DBSA per two 3-methyl indole units. ^{1}H NMR and ^{13}C NMR spectra were complex and even though consistent with the analysis, were inconclusive. To simplify the spectral interpretation, *p*-ethyl benzene sulfonic acid, *p*-toluene sulfonic acid, benzene sulfonic acid, ethane sulfonic acid and methane sulfonic acid were all reacted with 3-methyl indole. Each of these acids produced white solids with one sulfonic acid residue per two 3-methyl indole units. The resultant NMR and FTIR spectra of these compounds were clear and definitive. The spectral data collected, along with the proposed structures, will be discussed. The final structural proof by X-ray crystallograpic analysis of the compound produced from *p*-ethyl benzene sulfonic acid clearly shows the atom placement.

HELLMANN-FEYNMAN FORCES IN SMALL MOLECULES. K. Francis, J. Angel, T. Ta, S. Tran, G. Mahadevan and D. Shillady, Department of Chemistry, Virginia Commonwealth University, Richmond, VA 23298-2006. A small gaussian-lobe (3,1/2) basis set has been scaled to give molecular geometries with good agreement to experimental geometries using the one-electron Hellmann-Feynman force. Results are given for HF, H_2O, NH_3 and CH_4. A simple one-electron integral formula is derived in place of the usual gradient calculation which requires up to 2.5 times longer computer time than an all-electron Hartree Fock Roothaan calculation; offering a speed advantage for ab initio molecular dynamics in a gaussian lobe basis. FORTRAN-77 code is shown for the one-electron formula for motion of nucleus "C" relative to spherical gaussians <aA/ at (A_x,A_y,A_z) with exponent a and /bB>. (AB) is the distance between gaussians /aA> and /bB>; (CP) is the distance from the <aA/bB> centroid to nucleus C.

$$F_1(t) = -dF_0(t)/dt.$$

$$\langle aA/(dV_c/dX)/bB\rangle = (2\pi/(a+b))(-1)F_1[(a+b)(CP)^2](2)(a+b)(X-(CP)_x \cdot \exp(-(ab/(a+b))(AB)^2)$$ (analogous for Y and Z)

ISOLATION OF THE FIRST HOMOLEPTIC DIIMENE Pt(IV) COMPOUNDS: SYNTHESIS, DNA-BINDING AND CELL CULTURE STUDIES. R. M. Graner[1], J.N. Granger[2], R. L Davies[2], A. K. Addington[1]*, S. J. Garcia[2], A. K. Clark[1]*, T. Luong[3] * and M. Wilson[1]*. Chemistry Dept., Virginia Military Institute; [2]Biochemistry Dept., Sweet Briar College; [3]Chemistry Dept., Randolph Macon Woman's College. The synthesis and characterization of the first diimene Pt(IV) compounds, $[Pt(1,10\text{-phenanthroline})_3]^{4+}$ **(1)** and $[Pt(4,7\text{-dimethyl-}1,10\text{-phenanthroline})_3]^{4+}$ **(2)** are reported. Agarose gel-electrophoresis was used to explore the DNA-binding interactions of compound **(1)**. Gel-electrophoresis of the supercoiled DNA-plasmid pBR322 was conducted in the absence and presence of compound **(1)**. A 13% decrease in the rate of electrophoretic migration of the DNA plasmid in the presence of compound **(1)** was observed. The chemotherapeutic potential of compound **(1)** was explored with normal and transformed (Rous sarcoma) chicken embryo cells. Transformed cells demonstrated a 67% growth suppression and normal embryo cells demonstrated a 27% growth suppression in the presence of 2.0×10^{-5} M**(1)**.

STUDIES OF SURFACE CHEMISTRY AT NANOGRAM LEVELS USING ION MOBILITY SPECTROMETRY. Juliana Homstead and Edward J. Poziomek , Old Dominion University, Department of Chemistry and Biochemistry, Norfolk, Virginia 23529-0126. The surface chemistry of contraband drugs is very important in many detection techniques. The chemical nature of surfaces may facilitate drug decomposition or serve to stabilize the drugs. We have developed a simple technique to study the chemistry of contraband drugs such as cocaine HCl at nanogram levels. The normal operating modes of an IONSCAN 400 ion mobility spectrometer were adjusted to allow the chemistry of the drugs to be examined in the sample chamber of the spectrometer. For example, a membrane with deposited drug is held in the sample chamber at a specified temperature (typically 50°C or higher) up to 20 seconds with no air flow. An ON-OFF valve was placed in-line just before the carrier gas enters the desorption chamber where samples are heated. This modification allows the gas flow to be manually turned off while the sample is being heated. We have used this technique to examine the pyrolysis of cocaine hydrochloride under a variety of conditions. At the end of the designated reaction time, the air flow is turned on allowing the reaction products and any starting materials to flow into the spectrometer for analysis. This technique has allowed studies of the stability of the drugs at various temperatures on different surfaces. For example, evidence was obtained of cocaine HCl decomposition at 75°C for 5 seconds using Teflon as the support material. The use of this technique has also assisted us in choosing materials for pyrolysis studies in which the goal is to decompose target drugs quickly and efficiently for detection applications.

EXTRACTION OF PREFORMED METAL CHELATES FROM SOILS USING SUPERCRITICAL CARBON DIOXIDE. Gary. L. Long and Edwin. Lancaster, Department of Chemistry, Virginia Tech, Blacksburg, VA 24061-0212. Over the past decade, supercritical fluids (SF) have been investigated for the extraction of metals from contaminated soil samples. To aid in the extractability of these polar contaminants, chelating agents can be added (along with modifiers), to form a non-polar complexes which are extractable in CO_2. Although the formation of these metal complexes occurs with great proficiency in normal solvents, good recoveries are not achieved with SF CO_2. Our work shows this effect to tbe result of the increased acidity of the hydration layer of the sediment particle as CO_2 diffuses into this metal laden region. This acidic environment, from the conversion of CO_2 to H_2CO_3, causes the dissociation of the metal chelate. This reaction is rapid, as all preformed metal chelates undergo dissociation within ten minutes of contact with the supercritical fluids. Attempts to neutralize this effect with Na_2CO_3 and NH_4OH were not successful in remediating this depressing effect. Hence, SF CO_2 can not be used as a quantitative extraction method for metals in contaminated soils.

SURFACE ISOELECTRIC POINTS OF OXIDE-COVERED METALS, E. McCafferty and J. P. Wightman, Dept. of Chem., Virginia Polytechnic Institute and State University, Blacksburg, VA. 24061. The surface isoelectric point for the native air-formed oxide films on aluminum, chromium, and tantalum was determined by measurement of contact angles at the hexadecane/aqueous solution interface as a function of pH of the aqueous phase. Application of Young's equation, the Gibbs equation, and surface equilibria conditions for hydroxylated oxide films gives a mathematical expression which shows that the contact angle goes though a maximum at the isoelectric point of the oxide. The experimentally determined isoelectric point of oxide-covered chromium is 5.2, of oxide-covered aluminum is 9.5, and of oxide-covered tantalum is approximately -0.7. These values are within one to three pH units of the reported isoelectric points for the corresponding bulk oxide powders. Surfaces were cleaned by argon plasma treatment prior to measurement of contact angles, in that XPS measurements showed this treatment to be effective in reducing the thickness of the carbon contamination layer.

USE OF SOLID PHASE MICROEXTRACTION TECHNIQUES IN THE DETECTION OF CONTRABAND DRUGS. V. Tersol, G.E. Orzechowska, and E.J. Poziomek, Dept. of Chemistry and Biochemistry, Old Dominion University, Norfolk, VA, 23529-0126. Solid phase microextraction (SPME) has emerged as a rapid alternative to conventional sample extraction techniques. SPME can be used to sample solids, liquids, and sample headspace. Compounds are sorbed by a stationary phase coated on a fused silica fiber. The compounds are desorbed and analyzed using gas chromatography (GC), and high performance liquid chromatography (HPLC). As a part of the present work we have found that SPME can also be used conveniently with ion mobility spectrometry (IMS). This is a new SPME application. Cocaine and heroin vapors sorbed on a SPME fiber were detected using IMS. The use of SPME-GC or SPME-HPLC has been reported in analysis of urine samples containing cocaine and its metabolites. We are evaluating SPME-IMS, and SPME-GC systems for the detection of cocaine and heroin and their decomposition products in the headspace above surfaces. For example, SPME is used to sample at room temperature the headspace of 0.1 mL vials containing 1.0 μg or less of either cocaine freebase or cocaine hydrochloride. This is followed by analysis using IMS.

MODELING OF METAL COMPLEXES OF DESFERAL AND SALOPHEN. B. N. Ware and J. L. Hess, Department of Biochemistry, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061-0308. Effective antioxidant activity of Mn(III) salophen and Mn(III) desferal has been demonstrated in other laboratories. Hence, the 3D molecular structures of these compounds will help us understand their mode of action. The 3D structures of unsolvated and solvated Mn(III) desferal, Mn(III) deferoxamine, Mn(III) salophen, $[Mn(III)]_2$ $(salophen)_2$, and $[Mn(III)]_2$ desferal were studied using Quanta and Charmm. The relative stability of each compound was compared. Molecular mechanic force fields were utilized in modeling and molecular dynamics simulations. Molecular dynamics simulations were carried out on solvated structures for 5ps at 300 K. Water molecules within 1 Angstrom of the edge of the sphere of solvation were harmonically constrained in order to maintain solvation during dynamics simulations. The aromatic hydroxyl groups contribute to the most stable form of Mn(III) salophen. Mn(III) salophen dimers had only a small favorable interaction energy and readily dissociated into monomers. Unsolvated Mn(III) desferal was more stable than Mn(III) deferoxamine by about 470 kcal/mol. Dynamics simulations revealed that the methyl sulfate group of desferal associates with the Mn(III) rather than the terminal amino group and increased stability about 40 kcal/mol. Molecular mechanics energy minimization calculations revealed that $[Mn(III)]_2$ desferal dissociates into Mn(III) deferoxamine and Mn(III)-methylsulfate. Mn(III) salophen may carry out antioxidant activity on and within cell membranes because it is a stable hydrophobic structure.

TIME-OF-FLIGHT MASS SPECTROMETRY OF INORGANIC COMPLEXES. R. Craig Watson & Brian M. Tissue. Dept. of Chem., Va. Polytechnic Inst. & State Univ. Blacksburg, VA 24061. Using laser-ablation time-of-flight mass spectrometry (TOFMS) we have studied multimetallic inorganic complexes which were synthesized at Virginia Polytechnic Institute. Since coordination complexes have traditionally posed a challenge to characterize via MS due to their low vapor pressures, thermal lability, and often uncontrollable fragmentation, mass spectroscopic studies of these compounds have been few. Even the "softer" ionization techniques such as fast atom bombardment often fail to reveal the molecular ion. In an effort to characterize the inorganic compounds, we combined laser ablation with TOFMS under several sample preparation and ionization conditions. By analogy to the success of MALDI with high molecular mass materials, it seems that the matrix assisted procedure may be useful with high molecular weight coordination complexes as well. After finding that the direct laser ablation of the complex revealed extensive fragmentation, we employed several matrices for a more complete characterization of the inorganic multimetallic compounds.

SURFACE ANALYSIS OF CARBON FIBERS USED IN FIBER/MATRIX COMPOSITES. James P. Wightman and Nursel Dilsiz, Dept. of Chem., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Atomic force microscopy (AFM), x-ray photoelectron spectroscopy (XPS), and contact angle analyses were performed to study the contributions of the carbon fiber surface as well as the fiber/sizing interface to the mechanism of adhesion in fiber/polymer matrix composites. AFM images and surface roughness analyses showed that sizing changes the surface topography on a microscopic scale. The surface energy and atomic concentrations of functional groups of sized Hercules AS 4 carbon fibers decrease gradually compared to the unsized fibers. Surface functional groups and the surface energies of fibers are critical properties in predicting fiber/matrix adhesion. Angle dependent XPS, voltage contrast XPS, and perimeter measurements revealed that the thickness of poly(thioarlyene phosphine oxide) sizing on the carbon fibers was greater than for Ultem™ sized carbon fibers. [Work supported by the NSF Science & Technology Center at Virginia Tech]

PHOTOCHEMICAL ISOMERIZATION STUDIES OF TRANS-RESVERATROL. R.L. Williams, Gary Morris and Robin Blanche, Old Dominion University Enological Research Facility, Dept. of Chem./Biochem., Old Dominion Univ., Norfolk, Va.23529. Trans-resveratrol has recently been shown by this laboratory to be a potent phytoestrogen with anti-estrogenic activity in human breast cancer cells in culture. Trans-resveratrol is easily converted to it's cis geometric isomer photolytically. Cis-resveratrol appears to exhibit some rather different activity compared to the trans isomer and the isolation and characterization of this isomer is of major interest to this laboratory. The photolytic transformation of the trans to the cis isomer and the relative stability of the trans isomer in solution appears to be dependent on the solvent polarity. When trans-resveratrol is irradiated at high wavelengths for an extended period, there appears to be an additional photolytically induced reaction. Preliminary evidence would suggest ring closure of the cis isomer to a phenanthrene structure which may be capable of further cyclization to a phenanthrofuran structure. Similar photolytic reactions have been observed with trans-stilbene and trans-tamoxifen. The conditions of the photoisomerization and subsequent reactions will be described.

NATURAL PHYTOESTROGENS IN WINE, R.L. Williams, Mark Elliott and Carolyn Snare, Old Dominion University Enological Research Facility, Dept. of Chem./Biochem., Old Dominion Univ., Norfolk, Va. 23529. This laboratory has recently become very interested in natural phytoestrogenic agents; organic compounds from plants that exhibit estrogenic or anti-estrogenic activity. A variety of flavonoid and isoflavonoid compounds have been shown to exhibit such activity and several of these, namely Genestein, Daidezin and Apigenin have been described as components of wine and certain spirits. These compounds bind effectively to the estrogen receptors of human breast cancer cells in culture and may provide for some anti-estrogenic activity in humans with responsible moderate consumption. Trans-resveratol, a polyphenolic stilbene, has recently been described by this laboratory as an effective anti-estrogenic phytoestrogen in human breast cancer cells in culture. The structure activity relationship of this compound will be compared to trans-tamoxifen, a clinically prescribed anti-estrogenic agent for the treatment of human breast cancer. The binding studies with trans-resveratrol and the cytotoxicity of this agent to two human breast cancer cell lines in culture will be described in comparison to several other anti-estrogenic agents including tamoxifen and Genestein.

Computer Science

LISTPROC: A WEB-BASED MAILING LIST ADMINISTRATOR. Brian Rickabaugh & Anil M. Shende, Dept. of Mathematics, Computer Science, and Physics, Roanoke Col., Salem, Va. 24153. E-mail mailing lists are quickly becoming an effective means of situation and event advertisement in organizations. With the constantly increasing use of the Internet and Intranets within these organizations, a web-based, common-gateway interface (cgi)-driven administrator for mailing lists seemed a natural progression. Being web-driven gives a popular, platform independent means of administering any mailing list. From the Web, users can perform tasks that affect themselves, such as deleting their names from lists. Super-Users can create new lists and control access to these lists. Super-Users can view all access and errors logs for all of the created lists. List administrators can alter the lists for which they have access. Filtering and access control exists on an e-mail address level for local users or fully qualified e-mail addresses. All editing related activites are controlled via the local unix-user passwords. The future for listproc promises limited IP subnet access control, as well as dynamic mailing list creation via database queries.

INTELLIGENT ABSTRACT DATA TYPES. Ivy N. Carter, & Robert A. Willis, Jr., Dept. of Computer Science, Hampton Univ., Hampton, Va. 23668. This presentation will focus on continuing research in intelligent abstract data types (IADT). An IADT is an abstract data type which "intelligently" manages its internal data structures and also runs concurrently with its clients. The focus on this research is to investigate the situations in which a list IADT changes its internal data structures due to external demands. There are two general paradigms that can be used to trigger a change from one data representation to another: time over space and space over time. Our research efforts are presently focussed on investigating the time over space paradigm. This presentation will present background information on IADTs and the time over space paradigm. We will also discuss the parameters chosen to implement data representation changes using this paradigm.

AN INTRANET FOR MARY WASHINGTON COLLEGE. Peter H. Hua, Mary Washington Col., Fredericksburg, Va. 22401, & E. Ackermann, Dept. of Computer Science, Mary Washington Col., Fredericksburg, Va. 22401. There are two methods often used by website administrators to enforce privilege associated password authentication. The first uses the web browser to pop-up a window which asks the user for a username and password. Although simple to implement, this method will only block users from a particular directory of files, it does not block users from individual files within a directory. Once a user gains access to a file within a directory, he automatically has access to all other files within that directory. This method is controlled by two files on the web server often named .htaccess and .htpasswd. A .htaccess file is in all directories that require authentication. The .htpasswd file contains all valid usernames and their encrypted passwords. The second type of authentication uses CGI scripts and the HTML "FORM" tag to authenticate users, this method is often an extension to the first method because CGI scripts allow administrators to associate "privileges" to users. By using CGI scripts, an administrator gains powerful features because he has access to other files on the web server's hard drive. CGI scripts can limit what a user sees, read in the privileges of a user as well as modify information. Both methods offer security features parallel to that of UNIX password encryption since both use UNIX's "crypt" program for password encryption and comparison. More information is available at http://www.mwc.edu/~phua17gj/intranet.

A NEW APPROACH TO RAY TRACING USING WAVE THEORY OF LIGHT. Richard E. Pingry, & Anil M. Shende, Dept. of Mathematics, Computer Science, and Physics, Roanoke Col., Salem, Va. 24153. Ray tracing is a simple yet powerful method of generating images from three dimensional data. Traditionally, the data structures that describe light in ray tracing ignore the wave properties of light. Addressing this phenomenon is a ray tracer would allow effects like refraction, dispersion, and interference to realistically affect the generated image.

SNAKE HUNTS IN HYPERCUBES: A SURVEY, SOME CONJECTURES, AND EMPIRICAL SUCCESS. Anil M. Shende, Dept. of Mathematics, Computer Science & Physics, Roanoke College, Salem, VA 24153. The problem of finding the longest snakes in hypercubes was posed in 1958 in the contxt of coding theory, and is still an open problem. We define the problem, briefly survey the known results, discuss some new methods, and partial success, of trying to solve the problem, and present some conjectures based on these new methods.

EMPIRICAL RESULTS FROM A SONAR TRANSDUCER TO MICROCONTROLLER INTERFACE. Dan Werner, & Dr. Rhonda Eller-Meshreki, Dept. of Computer Science, Randolph-Macon Col., Ashland, VA 23005. Sonar transducers initiate a sonar signal and receive the reflected signal as an echo. If a sonar transducer is interfaced to a microcontroller board, then software can be written to determine the distance between the transducer and the object from which the sonar signal was reflected. This is accomplished by multiplying half of the round-trip sonar signal time by the speed of sound. This paper describes summer research completed on a Council of Undergraduate Research CURSOR award in which a hardware interface for a Polaroid sonar transducer was constructed to connect it to a Rug Warrior microcontroller board. Software was also written to allow the microcontroller board to control the sonar transducer. Once a reliable software/hardware interface was constructed, experiments were conducted to measure the sonar beam dispersion and the range of distances that could be measured reliably.

PSEUDO CLASSIFIERS TO REDUCE SEARCHES: REVISITED. Alec White, & Robert A. Willis, Jr., Dept. of Computer Science, Hampton Univ., Hampton, Va. 23668. A basic problem in searching is the expense of performing the search. In artificial intelligence (particularyly expert systems) considerable computational time is expended in searching. One solution to this problem is a mechanism that could be built to reduce the number of searches required in certain types of parallel systems. In order to reduce the number of searches, these mechanisms would possess the ability to "retain" the results of past searches. The mechanism is called a pseudo classifier and is based on the classifier concept proposed by L. B. Booker, D. E. Goldberg, and J. H. Holland in "Classifier Systems and Genetic Algorithms" (Artificial Intelligence, 40, 1989 235-282). The purpose of this research project is to continue the ongoing pseudo classifier research. Particularly to test the Taxi Simulation Program (TSP) which implements a novel search algorithm using pseudo classifiers and to begin a comparison of various classical search algorithms to the algorithm presently in use. This presentation will present background information on pseudo classifiers, the search algorithm presently in use, and one or two classical search algorithms. Finally, the current state and future plans for the project will be discussed.

Education

COGNITIVE CONNECTIONS: PRESERVICE TEACHERS LEARN GEOMETRY. Bobbye H. Bartels, Dept. of Math., Christopher Newport Univ., Newport News, VA 23606. Due to the influence of mathematics education reform documents like the NCTM Standards, making connections between mathematics concepts is a current emphasis in mathematics education; however, little is known about the effect of instruction on the way students make these cognitive connections. As part of a mathematics methods course, preservice elementary teachers learned to construct concept maps. To gain a better understanding of how students make cognitive connections, the concept maps and student discussion transcriptions were qualitatively analyzed. The analysis showed strong, correct, and complete cognitive connections were made when the instructor (a) made a connection explicit, (b) revisited the connection frequently, and (c) adequately discussed characteristics using physical models. Students' incomplete cognitive connections were difficult to change, most students did not take ownership for making their own connections, and prior learned knowledge sometimes interfered with new knowledge.

BRIDGING THE CULTURE GAP: SCIENTIFIC RESEARCH AND THE SCIENCE CURRICULUM. Michael Bentley and George Glasson, Dept. of Teaching and Learning, Virginia Tech, Blacksburg, VA 24061. The context of this paper is research and evaluation being conducted of the 1997 state conference, "Enhancing Instruction in Science, Math, and Technology," a program initiated by the new Virginia Tech Institute for Connecting Science Research to the Classroom. This study focuses upon identifying aspects of the nature of science, the science-technology-society interaction, and scientific knowledge communicated via Conference presentations. Tentative findings include that many sessions mirrored the Institute's mission and that, overall, the Conference made a positive contribution to science education in Virginia.

PRE-SERVICE SCIENCE TEACHERS' BELIEFS ABOUT DIVERSITY. Brenda R. Brand and George E. Glasson, Department of Teaching and Learning, Va Tech., Blacksburg, Va. The influences of the background experiences of five preservice Science teachers on their beliefs about diversity were the focus for this study. These individuals were followed throughout their teacher preparation program. The data for this study consisted of interviews, conducted before and after entering field experiences in schools. Data also consisted of any relevant written assignments from science methods classes. In this presentation, a case study of one individual will be reported. This report will consist of the rationale for conducting this research study, supported by quotes made by the student teacher as influenced by his subcultures. Initial data analysis has shown that perceptions on the role of diversity within the classroom directly relates to the student teacher's life experiences.

BREAKING PARADIGMS IN TEACHING BIOLOGY. Arthur L. Buikema, Jr., Dept. Of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061-0406. Breaking paradigms is frightening to most teachers. Basically it means letting go of control and inviting students to be part of the syllabus development. This paper will discuss three introductory Biology classes, General, Principles and Honors, Biology, that places the burden to learn the material on the student, not the teacher. The exact teaching strategy varies with the size of the class, not a perception of student ability. Classes range from 35 to 210 students each. The courses incorporate these key points: no lecture; student assignment-orientation; integration of on-campus and off-campus students; web-based instruction; open-book, take-home exams; collaborative learning; peer critique; writing intensive; critical thinking; and problem solving. Student response and participation have been overwhelming. The major student comment is "thanks for not lecturing."

CONNECTING SCIENCE RESEARCH TO THE SCHOOL SCIENCE PROGRAM: RESULTS OF THE STATE CONFERENCE "ENHANCING INSTRUCTION IN SCIENCE, MATH, AND TECHNOLOGY." George E. Glasson and Michael L. Bentley. Dept. of Teaching and Learning, Virginia Tech, Blacksburg, Va. 24061-0313. The evaluation data from a statewide conference associated with the Virginia Tech Institute for Connecting Science Research to the Classroom was shared. This conference, which took place in spring 1997, was designed to enhance instruction in science, math, and technology by translating scientific research findings to public school teachers. Four criteria were used to evaluate participants' perceptions of the conference and the attainment of institute goals: (1) nature of science; (2) science-technology-society; (3) science concepts/principles; and (4) connections to the classroom. The results of the evaluation indicate that the conference was successful in encouraging connections between science, mathematics and technology. Participants indicated that attainment of conference goals were met on the four criteria. A variety of different research protocols were shared from different science disciplines that connected societal needs. Participants also thought the presentations strongly emphasized scientific concepts that cross disciplinary boundaries.

ENGINEERING PHYSICS: A NEW COURSE AT THE CHANTILLY PROFESSIONAL TECHNICAL CENTER. Ken Lawwill, Chantilly Professional Tech. Ctr., Chantilly, Va., 20151–2600. Due to transportation limitations and the new graduation requirements, the two-year sequence of Principles of Technology will be consolidated into one-year course offerings. For the general diploma, Engineering Physics (9811) has been proposed. It will consist of a lab intensive overview of the fourteen sections of P. of T. Approximately fifty labs will be performed. Prerequisites: Algebra I and two prior lab sciences. For the Advanced Studies Diploma, Accelerated Engineering Physics (4520) has been proposed. It will count as a second physics course. Approximately seventy P. of T. labs and twenty computer assisted labs will be performed. Additionally, computers will be utilized to perform analysis of data, run simulations, and prepare lab reports. Prerequisites: two prior lab science courses and enrollment in Geometry or beyond. Physics I will be a suggested pre- or co-requisite. For students anticipating employment or further education in engineering, science, and technology, these courses will provide: 1) focus on human innovation, devices, systems, and structures, 2) unifying concepts across the systems of linear and rotational mechanics, electronics, hydraulics, pneumatics, and thermodynamics, and 3) unique and more extensive laboratory experiences. In summary, these course will provide better "prior knowledge" for students' future employment and education.

MENTORING A NEW SCIENCE TEACHER: THE ENLIGHTENMENT OF A SUCCESSFUL ENGINEER. Ken Lawwill, Chantilly Professional Tech. Ctr., Chantilly, Va., 20151–2600. Making a successful transition from another field into teaching requires a great deal more than patience and a desire to share years of acquired knowledge. Success in other fields does not ensure success when dealing with problems of instructional strategies, motivating apathetic students, equipment shortages/malfunction, attendance, and discipline. In addition to unforeseen institutional difficulties impeding student's learning , one also has to reassess one's individual traits and the ensuing student reaction and response. Most importantly one has to learn to : Teach the students the subject; not teach the subject to the students.

THE BIOLOGICAL SCIENCES INITIATIVE AT VIRGINIA TECH. Muriel Lederman, Department of Biology, Virginia Tech Blacksburg VA 24061-0406. Virginia Tech is the land-grant institution for the Commonwealth of Virginia; its curricula in the life sciences are spread across fifteen departments in five colleges. Recently, a 50% increase in life sciences undergraduates coincident with a dramatic reduction in state support for higher education resulted in increased class size, inability of students to schedule required courses, and lack of more specialized offerings. At the request of the faculty, the Biological Sciences Initiative (BSI) was formed. It coordinates improving the undergraduate life sciences experience by providing programs for which regular university funding is not available. Included are cross-college teaching and advising; strategies that allow the timely completion of undergraduate degrees; developing tracks in disciplines such as neuroscience and plant biology that take advantage of the expertise of faculty members in different departments; and funding and encouraging undergraduate research and teaching opportunities. Collaborating with other campus programs, the BSI helps faculty improve the teaching-learning process, by providing the tools and personnel to take advantage of learning theory, instructional design, and educational technologies. This cooperative, collaborative approach overcomes artificial boundaries and is a model for an easily transferable, university-wide re-structuring in the life sciences at land-grant institutions.

AQUARIUMS AS CLASSROOM LABORATORIES. Eugene G. Maurakis, Office of Museum Scientist, Science Museum of Virginia, 2500 W. Broad Street, Richmond, VA 23220. The Science Museum of Virginia has opened the Hirschler Aquarium Exhibition, featuring freshwater fishes of the James River. Nineteen species of freshwater fishes from the Montane, Piedmont, and Coastal Plain Provinces are displayed with interpretative graphics which can be used as tools in learning about the ecology, distribution, food webs, and community interactions of fishes in the James River by the general public and K-12 school teachers and students. The exhibition is accompanied by three educational publications: an 8-page coloring book; a guide to common freshwater fishes in the James River; and a 69-page, indexed teacher's guide composed of nine step-by-step activities, glossary, and hardcopy and internet resources for classroom instruction applicable to Virginia Standards of Learning. Supported in part by the Edward and Elizabeth Hirschler Aquarium Endowment Fund

CONCEPT MAPPING TO EXPLORE STUDENT PERCEPTIONS IN SCIENCE. Woody McKenzie, & Sara Plante*, Dept. of Chemistry & Physics, Radford Univ., Radford, VA 24142.<wmckenzi@runet.edu> Concept mapping was integrated into a process-oriented Physical Science course aimed primarily at K-8 pre-service teachers. Pairs of students constructed maps early and late in the course to address the question "What is science?". Students showed overall improvement in organization and coherence of maps completed later in the course. An analysis of content related concepts vs. process related concepts presented found that students showed a more process oriented view of science after their course experiences. Concept maps were computer-generated using freeware for the Macintosh platform. A list of useful references and guidelines for instruction of concept mapping is provided. While this study is situated in science education, it should also be emphasized that similar studies using this approach should work well in other disciplines.

SCOPE, SEQUENCE, AND COORDINATION—A HISTORICAL PERSPECTIVE. Pamela C. Turpin, Dept. of Chem., Roanoke College, Salem, Va. 24153. In 1992, the National Science Teachers' Association proposed three factors to be considered in the development and designing of science curricula for secondary schools –scope, sequence, and coordination. The foundations for the use of these three processes in curriculum development may have been laid over one hundred years ago. This research examines some of the ideas expressed by educators interested in the science curriculum one hundred years ago and the relationship of these ideas those suggested by the NSTA in 1992.

GENETICS IN THE CLASSROOM: DEVELOPMENT OF A TEACHER'S GUIDE ON HUMAN GENETICS. Deborah Wells, Eugene Maurakis, and Joann Bodurtha*. Science Museum of Virginia, 2500 West Broad St, Richmond, VA 23220 and Dept of Human Genetics, Medical Col of Virginia/Virginia Commonwealth Univ, Box 980033, Richmond, VA 23298. A teacher's guide on human genetics was developed for use in middle and high school classrooms. The guide is the result of surveying 84 science teachers in the Richmond area. Of these teachers, 84.5% expressed a need for more materials for teaching genetics in the classroom, particularly hands-on activities and information about recent advances in genetics. The guide consists of hands-on activities in four areas of genetics: (1) general genetic principles (including Mendelian inheritance and probability exercises), (2) molecular genetics and cytogenetics (with activities about DNA fingerprinting and chromosome analysis), (3) applications of new genetic technology (with emphasis on genetic counseling, ethical issues, and the Human Genome Project), and (4) common genetic conditions (summary information about some of the more common genetic conditions). A resource section is included to provide teachers with organizations and websites to contact for further information about human genetics.

INTERACTIVE LEARNING ABOUT BIOLOGICAL TIMING. Laura A. Young and Eugene G. Maurakis, Ph.D., Office of the Museum Scientist, Science Museum of Va., Richmond, Va., 23220. The Science Museum of Virginia currently is developing an interactive exhibition about biological timing and rhythms, an emerging area of research that will impact future thought and experimentation in biology and medicine. The exhibition is designed in four sections that will give visitors an introductory understanding of the wide occurrence of biological rhythms in nature, the relationship between biological rhythms and physical cycles, the selective advantage conferred upon organisms by biological timing structures, and the role of biological timing in human activities. Individual exhibit sections focus on biological timing behind known phenomena, including the sleep/wake cycle, hibernation, migration and jet lag. Visitors also will encounter new areas of research, including the physiology of biological timing, entrainment, clock mutations, and therapy for timing problems. A teacher guide providing interactive activities, reference material, and correlated with Virginia Standards of Learning accompanies the exhibition. It is designed as a pre-visit resource and as a compliment to classroom educational objectives. (Supported in part by a private Richmond foundation, Moses D. Nunnaly Charitable Trust, Richard and Caroline T. Gwathmey Foundation, Mary Morton Parsons Foundation, Windsor Foundation, and Merck Company Foundation.)

Environmental Science

PHENOTYPIC CHARACTERIZATION OF AN EXTREMELY HALOPHILIC ARCHAEBACTERIUM. Kimberly S. Barnes and C.D. Litchfield, Dept. of Biol., George Mason Univ., Fairfax, Va. 22030. An extremely halophilic archaebacterium was isolated from a solar evaporator located in Qaunghai, PRC. The organism (C-7) was cultivated at 37°C on modified casamino acids medium (MCA), containing a salt concentration of 20% (wt/vol) with an adjusted pH of 5.15. C-7 is a gram negative, nonmotile rod. It is oxidase and catalase positive, does not reduce nitrate, and does not hydrolyze starch. Acid is produced from glycerol; however, glucose, lactose, and sucrose are not utilized. Of the 14 antibiotics tested, sensitivity was observed only with novobiocin, bacitracin, and anisomycin. NaCl/temperature requirements ranged from 20%-30% NaCl at temperatures of 25°-50°C, with optimal growth occurring at a salt concentration of 25% at 42°C. The pH optimum ranged from 5.6-8.5, with stock cultures growing routinely at pH 5.1. The minimum Mg^{2+} requirement was 0.005M, with an optimum requirement of 0.02M. Growth was inhibited at levels exceeding 1.0M. Supplementation of MCA with a seven-trace element solution resulted in increased growth, but was not required. Based on polyphasic taxonomy, the organism is tentatively identified as *Halorubrum chinensis* (n. sp.)

ECOLOGICAL ASSESSMENT OF THE EFFECTS OF DEVELOPMENT ON MASSAPONAX CREEK, SPOTSYLVANIA COUNTY, VIRGINIA, M.L. BASS', A. FROME', Department of Environmental Science and Geology, Mary Washington College and John Tippett, Friends of the Rappahannock, Fredericksburg, VA. The rapid urbanization of parts of Spotsylvania County has shifted the attention of nonpoint source pollution from agriculture to commercial and suburban development. Investigators using the Izzak Walton League, SOS protocol sampled a rural low input stream, Hunting Run and an urbanization impacted stream Massaponax Creek. Massaponax Creek exhibited higher sediment deposition, bank erosion, lack of riparian vegetated borders in many developed areas and a decrease in quality of the macrobenthic habitat. Hunting Run had a higher indices for sensitive macroinvertebrates. Reparation of the riparian vegetation in areas along the stream has given better water quality. Repair efforts are continuing.

BONE STRENGTHS OF COLORADO MULE DEER IN RELATION TO FLUORIDE CONTENT. L. M. Borrero-Yu, P. F. Scanlon, Dept. of Fisheries and Wildlife Sciences, VPI & SU, Blacksburg, VA 24061. J. A Wilson, Dept. of Biological Systems and Engineering, VPI & SU, Blacksburg, VA 24061, and M. A. Cochran*, VPI & SU, Dept. of Fisheries and Wildlife Sciences, Blacksburg, VA 24061. Mule deer (*Odocoileus hemionus*) from the US Air Force Academy (USAFA) at Colorado Springs, CO were observed with brittle antlers and tooth lesions. The ingestion of high concentrations of fluoride have been related to tooth lesions and bone fragility. Deer jaws, donated by hunters, collected between 1993 through 1995 from the USAFA (n=193), Piñon Canyon Maneuver Site (PCMS), Model CO (n=22) and Game Management Units (GMU's) in northwestern CO (n=16) were used to determine the relationship between fluoride contents and bone strength. Bone fluoride concentrations and bone strength were determined using ion selective electrode and Instron apparatus, respectively. The bone strength was measured as Shear Force and Shear Stress. In deer (> 1.5 y.o.), mandibular bone fluoride concentrations (μg/g d.w.) were higher ($P<0.001$) at the USAFA than in PCMS and GMU's (medians= 848.7, 494.7, 446.0, respectively). The Shear Force (Newtons) was lower in deer ($P<0.001$) at the USAFA than in those at PCMS and GMU's (medians= 2359, 4007, 2613, respectively). No differences ($P=0.424$) were found among the three sites in the Shear Stress (MPa) measurement which takes into account the cross-sectional area of the bone (medians= 22.61, 24.56, 22.69, respectively). Within deer from the USAFA (n=193) a poor relationship was found between fluoride concentrations, Shear Force ($P<0.008$, $R^2=0.0367$, and Shear Stress ($P=0.711$, $R^2=0.0007$). Although weaker bones were found in deer from the USAFA, the data do not support a strong relationship between bones strength and fluoride concentrations.

ASSESSING THE SURVIVABILITY AND GROWTH OF ATLANTIC WHITE CEDAR (*CHAMAECYPARIS THYOIDES* (L.) B.S.P.) IN THE GREAT DISMAL SWAMP AND THE U.S. NAVAL SECURITY GROUP ACTIVITY NORTHWEST, CHESAPEAKE, VIRGINIA. D. A. Brown, Geo-Marine, Inc., Newport News, Va. 23606, & R. B. Atkinson, Dept. of Biol., Chem. and Env. Science, Christopher Newport Univ., Newport News, Va. 23606. Atlantic white cedar swamps in Virginia and North Carolina have been cleared for lumber and agriculture since the colonial era and less than 10% of the stands remain. Methods for reestablishing the dominant tree species, Atlantic white cedar (*Chamaecyparis thyoides* (L.) B.S.P) have not been developed. In this study, the effect of physical and competitive interactions on *C. thyoides* seedling growth and survivorship is examined at two sites. Site One is located in a recently abandoned agricultural field near a river basin in southeastern Virginia. Conditions for planting on this site were optimal and site preparation was limited to clearing herbaceous materials from a 0.20 ha area with hand-operated brush cutters. There were 259 bare-root seedlings planted in six transects across a 2.0% slope. First-year survivorship was 97.3% and growth was 138.9%. Site Two is in the Great Dismal Swamp National Wildlife Refuge. In 1990, a 2.8 ha portion of a senescent Atlantic white cedar stand was cleared of all vegetation, and 241 bare-root seedlings were planted in February 1996. First-year survivorship was 97.1% and growth was 183.7%. Within-site differences in growth appear to be correlated with elevation, and data analysis of soil moisture and vegetative cover is continuing. (Supported by the U.S. Navy and the U.S. Fish and Wildlife Service.)

PHYTOPLANKTON COMMUNITIES IN THE MARY WASHINGTON COLLEGE MICROCOSM AND THE YORK RIVER: A COMPARATIVE STUDY. Virginia Leontyne Clarke and S. B. Gough, Dept. of Biol., Mary Washington Col., Fredericksburg, Va 22401. Microcosms attempt to faithfully represent natural ecosystems so they can more readily study the latter. With good emulation simulated ecosystems can be used as experimental management tools. Obviously, adequate model fidelity must first be proven. This study was used for this purpose, comparing emulation constancy between a microcosm and a mesohaline portion of the York River by comparing the dynamics of phytoplankton in both systems. Community structure was ascertained by examining the Simpson diversity index, species richness and relative abundance of various taxa. The data suggested anomolies in the two systems, which could be due to the intermediate disturbance hypothesis, marine pulsing and/or current limitations of the microcosm.

INTERDISCIPLINARY STUDY: IN AND AROUND THE HEADWATERS OF THE POWELL RIVER--AN ECOLOGICAL STUDY, YEAR 1. W. Crouse[1], J. Rockett*[2], J. Spurlock*[3], S. Cromer*[4], and S. Rhea*[5], Depts. of [1]Natural Science and [5]English, [2]Director PRP Educational Center, Clinch Valley College, [3]Clintwood High School, and [4]Tazewell Middle School. Summer 1996 marked the twelfth annual Southwest Virginia Summer Scholars Program of Clinch Valley College. The Summer Scholars Program is an interdisciplinary, hands-on educational program which combines biology, chemistry, statistics, and communication skills. The central theme of the program was the measurement of the quality of the headwaters of the Powell River. The students, with faculty supervision, investigated the botanical diversity adjacent to the stream, the macroinvertebrate diversity of the stream, the chemistry (pH, hardness, dissolved oxygen, metals) of the water, and the nutrient composition of the soil adjacent to the stream at three sites of one branch of the Powell River, Wise County, VA. The overall quality of the stream and its surroundings was good despite surface and deep mining in the area. Water sulfate levels were high.

FACTORS AFFECTING THE UTILIZATION OF CLUPEID PREY BY SPORTFISHES IN TWO VIRGINIA RESERVOIRS. M.J. Cyterski, J.J. Ney, C.C. Bonds*, and R.O. Small*. Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061. Predator consumption of prey in reservoir systems is determined by three components of prey availability: morphology, distribution, and behavior. We examined the effect of these three factors on gizzard shad and alewife predation by striped and largemouth bass in two Virginia reservoirs - Smith Mountain Lake (SML) and Claytor Lake (CL). We expected to see differences in prey use in each lake due to distinctive site characteristics. Despite the recent introduction of gizzard shad into CL, striped bass consumption (by percent weight in the diet) of shad in the fall exceeded that of stripers in SML, where shad have been present for 34 years (89% vs. 62%, respectively). CL largemouth bass, on the other hand, ate less shad in the fall than their con-specifics in SML (16% vs. 37%, respectively). Shad and alewives grow faster and reach greater lengths in the more eutrophic CL. In SML, predators chose clupeid prey much smaller than their throat diameters would permit, indicating a behavioral preference for these smaller prey. In CL, striped bass ate shad of larger sizes, possibly due to increased growth rates of young shad in this system. In SML, striped bass did not consume shad during the summer months when water temperatures limited the former to the cool, well-oxygenated regions of the lower lake. At this time, shad were primarily uplake in warmer, more shallow waters. Largemouth bass and shad occupy similar habitat during these months, thus shad continued to be a significant dietary component for these predators (65% by weight). We suspect the same distributional limitation affects striped bass in CL in summer, marking the importance of the deep, cool-water alewife as prey for striped bass during this period.

IMPACT OF LOCALIZED HARVEST ON THE SMALLMOUTH BASS POPULATION OF LAKE MOOMAW, VIRGINIA. D.A. Garren, J.J. Ney, S.L. McMullin*, Dept. of Fisheries & Wildlife Sciences, Va. Polytechnic Inst.& State Univ., Blacksburg, Va 24061, and P.A. Bugas*, Va. Dept. of Game & Inland Fisheries, Verona, Va. 24482. Smallmouth bass congregate in the headwaters of Lake Moomaw, a 1024-ha flood-control reservoir, during the spring spawning period, where they are vulnerable to a shore-based, harvest-oriented fishery. We estimated the headwaters bass harvest in 1995-96 by creel survey, then used tagging and telemetry to assess the significance of the harvest to the whole-lake bass population. Electrofishing surveys of juvenile bass distribution were conducted to examine impacts on recruitment. The headwaters fishery accounted for 17% of the annual smallmouth bass harvest in Lake Moomaw; the combined annual harvest removed only 12% of the adult population. Bass spawning occurred throughout the lake. Only a subgroup of transient fish spawned in the headwaters, and juvenile bass were distributed throughout the lake. The headwaters fishery is a high-profile activity which, during 1995-96, had a low and sustainable impact on the Lake Moomaw smallmouth bass population.

IMMOBILIZATION OF SOLUBLE NITROGEN AND PHOSPHOROUS BY WASTE CARBON SOURCES IN AEROBIC POULTRY LITTER COMPOSTS. Samantha Hauser, Paula Kincaid and June H. Middleton, Dept. of Biol., James Madison University, Harrisonburg, VA 22801. Poultry litter (poultry waste plus bedding material) is high in nitrogen and phosphorous. When applied to agricultural soils during the growing season, the soluble nitrogen in poultry litter is used effectively by crops as a fertilizer. However, when poultry litter is applied to fallow fields, soluble N and P leach into ground water causing non-point source pollution. We were interested in determining which farm and urban waste sources high in carbon might most effectively be co-composted with poultry litter (PL) to stabilize the excess nitrogen and phosphorous. A lab scale passive aerobic composting system (PACS)was used to evaluate each C source. Triplicate samples of poultry litter and switchgrass or shredded white paper were mixed; the initial C:N ratio was set at approximately 25:1. Artificial composting was carried out by incubation for 14 days each at 58C, 37C and 24C with moisture content maintained at approximately 60%. The measured composting parameters included: pH, soluble nitrate and phosphorous, total C: N, microbial respiration and differential microbial community succession. The lab scale PACS provided reproducible composts as measured by chemical and microbiological parameters. However, the six week composting period did not produce mature compost as determined by microbial respiration.

PHYTOPLANKTON DYNAMICS IN LAKE BARCROFT, VIRGINIA: 1995-96. Saiful Islam and R. Christian Jones, Dept. of Biology, George Mason University, Fairfax, VA 22030. Lake Barcroft is a reservoir at the confluence of Holmes Run and Tripps Run in Falls Church, Virginia. It is a recreational lake for its 1,000 residents. The Lake is artificially destratified during May through October since 1987. Samples were collected bi-weekly from May through October in 1995-96. The samples were preserved, enumerated and identified. The phytoplankton densities in 1995 were higher than in 1996. Blue-greens were dominant in 1995-96 samples. The density of blue-greens in 1995 were much higher than the density of blue-greens in 1996. 199596 density data shows the blue-greens were still the major phytoplankton. They have the higher.densities and higher species numbers in the Lake Barcroft.

PERIPHYTON DYNAMICS AT A MESOHALINE SITE IN THE YORK RIVER, VIRGINIA, COMPARED TO A MESOCOSM. Aimee Lemieux and S. B. Gough, Dept. Of Biol. Sciences, Mary Washington Col., Fredericksburg, Va. 22401. Marine phytoplankton may serve as indicator species of water quality in that varying nutrient levels greatly influence the growth rates and numbers of various species. This research showed the comparison of water quality in both sites and evaluated the periphyton species present, thus serving as an assessment of the accuracy of the simulated ecosystem. By examining the differences between the two systems, it may be possible to predict conditions in the wild and avert or ameliorate adverse effects. Periodic sampling showed that the mesocosm fostered a large number of pennate diatoms and spinney blue-green algae, while the river samples displayed pennate diatoms in much lower levels. The mesocosm was of small size, however, and it supported higher nutrient levels. These findings support the idea that while a mesocosm may be a very valuable tool, one of such small scale may result in inaccuracies

TEN YEAR TRENDS IN DIVERSITY AND ABUNDANCE OF ZOOPLANKTON IN CHESAPEAKE BAY. G.B. Mateja, K. E. Carpenter (Dept. of Biol. Sci., Old Dominion University, Norfolk, VA 23529) & R. Alden (AMRL, ODU, Norfolk, VA 23529). An on-going, long-term water quality monitoring program is discussed for the Chesapeake Bay and several major tributaries. Over ten years of data have been analyzed to characterize the Virginia Chesapeake Bay zooplankton and water quality trends. Long-term trends of the Bay's tributaries and mainstem based on the zooplankton diversity and abundance data are presented. The mainstem, plus the Rappahannock and Elizabeth Rivers showed increasing trends of zooplankton abundance, in contrast to the tidal James and York Rivers. Supported by the Virginia Department of Environmental Quality and the US EPA.

CLEAN WATER BLUES: RESPONSE OF RESERVOIR FISHERIES TO REDUCED NUTRIENT LOADING. John J. Ney and Michael J. Cyterski, Dept. of Fisheries &Wildlife Sciences, Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061. Nutrient reduction(oligotrophication) occurs in reservoirs as the result of nutrient trapping by upstream impoundments or operation of advanced waste treatment plants on inflowing rivers. Case studies and regression analysis of the relationship between the concentration of the primary limiting nutrient, phosphorus, and fishery productivity demonstrate that oligotrophication is accompanied by substantial loss of forage-fish and sportfish biomass. Phytoplankton as well as fish productivity are each highly correlated (r=0.7-0.9) with total phosphorus concentration in lakes and reservoirs. Frequent algae blooms occur in temperate reservoirs when phosphorus exceeds 40 *ug*/L while fishery productivity does not peak at <100*ug*/L, providing the basis for conflicts between "clean lakes" and "good fishing" advocates. Remedial measures to restore fishery productivity after oligotrophication include in-lake fertilization and biomanipulation of the food web; both are likely to be unsuccessful. A more promising approach is to prevent undesirable oligotrophication through informed decision making based on appreciation of the consequences of nutrient reduction to the fishery resource.

THE METABOLISM OF PYRENE BY TWO MICROORGANISMS. Jonathan D. Ottke and Carol D. Litchfield, Dept. of Biol., George Mason University, Fairfax, VA 22030. Pyrene, a suspected carcinogen and constituent of creosote, can be used as a sole carbon and energy source by various microorganisms which makes the bioremediation of pyrene possible. Two microorganisms which grow on pyrene were identified and their growth on pyrene was examined. The microorganisms were identified using standard methods: Fatty Acid Methyl Ester Analysis, BIOLOG and 16S rRNA analysis. The first isolate 29L was identified as a member of *Pseudomonas fluorescens/putida* clad and the yeast 11y is tentatively identified as *Geotrichum canidum*. The two microorganisms were grown with and without nutritional supplements in sidearm flasks on nitrate, ammonia, and ammonia and nitrate minimal media broths with pyrene as a sole carbon and energy source. The pyrene was placed in dialysis tubing and allowed to diffuse into the surrounding media. Both the yeast and the bacterium were shown to use pyrene as evidenced by increases in all cell numbers and increases in ATP. *P. fluorescens* does not grow with nitrate as the sole nitrogen source despite nitrate reduction in complex media, while *G. canidum* is able to grow on pyrene with nitrogen as a sole carbon source.

GUT CONTENTS OF UNIONIDS FROM THE ZEBRA MUSSEL INFESTED OHIO RIVER, AND FROM ZEBRA MUSSEL-FREE POND REFUGIA. Bruce C. Parker, Catherine M. Gatenby, & Matthew A. Patterson, Dept. of Biol., Va Tech, Blacksburg, Va 24061. Gut contents of unionids collected from areas of the Ohio River with high and low zebra mussel (*Dreissena polymorpha*) infestation and from unionids held in zebra mussel-free pond refugia in Leetown, WV were examined to identify and quantify algal genera. Algae from the Ohio River and pond refugia also were identified and quantified. Unionids not sacrificed in the field were cleaned and transferred to a quarantine facility for a minimum of 4 weeks prior to transport to zebra-free refugia; gut contents of unionids from the river, from quarantine, and from specimens held in pond refugia for over 1 year were compared. The gut contents of mussels revealed much detritus and a wide variety of unicellular, colonial and filamentous algae, which included mostly diatoms, green algae, and blue-green algae. Algal cells ranged 5-100 μm, the 100 μm for filaments. Cell numbers in the guts ranged 10^4-10^6 cells/mL. Unionids from ponds expectedly had gut contents similar to the pond plankton. Apparently feeding is relatively non-selective as a wide variety of plankton are ingested.

USE OF GLYCOGEN LEVELS TO ASSESS THE GENERAL HEALTH OF UNIONIDS FROM THE ZEBRA MUSSEL INFESTED OHIO RIVER AND FROM QUARANTINE. Matthew A. Patterson and Bruce C. Parker, Dept. of Biol., Va Tech, Blacksburg, Va 24061. During the summer of 1996, 500 specimens of *Amblema plicata* and *Quadrula pustulosa* were collected from the Ohio River. Ten specimens of each were sacrificed in the field from areas of low zebra mussel (*Dreissena polymorpha*) infestation (0.3 zebra mussels/m^2) and high zebra mussel infestation (>300 hundred zebra mussels/m^2). Mussels not sacrificed in the field were transported to a quarantine facility and sacrificed at the end of one week, two weeks and four weeks prior to transport to pond refugia. Mussels were not fed to determine the impacts of starvation during quarantine. Mean glycogen levels (mg glycogen/g wet weight tissue) of *A. plicata* from the high infested site were significantly lower (2.73 mg/g) than those from the low infested site (8.08 mg/g)($p = 0.05$). Glycogen levels also dropped significantly at the end of one week of quarantine ($p = 0.05$). Glycogen levels of *Quadrula pustulosa* followed the same pattern except that significant declines in glycogen levels were not observed until the fourth week of quarantine. The data show that increased zebra mussel infestation and starvation during quarantine may result in significant reductions in energy stores of native unionids.

MATERIALS IN DRIVER'S EDUCATION MANUALS RELATIVE TO WILD ANIMALS AND ROAD SAFETY. Andrea L. Robinson, Patrick F. Scanlon, & James A. Parkhurst, Dept. Fisheries and Wildl. Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Free-running animals are a common occurrence along highways. Hazards include both collisions with animals and accidents resulting from attempted avoidance of animals on roads. Driver's Education manuals are widely used in instruction of novice drivers on safe driving techniques. As the content of Driver's Education manuals relative to dangers of animals on roads varies, copies of manuals were requested from all United States and territories and from several foreign sources. All information pertaining to animals contained in those driver's education manuals received, was reviewed and categorized from 42 of the United States and from Puerto Rico and the Virgin Islands, as well as from Ontario, Canada, from Victoria, Australia, from Ireland and from the United Kingdom. Of the 42 United States manuals reviewed, 20 had specific advice about coping with animals on the road; 25 used signs involving animals as illustrations; 6 dealt specifically with deer; while 14 referred to farm animals (horseback riders, animal-drawn vehicles, range animals). Both the Ontario and Victoria manuals provided a considerable range of advice relative to animals on the roads and the United Kingdom and Irish materials had advice relative to livestock on the roads. The consideration given in Drivers Education manuals to animal-related risks seems limited, particularly in giving specific advice to anticipate and deal with problems.

FLUORIDE CONTENTS OF VIRGINIA WHITE-TAILED DEER IN RELATION TO FLUORIDE RELATED TOOTH LESIONS. Michael V. Schiavone, Patrick F. Scanlon, and Luz M. Borrero-Yu, Dept. Fisheries and Wildl. Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. White-tailed deer (Odocoileus virginianus) jaws were collected from hunters during fall 1994 and teeth were examined for lesions possibly associated with fluorides and had fluoride concentrations of bones measured as ppm dry weight. Tooth lesions when present were scored on a 0-5 scale (Shupe et al. 1963, Am. J. Vet. Res. 24:624). Age and sex were recorded for the sampled deer. Lesion values of 0 ($n = 42$), 1 ($n = 41$), 2 ($n = 13$), and 3 ($n = 2$) were recorded for incisors; fluoride concentrations of bones were extremely low (mean values of less than 1 ppm dry weight). As fluoride values were sufficiently low that meaningful relationships with tooth lesions were difficult to establish. Meaningful relationships to sex and age were also difficult to establish. The findings are of interest, however, the fluoride concentrations were greatly lower than concentrations recorded for deer species elsewhere.

MECHANISMS BEHIND REDUCED DECOMPOSITION OF RED MAPLE (*ACER RUBRUM*) LEAVES IN A COPPER-CONTAMINATED STREAM. Alicia S. Schultheis & A. C. Hendricks*, Dept. of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061-0406. We investigated two possible mechanisms behind reduced decomposition of *Acer rubrum* leaves in a copper-contaminated stream. Mechanisms studied included: direct inhibition of leaf processing due to ambient copper concentrations and indirect inhibition through the accumulation of copper on the leaves. Correlation analysis showed that copper accumulated on the leaves in a stochastic fashion that was unrelated to the ambient copper concentrations ($r=0.2457$, $p>0.05$) and that the amount of copper accumulated on leaves was not related to the decomposition rate ($r=-0.1790$, $p>0.05$). While copper accumulations on the leaves were not significantly correlated with the decomposition rate, the ambient copper concentrations were, especially when data from Fall 1994, when temperature was the most important determinant of decomposition rate, was excluded ($r=0.5639$, $p=0.01$). Our findings indicate that there is a threshold at 0.01 mg/L, below which ambient copper concentrations do not substantially inhibit leaf processing. Since other studies have shown that microbial activity is inhibited at concentrations as low as 0.0025 mg/L, it is unlikely that the abrupt changes in the decomposition rate we observed at 0.01 mg/L were due to inhibition of leaf conditioning. Rather, the reduction in the decomposition rate at ambient copper concentrations greater than 0.01 mg/L is more likely due to the inhibition of shredders.

COMPARISON OF SELECTED HEAVY METALS IN SEDIMENTS AND *ULVA LATUCA* (ULVACEAE) AT A SITE IN THE YORK RIVER, VIRGINIA, AND IN A MICROCOSM. Anne Simpson and S. B. Gough, Dept. of Biol., Mary Washington Col., Fredericksburg, Va 22401. A suite of heavy metal values were determined in sediments and in sea lettuce in both the estuarine system and a microcosm designed to emulate the estuary. It was predicted that at least some metals would retain high values because of industrial activity upstream in the estuary. However, our results demonstrate little, if any, elevation in either the sediments or the algae. One question that has not been addressed however is the loading rate of sediments at the natural site. It is possible that values are elevated below the point at which we took samples. Further study is required to elucidate the factors between industry effluents and flux in the estuary. In any event, the microcosm values were very close to the York River concentrations.

USE OF THE *IN VITRO* BRAINSTEM PREPARATION OF *RANA CATESBEIANA* IN THE DEVELOPMENT OF A PHYSIOLOGICALLY-BASED RISK ASSESSMENT COMPUTER MODEL FOR LEAD NUEROTOXICITY AND IMMUNOTOXICITY. V.L. Willis, E.G. Smith, Ph.D., and J.A. Wise, Ph.D. The Dept. of Biol. Sci., Hampton Univ., Hampton, VA and Ctr. For Sleep and Resp. Neurobiol. Univ. of Pa School of Med., Phila. PA. To date no complete paradigm exists that satisfactorily integrates both the proposed anatomical and functional substrates of lead induced neurotoxicity and immunotoxicity. Preliminary studies have been conducted using the *in vitro* brainstem preparation of the larval form of *Rana catesbeiana* which show rhythmic neural activity related to lung and gill ventilation. This reduces some of the uncertainty in risk assessment for lead exposure. Discharges of the facial motor nucleus were recorded extracellularly. Altering the pCO_2 in the superfusate changes the frequency of the lung, but not the gill-related signal. A whole body exposure system was used for toxicity testing. The distribution of mortality vs. concentration of lead was plotted from the 24 hr acute toxicity test (n=6 for each concentration). The % mortality was: Control 0%; 1ppm 0%, 5ppm 0%, 10ppm 66.5%, 20 ppm, 100%, 30 ppm 100%. The LC_{50} (5.7 ppm) was determined using EPA probit analysis software. These data support the hypothesis that *Rana catesbeiana's* ventilatory responses to changes in CO_2 can be monitored to signal potential neurotoxic risk due to low concentration lead exposure. This model may also be ideal to monitor the immunotoxic effects of lead. These data will be used to continue to develop a physiologically-based computer model for lead toxicity reduction evaluations and to compare the effectiveness of different treatment technologies.

THE EFFECTS OF DIETARY LEAD ON TAIL REGENERATION IN EASTERN RED-SPOTTED NEWTS (NOTOPHTHALMUS VIRIDESCENS). R. L. Woods and P. F. Scanlon, Dept. Fisheries and Wildl. Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. In recent years, there has been an increase in concern about declining amphibian populations. There have been several proposed reasons for the declines. One proposed cause is pollution. Previous studies have shown that amphibians will accumulate lead in their tissues and that lead-enriched water causes behavioral changes which could make individuals more susceptible to predation. This study was initiated to look at the possible role of lead in amphibian population declines. We examined the effects of lead on captive adult eastern red-spotted newts and looked at the combined effects of lead and amount of food consumed on tail regeneration. Treatment groups included all permutations of lead vs. no lead, feeding 3X/week vs. 1X/week, and tail removed (partial) vs. tail intact. Treatment lasted for 5 weeks. Data were analyzed using a one-way analysis of variance. The amount of food consumed was affected by the frequency of feeding, while there were interactive effects of lead and tail removal and of lead and frequency of feeding on food consumption. The amount of tail regenerated over the course of the study was affected by the presence of lead in the diet. Body mass gained or lost was affected by lead in the diet, frequency of feeding, and the interaction of all factors tested. Preliminary evidence indicates that lead does have an adverse effect on newts and warrants further study.

THE EFFECTS OF POWER LINE RIGHT-OF-WAY ON THE DISTRIBUTION AND ABUNDANCE OF AMPHIBIANS, REPTILES, AND SMALL MAMMALS ON PATUXENT RESEARCH REFUGE. R. L. Woods and D. C. Forester, Biology Department, Towson State University, Towson, MD 21204. A power line right-of-way is often managed very differently than the surrounding area and the vegetative community is structurally very different. To examine the effect of a right-of-way (R.O.W.) on the distribution of reptiles, amphibians, and small mammals, we set up a series of trapping arrays within the right-of-way, along the edge, and within the surrounding forest. We sampled a total of 6 sites, with 3 trapping arrays at each site. Traps were monitored 4 days a week from April 1, 1995 - November 7, 1995 and February 23, 1996 - April 22, 1996. Individuals captured were given a trap-specific mark. Data were analyzed using a one-way Analysis of Variance. During the trapping seasons, we captured a total of 1779 individual amphibians of 17 species, 112 reptiles of 11 species, and 628 small mammals of 9 species. Overall, amphibians showed decreased abundance in the R.O.W. Snakes, the most frequently captured reptiles, were most abundant in the R.O.W., with relatively few individuals captured in either the forest or the edge. The three species of small mammals which were captured in large numbers varied in their distribution depending on the habits of the individual species. It is unclear whether the decrease in abundance of amphibians within the R.O.W. is a function of the R.O.W. itself or the result of the distance the R.O.W. is from natal ponds.

LOGGING THE TOLEDO DISTRICT BELIZE, CENTRAL AMERICA AND ITS EFFECTS ON THE INDIGENOUS MAYA. Laura Wyatt and Michael L. Bass, Environmental Science & Geology, Mary Washington College. The worldwide rate of deforestation is highest in the Central America subregion. One cause is the rapid incursion of multi-national Asian logging companies into poorer developing countries like Belize. Atlantic Industries, a Malaysian company, is logging in the southern Toledo district of Belize ignoring the agreed management plan and local laws. Infractions have caused increased erosion, polluted waterways and mud-mired roads. The subsistence Maya farmers living near the Columbia Forest Reserve (CFR) and elsewhere suffer from these incursions by logging companies on land where they tenuously live. The CFR is being logged despite environmentalist' objections that its endangering the biodiversity. Mahogany trees are being logged three times their sustainable rate. Enforcing the management plan and local laws, inclusion of local people in decision making, Maya land sovereignty, and developing more sustainable tourism industries, would support better land management and curb deforestation in the Toledo district.

KIDNEY FAT INDICES IN HUNTER-KILLED MULE DEER FROM COLORADO. J. F. Zohn, Jr., P. F. Scanlon and M. A. Cochran, Dept. Fisheries and Wildl. Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The Kidney Fat Index (KFI) is a ratio of perirenal fat mass to kidney mass and is used to assess body condition of a wide range of species. KFI and body mass were recorded for mule deer (Odocoileus hemionus) harvested during 1993 and 1994 from habitats in central Colorado. Two populations were sampled, one from the U.S. Air Force Academy (USAFA) and another at the Pinon Canyon Maneuver Site (PCMS). Deer were grouped by collection period (Period 1, Oct. 09 through Nov. 20; Period 2, Nov. 21 through Dec. 29). Age classes were determined for USAFA deer and were 0.5, 1.5, 2.5 and 3.5 years and older. Body mass, KFI and kidney mass were higher ($P < 0.001$) for males from the PCMS site and body mass and KFI were lower ($P < 0.001$) in Period 1 than Period 2. For females harvested from the USAFA site, KFI and kidney mass differed ($P < 0.001$) with respect to age, and body mass differed ($P < 0.001$) for both effects of age and collection period. Differences in KFI and body mass of males from the USAFA site were significant ($P < 0.001$) for age class and collection period, and kidney mass differed ($P < 0.001$) with respect to age only. Regression analysis showed a positive but moderate correlation between kidney weight and body weight for both males ($r^2 = 0.51$) and females ($r^2 = 0.29$). When both age and sex are considered, KFI appears to be an adequate indicator of body condition for mule deer during the interval October through December.

Geography

REMOTE SENSING OF LANDSCAPE PATTERNS FOR SUSTAINABLE DEVELOPMENT, EASTERN SHORE OF VIRGINIA. Thomas R. Allen, Department of Poli. Sci. and Geography, Old Dominion University, Norfolk, Va. 23529-0088. A benchmark program designed to measure progress the community makes toward sustainable development goals is underway. The project incorporates remote sensing and geographic information system (GIS) measurements for indicators. A pilot study used Landsat Thematic Mapper (TM) satellite imagery to characterize land cover types and patterns in the Eastern Shore watersheds. Land cover patterns in three coastal basins were compared using landscape pattern metrics. Results indicate that agricultural land use is potentially more extensive in bay estuaries than small sea-side basins. Watershed corridors are more extensive and functionally integrated by riparian and shoreline buffer zones in sea-side basins. The methods employed will provide helpful indicators for watershed management strategies that are linked to environmental integrity issues in sustainable development. The integrated GIS will next incorporate socio-economic, cultural, and environmental data sets to allow cross-analysis, display, querying, and mapping of landscape data.

SPATIAL ASPECTS OF THE INCIDENCE AND DIFFUSION OF *AEDES ALBOPICTUS* (ASIAN TIGER) MOSQUITO, HAMPTON ROADS, VIRGINIA. C. John Neely, Thomas Allen, & Justin Friberg Dept. of Geography, Old Dominion Univ., Norfolk, Va. Globally, *A. albopictus* mosquitoes are recognized as important vectors of arboviruses. The appearance of the mosquito in Hampton Roads is an important link in the component nidality exposing humans to disease. In this study a Geographic Information System (GIS) has been combined with landscape epidemiology to provide surveillance of the area's disease ecology. A data base format was established allowing sampled data to be mapped using GIS. This database, the CDC's EpiInfo software utilized address matching with a GPS corrected GIS base map to geocode sample incidence within a single block resolution. The product is a temporal diffusion of *A. albopictus* in a format ready for complex analysis using mapping capabilities of GIS integrated into the SAS (Statistical Analysis System) of EpiInfo to provide a Geographic Analysis Machine (GAM). The system is currently being utilized in a sentinel surveillance study of enzootic *Eastern equine encephalitis* in the Norfolk area.

Key Terms: Arbovirus, enzootic, vector.

IDENTIFYING PREDICTORS WHICH CONTRIBUTE TO THE SPATIAL DISTRIBUTION OF SHEEP IN VIRGINIA. Stephen E. Wright, Center for Geographic Information Science, James Madison University, Harrisonburg, Va. 22807. Using nine selected variables, correlation analysis and regression analysis the spatial distribution of sheep in Virginia was investigated. Of the variables selected, only market value of livestock and poultry, market value of agricultural products sold, total cropland (acres), and operators by principal occupation- Farmer were the variables which significantly contributed to the spatial distribution of sheep in Virginia. Future geographic research in this area should use factor analysis as the research methodology.

Geology

PETROGRAPHIC INVESTIGATION OF AN EARLY-SILURIAN CORAL REEF COMPLEX, MANITOULIN ISLAND, LAKE ONTARIO, CANADA. Scott W. Beatson and Parvinder S. Sethi, Dept. of Geology, Radford University, Radford, Virginia 24142. One of the world's largest coral-reef deposits from the Silurian is located on Manitoulin Island in Ontario, Canada. Controversy, however, exists regarding the mode of dolomitization as whether being primary or secondary in origin. The hypothesis of this study was that the original reef strata accumulated in a very dynamic, coastal environment; one subject to frequent events of storm activity. Further, the deposits experienced multiple episodes of dolomitization during early and late diagenesis. Petrographic analyses of twenty-five thin sections reveal the strata to be generally characterized by a fine-grained, muddy, dolomitic matrix with pyritization and secondary dolomitization evidenced by clearer, coarser, euhedral (rhombic) dolomite crystals. Data also suggest a change in lithofacies proceeding from the more resistant, crystalline, fossil-rich dolomite [Manitoulin Fm. strata] to a blocky, green and reddish-brown shale [Cabot Head Fm. strata]. Integration of macrostructures, macro-and trace fossils, and petrographic data suggests that the patch-reef sediments were subjected to episodic, high-energy, turbidity events. Sequence stratigraphically, a transgressive signature is preserved in the strata as evidenced by accumulation of finer-grained, mudstones and shales in the upper parts of the stratigraphic section.

COMPOSITIONS OF PYROXENE AND PLAGIOCLASE IN THE MESOZOIC FARMVILLE DIABASE DIKE. William J. Bounds and Francis O. Dudas, Geological Sciences Program, Old Dominion Univ., Norfolk, VA 23529. The Farmville dike is a mesozoic diabase intrusion with a granophyre rich core. The dike was studied to see if fractionation of existing mineral assemblage could produce the late stage granophyre core. The dike trends north-south and has two roadcuts along route 460 and route 15. Samples were collected from both locations to be analyzed with the electron microprobe to determine elemental compositions of the minerals. Plagioclase was determined to be dominantly labradorite (An 65 - An 44), clinopyroxene is comprised of 60% augite and 40% pigeonite, the opaque minerals are ilmanite and titano-magnetite. Elemental compositions of the minerals were used to calculate potential fractionation paths for the magma, based on bulk rock chemistry determined by Rogan, P. T., (1993). Calcium is the only element that has a fractionation path that moves towards the granophyre composition. Minerals which fractionated in the early stages of crystallization do not allow the fractionation path to reach the composition of the granophyre rich core. Fractionation alone did not lead to the granophyre rich core of the Farmville dike; some other processes, such as magma mixing or crystal contamination, needed to occur along with fractionation.

Rogan, P. T., 1993: "Petrology of a Large, Granophyre-Rich Mesozoic Diabase Dike Near Farmville, Virginia" M.S. Thesis, Old Dominion University, Norfolk, VA.

ENGINEERING GEOLOGY CONSIDERATIONS OF THE BRISTOL CITY LIMESTONE QUARRY LANDFILL, BRISTOL, VIRGINIA. Leslie N. Bright and C.F. Watts, Dept. of Geol., Radford Univ., Radford, Va. 24142, Steve Fradkin* and Robert Twardock*, STS Consultants, Chicago, Il. The city of Bristol, Virginia, has initiated a project to convert a limestone quarry into a municipal solid waste facility. The quarry, having near-vertical walls 320 to 370 ft high, presented several challenges in slope stability remediation. To create a safe work environment for the development and operation of the facility, numerous techniques are being utilized. Slope stability analyses, including rockfall hazard rating schemes modified from the Federal Highway Administration and the Oregon Department of Transportation, were first utilized to identify high-risk areas of the slope. Potential for rockfalls, as well as translational and toppling failures were identified. Safety factors were calculated by computer modeling. Scaling by hand and by machine, blasting, wire rope netting, and rock bolting have been used to stabilize various portions of the quarry as needed based on the analyses.

A TEST OF EVOLUTIONARY STASIS IN TIME-AVERAGED ASSEMBLAGES OF *MERCENARIA* CLAMS. Andrew M. Bush, Dept. of Geological Sciences, Va. Tech., Blacksburg, VA 24061. Previous attempts at demonstrating evolutionary stasis (the absence of change in shape or size in a species over time) have compared the average morphological characteristics of a species at different points in time. This only demonstrates net stasis. A new method can test actual stasis. A sample of 48 live *Mercenaria mercenaria* were collected and 21 shape measurements were made. The same measurements were made on 48 Pleistocene *M. campechiensis* collected from a single stratigraphic level. Due to time-averaging, fossils in this sample would be expected to vary in age by about 1000 years. If no evolutionary change occurred during this time interval, the variances of the measurements on the fossils should be comparable to those in the recent single living population. If evolutionary change was occurring during the time the fossil assemblage accumulated, the fossil sample should be more variable, since the time-averaging process would sample individuals from a series of populations with different mean characteristics. The differences in variance of 19 out of 21 characteristics were statistically insignificant; one measurement was more variable in the fossil sample, and one in the recent sample. Because the fossils are not significantly more variable in shape than the recent population, evolutionary stasis is inferred. This supports the punctuated equilibrium model of evolution.

HIGH RESOLUTION SEQUENCE STRATIGRAPHY OF PALEOGENE NON-TROPICAL CARBONATES, N.C. COASTAL PLAIN. Brian P. Coffey, Dept. of Geological Sciences, Virginia Tech, Blacksburg, VA 24061. Existing sequence stratigraphic models proposed for carbonate rocks are based on studies of tropical platforms, however, non-tropical carbonate systems differ significantly in terms of depositional environments and lithology from tropical models. This project will use Paleogene mixed-carbonate-and-terrigenous sediments from the North Carolina coastal plain to generate a revised sedimentologic-based sequence stratigraphic model for non-tropical mixed carbonate-siliciclastic rocks, concentrating on thick (0 to 500 m) sections from exploratory oil/gas wells. Detailed measured sections from outcrops and core, geophysical logs, and cuttings from closely-spaced wells will be compiled to generate detailed lithologic cross-sections for the region, constrained by biostratigraphy and sequence boundary picks. The study will focus on petrographic analysis of plastic impregnated and thin sectioned cuttings (sampled at 3 to 5 m intervals) selected from over 70 exploratory wells in the deep basin. Detailed diagenetic studies will be coupled with the sea level history, global paleoclimate data, and timing of deposition of confining beds, to better understand the Cenozoic history of porosity modification of these sediments. The diagenetic history will also be incorporated into a sequence stratigraphic framework to greatly increase our understanding of the diagenetic evolution of non-tropical Paleogene platforms. A refined sequence stratigraphic model for the Paleogene mixed clastic-carbonate succession of the region will incorporate the wave-and ocean current-dominated setting, the widespread non-depositional, wave-abraded inner shelf (hardground), the near shore siliciclastic estuarine/lagoon/barrier systems, the echinoderm and bryozoan-rich outer shelf facies, and marine vs. fluvial incisional events into a non-tropical depositional framework.

TEXTURAL ANALYSIS OF A PERIGLACIAL (?) SURFICIAL DEPOSIT AT GRAVES MILL, MADISON COUNTY, VIRGINIA, Rachel C. Davis and W. C. Sherwood, Dept. of Geology and Environmental Studies, James Madison University, Harrisonburg, VA 22807. The catastrophic storm which impacted western Madison County on June 27, 1995 triggered over 500 slope failures and resulted in massive debris flow activity. Active down cutting exposed numerous older unconsolidated deposits. This study involves a near vertical, 10m section exposed by the flooding along Upper Kinsey Run near Graves Mill. Thirty nearly horizontal units composed of a sandy matrix with angular, foliated pebbles oriented parallel to the bedding were recognized and sampled. Fifteen samples were chosen for sieving and pipette analysis. When plotted on a ternary textural diagram, all samples showed low clay, moderate silt, and high pebble and sand fractions. Statistical analyses of the textural data for standard deviation (sorting), skewness, and mean phi grain size resulted in no discernible correlations. Most striking were the high standard deviations which are indicative of poor sorting. According to Friedmans (1962) scale most of the samples fell in the category of "extremely poorly sorted" which is characteristic of reworked glaciofluvial tills and mudflow deposits (Flint, 1971). Considering the context, nature of the beds, lack of grain rounding, and extremely poor sorting the writers believe that these deposits may be soliflucted material moved downslope and deposited in their present position during the late Piestocene.

ROCK SLOPE STABILITY ANALYSIS OF A ROADCUT IN INTERBEDDED SANDSTONE AND SHALE, BLAND, VIRGINIA. Brendan R. Fisher, C.F. Watts, and Jason B. Shelton, Dept. of Geology, Radford Univ., Radford, VA 24142. A rock slope stability analysis of a roadcut located in the Price Formation on Route 42 near Bland, Virginia was conducted by Radford University. Funding was provided by the US Geological Survey through the EDMAP Program and the Colorado Scientific Society through the Edwin B. Eckel Memorial Fund for Engineering Geology. Data were collected in the field and analyzed using ROCKPACK, a rock slope engineering program written by C. F. Watts, Director of The Institute for Engineering Geosciences at Radford University. Friction and cohesion values were determined using direct shear pull tests at Radford University. Over 80 pull tests were completed which show a friction angle of 32.8 degrees and a cohesion value of 1.33 psf. Factor of safety calculation results range from 0.96 - 0.41 depending on the amount of water present within discontinuities. These results indicate that translational sliding will occur along bedding planes and joints in the Price Formation at this site. Failures will move along daylighting discontinuities during wet periods when pressure in dicontinuities builds.

HYDROGEOMORPHOLOGY - THE CORPS' APPROACH TO THE FUNCTIONAL ASSESSMENT OF WETLANDS. G. Richard Whittecar, Prog. in Geol. Sci., Old Dominion Univ., Norfolk, VA 23529. The U.S. Army Corps of Engineers is developing a new "hydrogeomorphic" (HGM) approach to assess the functions of natural and created wetlands. Wetland classification is based on geomorphic position (e.g. slope, depressional, riverine, estuary fringe), water sources (e.g. precipitation, ground water) and hydrodynamics (e.g. bidirectional or unidirection surface flow). Assessments of wetland functions require evaluations of variables that describe hydrologic (geomorphic), biogeochemical (soils), and ecological factors. In order to create standards of reference for these functions for each wetland classes in the country, reference wetlands are being evaluated in regions ("reference domains") determined by physiographic features. Excavated areas used for created wetlands sites have geomorphic and biogeochemical characteristics different than natural reference wetlands because of the newness of the landform. The HGM assessment procedures should include variables that force wetland designers to recognize every wetland has a geologic history that controls modern wetland functions.

MINERALOGY AND GEOTHERMOBAROMETRY OF METAMORPHIC ROCKS NEAR MINERAL, VIRGINIA. Stephen W. Herman and Francis Ö. Dudás*, Prog. Geological Sciences, Old Dominion Univ., Norfolk, Va. 23529. Exposures of rocks along Contrary Creek, Louisa County, north of Mineral, Virginia, display an unusual assemblage of metamorphic minerals. The Chopawamsic Formation is dominated by mafic metavolcanic rocks, however, at this locality, a metapelite within the volcanics offers a unique opportunity to constrain the conditions of metamorphism. In addition to Qtz, Mu, Bio, Chl, Hbl, Ep, Gt, St, Ky, Mt, Il, and sulfides reported by other workers, two additional minerals have been identified during this study: margarite and chloritoid. Feldspar is absent. An AFM plot suggests a wide range of bulk composition based on co-existing mineral assmblages. A muscovite schist that contains Ky is topographically above this metapelitic unit; the presence of Ky constrains minimum pressure conditions. Maximum temperature is constrained by persistence of staurolite. Temperature and pressure determinations were made based on petrogentic grids and the Gt-Bio geothermometer. Temperature and pressure determined from the petrogenetic grid were 544°C ± 30°C and 6.5 kBar ± 2 kBar, respectively. Temperature values from the Grt-Bio geothermometer are 490°C ± 10°C.

BEACH RIDGES, BURIED SOILS, AND BODIE ISLAND DUNES. Daniel M. Holloway, & G. Richard Whittecar, Geological Sciences Program, Old Dominion Univ., Norfolk, Va. 23529. Three landform units are recognized on northern Bodie Island: beach ridges, located at Kitty Hawk Woods and Collington Island; stabilized transverse and parabolic sand dunes, located in Nags Head Woods; and actively migrating sand dunes, located at Jockys Ridge and Run Hill. The beach ridges and the stabilized dune field both contain established maritime forests with soil development. Soil data from the landform units reveal the beach ridge soils to have thicker horizons and more developed profiles than the soils of the stabilized dune field indicating the beach ridges to be older (mid to late Holocene). Soil data comparing transverse and parabolic dunes show no discernible difference in horizon thickness and profile development indicating that these dunes started forming soils at relatively the same time (few hundred to few thousand years ago). The active dunes contain buried soils differing in morphology from the other two landform units. The buried soil on Jockeys Ridge yields a radiocarbon date of approx. 230 ybp, indicating that it is the youngest of the landforms and developed rapidly. The rubification of the profile indicates that the soil underwent different processes than that of the beach ridges and stabilized dunes (maybe related to forest fires).

FLUID INCLUSION THERMOMETRY OF QUARTZ VEINS IN BIOTITE GNEISSES AND ASSOCIATED GRANITOIDS AT PEMAQUID POINT, MAINE. Brian G. Hough and Francis Ö. Dudás, Dept. of Geological Sciences, Old Dominion Univ., Norfolk, VA 23529. Morphology of quartz veins in pegmatite granitoids at Pemaquid Point, ME, suggests that they formed by dewatering of the enclosing biotite gneiss. This study tests this hypothesis by examining fluid inclusions in the quartz veins and by determining the conditions of metamorphism. Rocks at Pemaquid Point are assigned tot he Bucksport Fm. Of the Late Proterozoic to Ordovician Casco Bay Group. They lie east of the Iapetus suture, and were metamorphosed during closure of the Iapetus. Rod-like bodies of pegmatitic granitoids, interpreted to be partial melts of the enclosing gneisses, occur in the hinges of asymmetric, east-verging antiforms. Quartz veins, rooted near pinch structures along the granitoid-gneiss contact, cut the granitoids but are absent from the gneisses. The mineralogically simple gneisses contain biotite, amphibole, plagioclase and quartz as major phases; K-feldspar is absent. Amphibole-plagioclase thermometry and amphibole barometry suggest T near 715±80°C and P near 2±1kb, which approximate conditions for wet melting of granite. Fluid inclusions are almost all secondary and include four populations: 1. Two phase inclusions with vapor ≤30%; 2. Two phase inclusions with vapor ≥70%; 3. All liquid inclusions; and 4. CO_2-bearing inclusions. Low-vapor inclusions are most abundant; CO_2-bearing inclusions are rare. Vapor-rich and liquid-rich inclusions occur along separate fractures. All liquid inclusions occur in fractures that cut other inclusion trains at high angles. Salinities in low-vapor inclusions range up to 20 wt.% NaCl equivalent.

SHRINK-SWELL PROPERTIES OF THE CREEDMOOR SOIL, CHESTERFIELD COUNTY, VIRGINIA. Christy L. Hudson and Brain C. Aster, Dept. of Geology and Environmental Studies, James Madison Univ., Harrisonburg, VA 22807. Expansive soils which exhibit potentially damaging shrink-swell behavior underlie some one fifth of the United States. According to the Federal Energy Management Agency, expansive soils cause more damage to structures then all other natural hazards combined. Over the past decade a number of homes in the Brandermill development of Chesterfield County, Virginia, were found to be damaged by expansive soils mapped in the Creedmoor Series. For this study, 5 samples (labeled A through E) of Creedmoor B horizon material were collected and tested using a Potential Volume Change (PVC) instrument. Prior to testing, the soils were air dried in the lab, disaggregated, and 7.5% water by dry wt. of soil was added. Each soil was tested twice using the test method recommended for the Model C-260 Soil Volume Change Meter. Results of the two tests were averaged and plotted. Using a curve supplied by the manufacturer, test dial values were equated to a swell index in lbs/ft^2. Using this system the five Creedmoor samples rated as follows: Sample B rated as Marginal (1675-3200 lbs/ft^3), Sample D rated as Critical (3200-4725 lbs/ft^2) and Samples A, C and E rated as Very Critical (>4725 lbs/ft^2). Many shallow foundations and basement walls are subject to serious structural damage when exposed to swelling pressures of this magnitude. It is concluded that the Creedmoor soils of Chesterfield County, should be tested for shrink-swell behavior prior to any construction and proper design practices incorporated where critical expansions are indicated.

MINERAL CHEMISTRY OF HEAVY MINERALS IN THE OLD HICKORY DEPOSIT, SUSSEX AND DINWIDDIE COUNTIES, VIRGINIA. Edward F. Lener, Dept. of Geological Sciences, Virginia Tech, Blacksburg, VA 24061. The Old Hickory is the largest of a series of Pliocene (?) age heavy mineral sand deposits in Virginia and North Carolina. The high density (specific gravity of 2.9 or greater) of heavy minerals allows for selective concentration during fluvial and/or marine transport. Under the right conditions, placer deposits of considerable size can be formed. The elliptically shaped ore body of the Old Hickory Deposit extends in a North - South direction and is approximately 13 km (8 miles) long and up to 2.5 km (1.5 miles) wide, with an average thickness of 6.5 m (20 feet). The deposit lies along the Fall Zone, where a thin wedge of Cenozoic Coastal Plain sediments meets the older rocks of the Piedmont Region. The principal minerals of economic interest found in the heavy mineral sands at the site are ilmenite ($FeTiO_3$), leucoxene ($Fe_{2-x}Ti_{3+x}O_{9+x/2}$) where $x \leq 2$, rutile (TiO_2), and zircon ($ZrSiO_4$). An important focus of the present study is the alteration of ilmenite by leaching away of iron, which results in enrichment in titanium. As the value of the ore is heavily dependent on the titanium content, the weathering process is a matter of considerable interest to the mineral industry.

INVESTIGATION OF THE EARLY STAGES OF CLAY MINERAL FORMATION ON WEATHERED SILICATE SURFACES. Jodi J. Rosso and J. Donald Rimstidt*, Dept. of Geological Sciences, Virginia Tech, Blacksburg, VA 24061. In pH 4.0 HNO_3, 10 ppm Al^{3+} solutions, at 25°C a thin coating of a Mg, Al, Si-rich precipitate forms on dissolving forsterite (Mg_2SiO_4) surfaces within 9 days of exposure. These experiments were conducted in an externally-recycled mixed-flow reactor. To constrain the solution composition, the dissolution of forsterite was first studied in pH 4.0 HNO_3 solutions. At pH 4.0, the rates of Si and Mg release from forsterite surfaces are 1.37 x 10^{-10} mol/m^2/sec and 3.21 x 10^{-10} mol/m^2/sec, respectively. When pH 4.0, 10 ppm Al^{3+} solutions were pumped into the system, the Si and Mg release rates dramatically decrease over a 9 day period, to the point where Si and Mg could no longer be detected by our analytical methods (<0.05 ppm for both Si & Mg). After 2 weeks of reaction, the solids were removed from the reactor, rinsed in DDi-H_2O and dried in air. When dried, a thin, flaky precipitate spalled off the outside of the forsterite grains. This material is X-ray amorphous. Micro-FTIR analyses suggest that these precipitates are hydrous as indicated by the strong absorbance around 3600 cm^{-1}. Electron microprobe analyses reveal that these flakes have a Mg:Al:Si cation ratio of 0.4:2:8. It appears that this material is similar to palygorskite $(Mg,Al)_{3.5}Si_8O_{20}(OH)_2 \bullet (H_2O)_4$. These results demonstrate the intimate chemical link between dissolving minerals and the formation of secondary phases, such as clays.

SPECTROSCOPIC AND MICROSCOPIC INVESTIGATION OF THE FUNDAMENTAL CHARACTERISTICS AND REACTIVITY OF SULFIDE SURFACES. Kevin M. Rosso* and Michael F. Hochella Jr., Dept. of Geological Sciences, Virginia Polytechnic Inst. and State University, Blacksburg, VA 24061. Various surfaces of galena, pyrite, and covellite single crystals are being investigated with a number of surface sensitive techniques towards an end of understanding the fundamental nature of sulfide surface reactivity. Pristine surfaces of these minerals and their chemical behavior when exposed to controlled doses of O_2, H_2O, and mixtures thereof, are being studied in ultra-high vacuum (UHV), the only environment where experimental variables can be constrained with a suitable level of chemical isolation. The atomic-scale surface electronic structure of the unreacted and reacted surfaces are being investigated using scanning tunneling microscopy and spectroscopy (UHVSTM/STS) with interpretative support from quantum mechanical calculations. Pristine fracture surfaces of these minerals are generated either in UHV or in an inert nitrogen atmosphere before performing analyses. Growth surfaces of pyrite are being studied for the purpose of comparing their reactivities with that of the fractured surfaces. Pyrite growth surfaces are atomically cleaned (as documented with X-ray photoelectron spectroscopy) and reordered (as documented with low-energy electron diffraction) in UHV using cycles of 200 eV He^+ sputtering and thermal annealing to 300°C. UHVSTM/STS data on unreacted galena, pyrite, and covellite demonstrate their distinctly different electronic structures. At a larger scale, growth surfaces of pyrite studied-to-date exhibit significant nanometer-scale roughness and pitting, as observed with UHVSTM, the effects of which may have substantial implications towards our perception of surface reaction controls.

ALTERNATING DIATOMITE-MUDSTONE STRATA IN THE EARLY PLIOCENE TRINIDAD FORMATION, SAN JOSE DEL CABO BASIN OF SOUTHERN BAJA, MEXICO. Christopher L. Rupe and Parvinder S. Sethi, Dept. of Geology, Radford Univ., Radford, VA 24142. The San Jose del Cabo basin is a classic extensional, rift-type basin located in the southern Baja region of Mexico. The basin contains middle Miocene to Recent sediments which in turn overlie pre-Tertiary igneous and metamorphic basement rocks. Previous research on the Trinidad Formation strata suggests the sediments accumulated during a larger-scale, eustatic, marine transgression during the middle Miocene. The objective of this study was to decipher signatures of higher frequency (order of hundreds of thousands of years) sea-level changes as preserved in the middle Miocene strata. Detailed stratigraphic analysis of the middle Trinidad Formation reveals the presence of cm-scale, alternating layers of diatomite and mudstone. Calcium carbonate data reveals consistently lower carbonate contents in the mudstone layers as compared to the diatomite strata. Integrated analysis involving macrostructures, grain-size distribution, diatom mounts, and inorganic carbon contents suggests accumulation of the diatomite-mudstone couplets in a protected marine shelfal environment. The mudstone strata are interpreted as reflecting times of increased terrigenous sedimentation as a consequence of fluctuations in mesoscale storm events or climate on a hundred thousand year time scale.

SHALLOW SUBSURFACE GEOPHYSICAL STUDY ALONG THE MOUNTAIN RUN FAULT NEAR CHARLOTTESVILLE, VIRGINIA. William J. Seaton, 4044 Derring Hall, Dept. of Geological Sciences, Va. Tech, Blacksburg, Va.24061. A series of surface resistivity profiles and VLF (Very Low Frequency) electromagnetic traverses in the vicinity of the Mountain Run Fault near Albemarle County, Virginia, reveal the shallow subsurface expression of the steeply dipping strata of the easternmost Blue Ridge Province and the low angle Mountain Run thrust fault of the Western Piedmont Province. Also seen in these surveys is the near-surface expression of sub-vertical fractures that may be associated with the downward flow of groundwater. The difference in water content between the relatively dry and steeply dipping Candler phyllites and schists, and the more porous Everona Limestone causes a sharp contrast in formation resistivities and provides a means of detection via the resistivity profiles. This contrast also exists between the Everona Limestone and the Mine Run Complex metasedimentary rocks. The variability in water content also changes the electromagnetic conductivity of the earth allowing for detection of water bearing zones with VLF methods. The results of the geophysical methods used here are consistent with mapped surface geology, reflection seismic data, and water well data in the study area.

MILANKOVITCH-BAND CLIMATE CHANGES AND RELATIONSHIP TO GENERATION OF HYDROCARBONS: EXAMPLES FROM THE NORTH AMERICAN CRETACEOUS AND PENNSYLVANIAN DEPOSITS. Parvinder S. Sethi, Dept. of Geology, Radford University, Radford, VA 24142. In recent years, concepts of sequence stratigraphy have greatly aided our understanding of the relationship between formation of source rocks and control of longer-term (i.e. first through third-order) sea-level changes. The exact manner in which higher-frequency (Milankovitch band) climate cycles may have impacted preservation of labile organic matter in fine-grained successions, however, is not as clear. The application of high-resolution, chronostratigraphic techniques to correlation of basinal-scale, fine-grained strata has significantly enhanced our ability to decipher signatures of 100 kyr-scale climate changes preserved in the stratigraphic record. This paper presents results of two studies, both aimed at investigating the relationship between climate change and preservation of organic matter. One study involves the Cenomanian/Turonian, Tropic Shale strata which accumulated in the prodeltaic setting of the Western Interior Basin. The other study focuses on deciphering probable mechanism(s) responsible for mm-scale fluctuations in the amount of total organic carbon preserved within the Missourian, Eudora Core Black Shale in Eastern Kansas.

HIGH-RESOLUTION EVENT STRATIGRAPHY OF THE EARLY PLIOCENE DIATOM-RICH TRINIDAD FORMATION; SANTIAGO, SOUTHERN BAJA PENINSULA OF MEXICO. Jason B. Shelton and Parvinder S. Sethi, Dept. of Geology, Radford University, Radford, VA 24142. A recently mapped site in the Southern Baja Peninsula, Mexico contains sediments ranging in age from the middle Miocene to Pleistocene. Detailed stratigraphic analyses of the middle Trinidad Formation by Rupe and Sethi (1997) reveals the presence of cm-scale, alternating strata of diatomites and mudstones. The objective of this study was to conduct a high-resolution (cm-scale) paleoenvironmental assessment of a part of the stratigraphic section at the El Torete site, containing the thickest strata (upto 75 cm thick) of diatomite. Analysis of weight % calcium carbonate trends in conjunction with macrostructures and grain-size distribution reveals that: 1) the diatomite layers are characterized by higher $CaCO_3$ contents relative to the mudstones, and 2) there is little fluctuation in the $CaCO_3$ contents within the thick diatomite layers themselves. Integration of the available sedimentologic and geochemical data suggests that the thick diatomite strata reflect accumulation under conditions of sustained, high primary productivity in an ancient, protected, outer shelf environment.

ORIENTATIONS AND MAGNITUDES OF PALEOSTRESS IN THE GREAT VALLEY PROVINCE OF NORTHERN VIRGINIA. Ginger L. Vaughn, R.D. Law, Dept. of Geol. Sciences, Virginia Tech, Blacksburg, VA. 24060. Compression axes after Turner (1953) have been calculated for both matrix cements and younger fracture fills in late Cambrian to Middle Ordovician age limestone samples from the North Mountain thrust sheet. Paleostress magnitude estimates using the Rowe and Rutter (1990) twin density technique indicate a differential stress of 240± 31 MPa for samples collected from both limbs of the syncline. Three distinct patterns of paleostress orientations (compression directions) have been detected in the samples; each pattern is observed on both the NW and SE limbs of the syncline. The first pattern, exhibited by calcite grains cementing late fractures, is characterized by a maximum of compression axes oriented sub-perpendicular to bedding possibly indicating either thrust sheet loading or stress refraction associated with folding. Samples in which calcite grains from both fracture fills and earlier matrix cements were measured are characterized by a bimodal distribution of compression axes - the first point maximum being oriented sub-perpendicular to bedding, the second maximum placing compression directions at low to moderate angles to bedding. Restoration of bedding to horizontal results in these compression axes plunging to either the SE or NW, sub-parallel to the regional thrust transport direction. The third pattern, originating from early cements, places compression directions plunging to the NE-SW at angles which are sub-parallel to bedding. These compression directions seem to correlate with local structures oblique to regional strike.

GEOLOGY AND THE CIVIL WAR IN SOUTHWESTERN VIRGINIA: THE SMYTH COUNTY SALT WORKS. Robert C. Whisonant, Dept. of Geology, Radford Univ., Radford, VA 24142. When the opening guns of the American Civil War thundered at Fort Sumter in April 1861, Virginia was by far the major mineral-producing state in the South. During the conflict, the Old Dominion supplied enormous quantities of salt, lead, iron, niter (saltpeter), and coal to the Confederate war machine. Except for the coal, which came primarily from the Richmond Mesozoic Basin, nearly all of these strategic materials were produced west of the Blue Ridge. The salt operations were located at Saltville in northwestern Smyth County in the Valley and Ridge province. Here, an enormous production complex arose to obtain salt from Mississippian evaporite deposits. The salt at Saltville was never mined; rather, it was manufactured through a system of brine wells and pumps, open-shed furnaces, and evaporating kettles. Saltville produced approximately four million bushels in its peak year of 1864, ultimately providing the Confederacy with two-thirds of its total salt supply. The salt works were subjected to a number of attacks by Federal forces throughout the war. Amazingly, the salt operations, along with the Wythe County lead mines and the Virginia and Tennessee Railroad (over which the lead and salt moved), remained intact and operational until near the end of the war.

AN OVERVIEW OF THE GEOLOGY OF ROCKBRIDGE COUNTY, VIRGINIA. G. P. Wilkes, Va. Div. Min. Resources, Charlottesville, Va. 22903, E.W. Spencer, Washington and Lee University, Lexington, Va. 24450, and N. H. Evans, Va. Div. Min. Resources, Charlottesville, Va. 22903. Rockbridge County, in the Valley and Ridge and Blue Ridge of west central Virginia, contains rocks ranging from Proterozoic to Devonian in age. Recent detailed geologic mapping in preparation for a new 1:50,000-scale geologic map of the county, has refined the understanding of the of stratigraphy and structure in many parts of the county. The Middle Ordovician carbonate section in Rockbridge County displays evidence for the transition from the northern Valley "Lincolnshire-New Market" lithologies to that more similar to the Southwest Virginia Middle Ordovician section. Thrust faulting, some of which have been folded by a continuous tectonic event, represents the overall structural style in the Goshen Pass-Mill Mountain area. The southern terminus of the North Mountain fault has been mapped in a anticlinal structure southwest of Collierstown. The Brownsburg window, where Beekmantown dolostone is exposed structurally below the North Mountain fault, has been expanded to include a previously unrecognized area. In the Big Mary's-Vesuvius area, previously unmapped faults and folds have produced an intricate map pattern in clastic rocks of the Antietam, Harpers, and Unicoi Formations. Thrust faults in Cambrian cover rocks in the Irish Creek area map into cataclastic shear zones in granulites and leucogranites of the Blue Ridge basement complex.

ENGINEERING AND GEOLOGICAL INVESTIGATION OF THE MIDDLE DEVONIAN MILLBORO SHALE AT BULLPASTURE MOUNTAIN, HIGHLAND COUNTY, VA: PRELIMINARY RESULTS. Woodard, Martin J. and Sethi, Parvinder S., Dept. of Geology, Radford Univ., Radford, VA 24142. A 950-foot road cut on Bullpasture Mountain, Highland County, Virginia was examined for its sedimentological and engineering properties. Stratigraphically the section contains the Lower Devonian Needmore Shale, the Tioga Bentonite, and Middle to Upper Devonian Millboro Shale. A progressive change in the level of benthic oxygenation from oxic to dysoxic/anoxic is evidenced by variations in sediment color, ichnofabric indices and amount of pyritization. Moreover, benthic change is suggested by a calcareous zone in the Millboro exhibiting concretions as large as three feet in diameter. Slope stability is controlled by bedding planes dipping at approximately 45° with the dip direction 50 into the outcrop with respect to the orientation of the road. Stability of the strata is further complicated due to presence of major joint and fracture patterns. A section exhibiting anthracitic characteristics and slickened bedding planes is also present severely weakening the slope and necessitating support via a rock buttress. Furthermore, the oxidation of pyrite in Millboro poses a significant environmental hazard in the drainage basin due to release of sulfuric acid.

MIDDLE WISCONSIN PALEOCLIMATES IN THE SOUTHWESTERN VIRGINIA HIGHLANDS. Thomas A. Wynn and G. Richard Whittecar, Prog. Geological Sciences, Old Dominion Univ., Norfolk, Va. 23529. In Russell County, Va., a fossil-rich Quaternary deposit lies in a first-order valley on the north-western slope of Clinch Mountain that drains into Moccasin Creek. Preserved within the deposit are mammoth bones, logs, and plant macrofossils. Radiocarbon analyses indicate the age of the organic-rich sediments ranges 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. Sedimentary processes fluctuated between debris flow activity and deposition in a body of standing water. As much as 5.2 m of organic-rich sediments accumulated in the hollow prior to 29,000 BP. Sedimentation rates increase upward through the section from 0.009 cm/yr to 0.05 cm/yr. After 29,000 BP, debris fan deposits from adjacent valleys buried the site in nearly 5 m of pebbly colluvium. Plant macrofossil evidence indicates the study site had a Boreal type environment from >44,000 BP to 29,000 BP. The slopes of the valley were covered by a spruce/jack-pine forest and the valley floor was a boggy area with standing water. The forest edges were dominated by the shrub *Rubus parviflorus* (Thimble Berry).

GEOMORPHIC EVOLUTION OF AN ALLUVIAL FAN COMPLEX, WINTERGREEN, VIRGINA. Melinda Youngblood* and G. R. Whittecar Prog. in Geol. Sci., Old Dominion Univ., Norfolk, VA 23529. Alluvial fans blanket many valley bottoms along the eastern slope of the Blue Ridge Mountains. In a seven km2 fan complex in the Rockfish Valley of Virginia, three mappable alluvial surfaces are distinguishable using soil and rock weathering criteria, and topographic position. Surficial fan sediments are clast-supported fluvial deposits that consist primarily of greenstone and chanokite cobbles. These are underlain by a discontinuous, saprolitized unit with similar composition and sedimentary structures that is recognized only in outcrops. This unit indicates a period of very prolonged or intense weathering. The highest surface remnants are the most weathered with very high clay contents (70-80%), very red soil matrix colors (10R to 2.5YR), and highly weathered clasts. Fan surfaces of intermediate elevation have high clay contents (60-75%), medium red-to-orange (2.5YR to 7.5YR) colors, and a mixture of rind types and rock competencies. The lowest fan surfaces contain relatively little clay (15-30%), yellow-to-brown (10YR) colors, and thin pale rinds. Rapid increases in color and clay between lower and higher surfaces may indicate rapid soil development or long periods of time between deposition. Data collected thus far does not disagree with previous studies of fans on the opposite side of the Ridge that suggested one large tectonically influenced deposit that maybe as old as Miocene, followed by climatically influenced short episodic events. Although evidence from the present study may support these hypotheses, absolute ages of the fan surfaces will be needed for confirmation.

Materials Science

NANOSTRUCTURED Fe-xAl ALLOYS FORMED BY MECHANICAL PROCESSING. Rama Balasubramanian[1], Desmond C. Cook[1], James C. Rawers[2]. [1]Physics Department, Old Dominion University, Norfolk, VA 23529. [2]U.S. Department of Energy, Albany Research Center, Albany, OR 97321. Blended Fe-xAl (where x = 0-20 wt.%) powders were mechanically processed in argon gas for times of 25, 50, 100 and 150 hours using an Attritor ball-mill. A study of the development of some of the nanocrystalline and microstructural properties as a function of different processing times was performed. Processing in an inert gas environment resulted in a continuous decrease in the grain size for aluminium concentrations up to 5 wt%. However, for aluminium concentration above 8 wt.%, the grain size decreased quickly for processing times less than 50 hours and then remained constant. For a processing time of 150 hours, the lattice parameter increased continuously as a function of aluminium concentration up to and including 10 wt.%. Aluminium was present predominantly at the grain boundaries, and the lattice was highly strained.

EXPERIMENTAL SETUP FOR CLAMPING FORCE MEASUREMENTS ON ELECTROSTATIC CHUCKS. Jesus Noel Calata & Guo-Quan Lu*, Dept. of Materials Science and Engineering, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061-0237. Wafer handling equipment play an important role in semiconductor wafer processing. Electrostatic wafer chucks are intended to replace the mechanical chucks that are currently used and eliminate most of the problems associated with mechanical chucks such as temperature uniformity, wafer flatness and particle contamination. An inexpensive apparatus was designed and fabricated to quickly measure the clamping force developed in electrostatic chucks. A load cell attached to a flat electrode that is in direct contact with the dielectric coating of the chuck is used to measure the clamping force. The chuck is mounted on top of a disk heater to allow clamping force measurements to be made above room temperature. Measurements obtained using the set-up show that the clamping force is proportional to the square of the applied voltage as predicted by mathematical models. At present, the apparatus can only be used at moderately high temperatures due to limits on the operating temperature of the load cell. Modifications are also necessary for accurate determination of the dechucking characteristics of electrostatic chucks.

IRON-ZINC PHASE MODIFICATION IN GALVANNEALED STEEL Trevor Q. Coddington & Desmond C. Cook, Dept. of Physics, Old Dominion Univ., Norfolk, VA 23529. Galvanneal steel is widely used within the international automotive industry to increase corrosion resistance of automobile body paneling. By allowing steel to anneal after hot-dip galvanizing, iron-zinc intermetallic phases form within the coating. Aluminum added to the galvanizing bath before annealing is believed to modify the formation of iron-zinc phases and to some extent control the coating characteristics of commercially produced galvanneal steel sheet. Our research is primarily concerned with the effect aluminum has on suppression or enhancement of the particular iron-zinc alloy phases present within the coating during galvannealing. The microstructure of commercially simulated galvanneal steel coatings was studied with aluminum contents of 0.11 and 0.15 weight percent, anneal temperatures of 482°C and 538°C, and varying anneal hold times between 0 and 25 seconds. Scattering Mössbauer spectroscopy, scanning electron microscopy, as well as X-ray diffraction were used to identify all iron-zinc phases in the approximately 10 μm thick coatings. Conversion electron Mössbauer spectroscopy was used to identify the outer surface layer of these coatings. Phase formation as a function of aluminum content in the galvanizing bath, anneal time, and anneal temperature will be presented.

ATMOSPHERIC CORROSION IN MÉXICO#. Desmond C. Cook[1], Sei J. Oh[1], Ann C. Van Orden[2] and Juan J. Carpio[3]. [1]Department of Physics, [2]Department of Mechanical Engineering, Old Dominion University, Norfolk, VA 23529, and [3]Programa de Corrosion del Golfo de México, Universidad Autonoma de Campeche, México. The regions surrounding the Gulf of México have some of the harshest environmental conditions in the world. Recently, a collaborative research program was formulated to address the issues involving corrosion in México with the aim of providing performance data on U.S. and Méxican produced structural steels which will be exposed at 12 sites between México city and Campeche. The initial findings concerning the atmospheric parameters show that time-of-wetness, chloride and sulfide concentrations at many locations are far higher than at any location in the United States. The site corrosion classifications of the International Standards Organization (ISO) find nearly all the Gulf sites falling into class 5, the most aggressive. This shows an inadequacy in the classification scheme since the corrosivity at many sites, although very high, is different. Initial carbon steel corrosivity data shows that some sites promote nearly twice the corrosion rate (300 μm/year) than that observed at the most aggressive site in the U.S. (160 μm/year). This is most likely due to the high combined chloride and sulfide pollutants, a situation which does not exist in the U.S. # N.S.F. Award: INT-96-02990.

INFLUENCE OF PLASMA COMPOSITION ON Ni_3AL FOIL QUALITY, Vincent H. Hammond, Dana M. Elzey, and Frank E. Wawner, Dept. of Materials Science and Engineering, Univ. of Va., Charlottesville, Va. 22903. Recently, interest in intermetallic matrix composites (IMC) has grown in response to demands for structural materials capable of operating at elevated temperatures. One such system currently under investigation is Al_2O_3 fiber-reinforced Ni_3Al. Ni_3Al is attractive for use at elevated temperatures due to its good oxidation and corrosion resistance, its low density, and superior strength retention at higher temperatures. Traditionally, IMCs have been produced by the foil/fiber/foil process, in which alternating layers of foil and fibers are stacked together for subsequent consolidation. Plasma spray deposition offers an alternative approach in which less expensive matrix powder is used. Molten droplets are created by injecting powder into a plasma torch. The droplets are then directed onto a substrate where they solidify to form a thin foil, or monotape, of material. Prior to manufacturing fiber-reinforced tapes, it is important to understand the influence that plasma gas composition has on the quality of deposited matrix foils. Tapes have been produced using both argon/hydrogen (Ar/H_2) and argon/helium (Ar/He) plasmas. Brittleness and poor surface quality were significant problems with foils produced using the Ar/H_2 plasma. The brittleness of the foil is attributed to the pickup of excess hydrogen during the deposition process. Microstructural studies revealed the cause of the poor surface quality to be the widespread distribution of micron sized particles on the foil surface. Both problems were eliminated when an Ar/He plasma was used in the deposition process. The improvement in foil ductility is explained by an approximate 7 fold reduction in hydrogen content. Examination of the foil surfaces revealed that the small particles present on the Ar/H_2 foil were absent from the surface of the Ar/He deposit.

INTERFACE ENGINEERING OF POWER ELECTRONIC MULTI-LAYERED DEVICES. Ashim Shatil Haque & Guo-Quan Lu*, Dept. of Materials Science and Engineering, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061-0237. Several issues related to first generation PEBB (Power Electronic Building Block) and the development of new PEBB structures with optimized materials selection and processing techniques is the main focus of this research. Various packaging technologies and substrate materials are being thoroughly examined for miniaturized power circuits including metals, ceramics, tape ceramics, laminated to high-performance ceramics, copper-clad ceramics, metal matrix composites and other state of the art engineered materials. Potential value of using new materials to replace the metal core, the heat spreader and the substrate in developing novel PEBB structures are also being investigated. Determination and evaluation of bonding techniques and the effects of interfaces and interlayers (based on the selected bonding techniques) on the properties of the assembled structure are being studied for efficient packaging. The overall optimization of these aforementioned parameters will ensure a strongly bonded PEBB package with excellent electrical and thermal management.

TRANSPARENT ABRASION RESISTANT SOL-GEL COATINGS. Kurt Jordens and Garth Wilkes*, Dept. of Chem. Engr., Va. Polytechnic Inst. & State Univ., Blacksburg, VA. 24061-0211. Using a modified sol-gel approach, highly abrasion resistant coatings can be made for metal substrates. Triethoxysilane functionalized organics combined with metal alkoxides in the sol-gel reaction can co-condense to form direct covalent bonds between the inorganic and organic components in the resulting three dimensional network. Incorporation of organics can reduce shrinkage upon curing and also lend flexibility. Thermal curing at elevated temperatures (in the range of 175°C for one hour) produces a uniform, highly abrasion resistant coating of ca. 2 microns in thickness. Such a coating on polished aluminum exhibits excellent adhesion. Folding such a coated specimen back upon itself ("0T fold") will not crack or debond the coating from the polished aluminum. Since mechanical interlocking likely plays little role in the adhesion to this substrate, we propose that the observed adhesion could be the result of direct covalent bonds between the aluminum surface and the coating. This is feasible through the reaction of alkoxysilane groups in the coating formulation with surface hydroxyls on the polished aluminum. Other substrates such as copper, brass, and stainless steel have been observed to benefit by such abrasion resistant coatings analogously.

INFLUENCE OF DIETHANOL AMINE ON THE STRUCTURE-PROPERTY RELATIONSHIPS OF MOLDED FLEXIBLE POLYURETHANE FOAMS. Bryan D. Kaushiva and Garth L. Wilkes, Chemical Engineering Dept., Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061-0211. The addition of the cross-linking agent diethanol amine (DEOA) to molded flexible polyurethane foams is common. However, the effect that this has on structure-property relationships of the foams is not well understood. This was studied through the use of solvent extraction, dynamic mechanical analysis (DMA), differential scanning calorimetry (DSC), small and wide angle x-ray scattering (SAXS and WAXS). Solvent extraction results indicate that DEOA does increase the covalent nature of the network. However, the DMA and DSC results show that DEOA does not increase the degree of phase mixing between the hard and soft segments in the foam. WAXS indicates that the addition of almost any significant amount of DEOA disrupts the "paracrystalline" ordering of the hard segments. Finally, SAXS reveals systematic increase of long spacing with DEOA addition, which, when considered with the data from the other tests, suggests an increasing size of the hard domains. These results indicate that DEOA largely resides in the hard domains and that the degree of phase separation is not affected. They also suggest that higher temperature physical properties rely more on the covalent network in contrast to the microphase texture of the hard domains.

DETERMINATION OF THE CORROSIVE SOLUTION FORMED WITHIN AIRCRAFT LAP-SPLICE JOINTS. Karen S. Lewis & Dr. Robert G. Kelly *, Dept. of Materials Sci. & Eng., Univ. of Va., Charlottesville, VA 22903. As the aircraft fleet ages, the need for accurate predictive corrosion models increases. Occluded sites are important to model due to changes in local chemistry. The lap-splice joint formed at the junction of the aircraft skin suffers extensive corrosion in some cases. The first step is to understand the solutions that evolve during service. The goal of this project is to determine the corrosive species present and make predictions about the effects of these within the lap-splice. The solutions collected are analyzed with capillary electrophoresis (CE). Common cations found are K^+, Al^{3+}, Mg^{2+}, Na^+, and Ca^{2+}. Common anions are NO_2^-, Cl^-, SO_4^{2-}, NO_3^-, F^-, HPO_4^{2-}, and HCO_3^-. These results cast doubt on use of neutral or acidified 3.5% NaCl as a simulant for conditions within lap-splice joints. The future goals are to obtain and analyze more joints and to refine the model solution.

MICROBUCKLING IN UNIDIRECTIONAL FIBER REINFORCED POLYMER MATRIX COMPOSITES IN END-LOADED BENDING. Céline Agnès Mahieux and K. L. Reifsnider*, Depts. of Materials Engineering and Science and Engineering Science and Mechanics, Va. Polytechnic Inst. & State Univ. Blacksburg, VA 24060. The effect of time and temperature on unidirectional carbon fiber reinforced polymer matrix composites under a quasi-static bending load has been investigated. These materials have been shown to exhibit a viscoelastic behavior. Stress rupture in compression bending at elevated temperatures has been observed for the first time. The matrix undergoes simultaneous creep and relaxation, allowing local buckling of the fibers. The overall failure process of the specimen was found to be driven by the nucleation and propagation of microbuckles. Microscopic and macroscopic observations enabled a better understanding of the microbuckling process. Three different micromechanical models have been applied to analyze the time-to-failure versus strain behavior at two temperatures - one below and one above the glass transition. The first micromechanical model considers the nucleation of the microbuckles as the main cause of failure. In addition, the stiffness and stress distributions at any time before failure are calculated based upon the rotation of the fibers in the damaged regions. The second and last models, based upon a Paris Law and energy considerations, respectively, relate the time-to-failure to the propagation of the main microbuckle. For this last model, a good correlation between experimental and theoretical data has been obtained. Finally the influence of the temperature on these models has been investigated. (Supported by AFOSR under Grant No. F49620-95-1-0217)

MÖSSBAUER AND RAMAN STUDIES ON WEATHERING STEELS EXPOSED FOR SIXTEEN YEARS. Sei Jin Oh, D.C. Cook and H.E. Townsend[1], Dept. of Physics, Old Dominion Univ. Norfolk, VA 23529, [1]Bethlehem Steel Corporation, Bethlehem, PA 18016. The corrosion products formed on six different weathering steels, have been investigated using Mössbauer and Micro-Raman spectroscopies. The coupons were exposed for sixteen years in an industrial environment. α-FeOOH, γ-FeOOH, γ-Fe_2O_3 and Fe_3O_4 were identified in the corrosion products present on the coupons. The dominant oxide was α-FeOOH or γ-Fe_2O_3. The largest relative fractions of nano-sized γ-Fe_2O_3 appeared in the corrosion products present on coupons containing high amounts of Si and Cr in the steel substrate. By increasing P content, the relative fraction of α-FeOOH increased in the corrosion products. The corrosion layer generally consisted of an inner layer composed of the α-FeOOH and nano-sized γ-Fe_2O_3 phases and an outer layer composed of the α-FeOOH and γ-FeOOH phases independent of the weathering steel type. The protective layer present in corrosion products corresponded to the inner layer. By increasing Si and Cr contents, the relative fraction of the protective layer increased, while the corrosion rate decreased. It is concluded that the corrosion resistance of weathering steel increases until increase Si and Cr contents.

SEGMENTAL COOPERATIVITY IN GLASS-FORMING MISCIBLE POLYMER BLENDS AND THE INFLUENCE ON STRUCTURAL RELAXATION. Christopher Robertson and Garth Wilkes, Chemical Engineering Department, Polymer Materials and Interfaces Laboratory, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0211. Structural relaxation rates for miscible polymer blends of atactic polystyrene (a-PS) and poly(2,6-dimethyl-1,4-phenylene oxide) (PPO) were assessed for isothermal aging in the glassy state and compared to the pure polymer relaxation rates. Specifically, volume relaxation rates were measured via dilatometry at 30°C below the inflection glass transition temperature (T_g), and enthalpy relaxation rates were determined for aging at T_g-30°C. The compositional dependence was qualitatively similar for volume relaxation compared to enthalpy relaxation, and the trend featured the blend relaxation rates falling below weighted contributions from the structural relaxation rates of the pure components. The blends exhibited cooperative domains, for dynamic mechanical relaxation at T_g, which possessed greater numbers of segments than expected based upon the values of the neat materials. This indicates that the decreased structural relaxation rates for the blends aged at T_g-30°C were correlated with an increased degree of required segmental cooperativity between relaxing segments in the blends compared to the pure polymers.

THE FORMATION OF DISPERSOIDS IN ALUMINUM VIA REACTION PROCESSING. 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. Surface oxides or other oxides added to the powder mixture were responsible for any strengthening. Using a different approach, this study achieved in-situ formation of dispersoids via MA and displacement reactions. Mixtures of aluminum and Fe_2O_3 were produced using MA for various different milling times. The resulting powders were compacted and annealed to initiate a "thermite-type" displacement reaction which produced dispersoids of Al_2O_3 and Al_3Fe. Product dispersoid size was strongly dependent on MA milling time. As MA milling time increased, reaction product size decreased. As a result of the decreased dispersoid size, hardness of the aluminum alloy was markedly increased.

THE MEASURED STRESS/STRAIN RESPONSE OF AN ALUMINA FIBER BUNDLE. Paul Cantonwine and Haydn Wadley, Dept. Mat. Sci. and Engr., University of Virginia, Charlottesville, Va 22903. Oxide/oxide ceramic matrix composites (CMCs) are being developed for high temperature applications where environmental degradation is a major concern. An important aspect of this development is understanding when and why failure occurs. Our work has concentrated specifically on how high temperature affects the reinforcing filaments of an oxide/oxide CMC. Alumina bundles made by 3M (Nextel 610) were heat treated from 1100 to 1450 °C for 1 minute. The single filament strengths were measured and the Weibull parameters calculated. The single filament strength was about 3.3 GPa in the as-received condition and dropped to 2.7 GPa after heat treating at 1450 °C. The room temperature bundle stress/strain response was measured and compared to ideal bundle predictions. An ATS 1100 series and an OPTRA laser extensometer 3000 were used to measure the load and strain directly. The alumina bundles behaved ideally until the heat treatment at 1400 °C. At 1400 and 1450 °C, the ideal bundle model over-predicted the strength significantly. From fractography analysis the lower than expected strengths were attributed to filament/filament sintering.

Medical Science

EVALUATION OF THE ADJUVANT ACTIVITY OF THE SILICONE COMPONENTS OF MEDICAL DEVICES IN FEMALE B6C3F1 MICE. David M. Barrett, Leon F. Butterworth*, and Kimber L. White, Jr., Dept. of Biomedical Engineering, Va. Commonwealth Univ., Richmond, Va., 23298. Silicone containing devices have long been used as medical implants. Recently, however, concern has arisen over the ability of silicone materials to contribute to autoimmune disease by way of their adjuvant properties. The purpose of this study was to assess several silicone gels, small linear siloxanes and small cyclic siloxanes for adjuvant potential and investigate their mechanisms of action and thus provide insight into their potential to induce autoimmune diseases. The silicones studied included Dow Corning Mammary Gel, Dow Corning Testicular Gel, Mentor Testicular Gel, octamethyltrisiloxane (L3) and octamethylcyclotetrasiloxane (D4). The silicone materials were mixed with bovine serum albumin (BSA) and injected intramuscularly (i.m.) in female B6C3F1 mice. Adjuvant activity was quantified by serum antigen-specific IgG antibody levels measured by a multi-point ELISA procedure. All silicone gels demonstrated adjuvant activity. The small siloxanes L3 and D4 proved to be the most potent adjuvants of their respective classes, capable of statistically significantly increasing antibody levels to BSA above control levels. All silicone materials had to be mixed with the antigen to produce increased antibody levels. Investigation with L3 revealed only two IgG subclasses (IgG1 and IgG2b) were significantly elevated, suggesting an effect on specific cytokine production. While the silicone gels are thought to act as adjuvants by acting as a deposition site for antigen retention, D4 and L3 cause a significant inflammatory response and appear to act as adjuvants not by the deposition site mechanism but by modulating cytokine production. (Supported in part by Dow Corning Corporation and NIEHS training grant ESO 7087.)

ANTINOCICEPTIVE EFFECTS OF OPIOID AGONISTS AND ATP-GATED POTASSIUM CHANNEL OPENERS IN THE MOUSE BRAIN. Alka Bhargava and Sandra P. Welch, Dept. of Pharm./Tox, Va. Commonwealth Univ., Richmond, VA 23298. Potassium channel openers and opiates are both hypothesized to produce antinociception by cell hyperpolarization. This alteration in resting potential decreases intracellular calcium levels which arrests neurotransmitter release leading to analgesia. Both the ATP- gated potassium channel openers diazoxide, lemakalim and the opiate morphine induce cell hyperpolarization by opening the potassium channels and enhancing potassium efflux. Diazoxide, administered i.c.v., produced antinociception as determined by the tail-flick method. The ED_{50} was 80 µg per mouse (±confidence limits 41-154 µg). It should be noted that diazoxide was only a partial agonist. Similarly, lemakalim demonstrated dose-dependent antinociception. Diazoxide- and lemakalin-induced antinociception were attenuated by naloxone (20µg/mouse), the opiate antagonist, upon i.c.v. administration. The antinociceptive effects of diazoxide were only partially blocked by the ATP-gated potassium channel antagonist, glyburide (20µg/mouse). Increasing doses of glyburide produced a biphasic antinociception with an ED_{50} 46 µg (±25-89). The release of endogenous opioids as the mediator of potassium channel opener induced antinociception remains under further investigation.

This work was supported by NIDA grant #'s DA01647-20 and K02 DA00186-05.

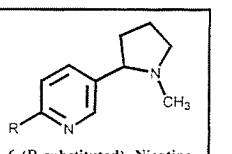
EFFECTS OF VOLATILE SOLVENTS ON SENSORIMOTOR REACTIVITY IN RATS. Scott E. Bowen, Jenny L. Wiley, and Robert L. Balster*, Dept. of Pharmacology & Toxicology, Va. Commonwealth Univ., Richmond, VA 23298. Abused inhalants can produce behavioral abnormalities at concentrations even lower than those that cause organic dysfunction. The purpose of the present study was to examine the effects of abused inhalants in the acoustic startle paradigm. This procedure has been used to model sensorimotor reactivity and gating, pre-attentional processes that may be disrupted by mental illness, substance abuse, or drug withdrawal. Following exposure to a volatile inhalant or to air, rats were placed in startle chambers in which they were exposed to acoustic pulses presented alone or preceded by a prepulse. Similar to the results with CNS depressant drugs, ethanol and pentobarbital, higher concentrations of 1,1,1-trichloroethane, methoxyflurane, xylene, and flurothyl decreased startle amplitudes during pulse alone trials, but none of these compounds affected prepulse inhibition. In contrast, toluene produced increases in startle amplitudes during pulse alone trials but did not affect prepulse inhibition. Although all of the solvents affected sensorimotor reactivity, differences between the effects of toluene and those of the other solvents suggest that abused inhalants may not represent a homogenous class of compounds. (Supported by NIDA grants DA-05670 and DA-03112.)

THE EFFECTS OF OPIOID ANTINOCICEPTION BY ORAL ADMINISTRATION OF DELTA-9 TETRAHYDROCANNABINOL. Diana L. Cichewicz, Zachary L. Martin, Forrest L. Smith & Sandra P. Welch, Dept. of Pharm/Tox, Va. Commonwealth Univ, Richmond, Va. 23298. Delta-9 tetrahydrocannabinol (THC) is a Schedule II drug (Marinol) approved for medical use. The use of Marinol has prompted our studies of its effects in combination with other drugs. Previous reports demonstrate that THC administered orally to mice enhances the potency of morphine-induced antinociception when given subcutaneous or orally. Therefore, other opioid drugs may also be enhanced by prior administration of inactive doses of THC. A dose of THC (20 mg/kg) was administered to mice p.o. prior to the opioids, and antinociception was measured by the tail-flick test. Fentanyl and pentazocine showed little or no enhancement in potency when preceded by THC treatment. The ED50 for oxymorphone was shifted from 2.8 mg/kg (1.0-8.4) to 0.6 mg/kg (0.2-1.6) by THC. The shift in ED50 for methadone due to THC pretreatment was from 12.7 mg/kg (6.7-24.0) to 3.0 mg/kg (1.2-7.7). The maximum effect of codeine at a 10 mg/kg dose was 8% MPE, while the maximum effect of THC plus codeine at 10 mg/kg was 80% MPE. The maximum effect of meperidine at 30 mg/kg was 29% MPE, and the maximum effect with THC at 30 mg/kg was 66% MPE. In summary, we found that not all opioids are enhanced by prior administration of THC, suggesting there is a selectivity among the opioids. Although the mechanism of this selectivity is unknown, it may represent a kinetic interaction. These results may give some insight into treatment for human cancer patients, allowing a reduction in opioid dose in combination with THC to reduce undesired side effects, to prevent tolerance and to treat opioid-resistant pain. This work is supported by NIDA grants #DA05275 & DAK0200186.

TRACKING OF SPECTRAL DIPOLES OF TOXIC POLLUTANTS CONCENTRATION FROM WATER TO FISH BILE. Germille Colmano, Dept. of Biomedical Sciences and Pathobiology, VT. An animal body, a sac of salt water, evolved from the original sea water, is the container we fancy as homo sapiens, explaining his/her world in their own image. Science, claims we are chemically made of elements (H,O,N,C, and a sprinkle of salts: Ca,Fe,Mg,P,Mg..), or physical photonic particles, that shows us as dipoles of organized energy. A spectrophotometer, scanning fluids of the body, can detect molecular changes in frequency of molecular vibrations, depicting differences between normal (so-called healthy) and abnormal (diseased) conditions. The toxic pollutants that affect us have detectable molecular fingerprints we can follow within our own sac of molecular vibrational frequency patterns. Fish, a sea representative, is an optimal laboratory, concentrating its body's metabolites in the bile. We followed 15 fishes [5 controls, 5 on low, and 5 on high benzo(a)pyrene] and found distinct differences with 3 completely different patterns for the 3 groups.

MODULATION OF ATP-GATED POTASSIUM CHANNELS FOLLOWING MORPHINE TOLERANCE AND WITHDRAWAL. Vera Combs and Sandra Welch Ph.D., Dept of Pharm. and Tox., Va. Commonwealth Univ., Richmond, VA 23298. Potassium channel blockers and openers were utilized to evaluate the modulatory role of morphine on ATP-gated K^+ channels. Potassium channels play an important role in setting the resting membrane potential in many cells. This regulates the cell's electrical activity and ion transport. Glyburide and glipizide are blockers of ATP-gated K^+ channels which increase Ca^{2+} conductance. Potassium channel openers on the other hand produce cellular hyperpolarization and a decrease in Ca^{2+} influx. Lemakalim, diazoxide, minoxidil, and opioids function as openers of K^+ channels. Apamin and charybdotoxin are blockers of small and large conductance Ca^{2+}-gated K^+ channels, respectively. They were also shown to block the effects of opioids. Apamin blocked the effects of the opioids morphine, DPDPE, and U50, 488H. The voltage gated potassium channel blockers TEA and 4-AP did not block the effects of the opioids or the ATP-gated K^+ channel openers. Glyburide blocked the effects of morphine as well as lemakalim, diazoxide, and minoxidil. Previous studies indicate that neither morphine nor glyburide displaces one another in binding studies. This indicates they are acting at different receptor populations. Acutely, morphine increases the affinity of those sites and produces no change in receptor number. Upon chronic morphine administration there is a change in glyburide-sensitive binding sites. There is an upregulation of glyburide receptors as well as a decrease in affinity. Therefore, we want to quantify the changes that occur in receptor number and affinity following spontaneous withdrawal. We would also like to determine how long the receptor changes last. The second goal of this project is to show that ATP-gated K^+ channel openers release endogenous opioids. Lemakalim, diazoxide, and minoxidil produce antinociception upon central administration. These antinociceptive effects are attenuated by the opioid antagonist naloxone. Such data indicate that the K^+ channel openers may release endogenous opioids in the spinal cord. Endogenous opioid levels are quantifiable in Sprague Dawley rats using the spinal perfusion method and radioimmunoassay. In summary, considerable evidence suggests a role for ATP-gated K^+ channels in opioid antinociception and tolerance. Conversely, K^+ channel openers appear to act via release of endogenous opioids. The evaluation of such an interaction of opioids with the K^+ channel may clarify the mechanisms underlying the expression of tolerance.

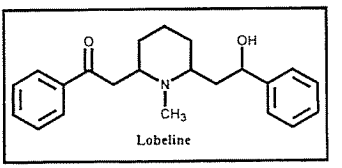
ROLE OF 6-POSITION SUBSTITUENTS ON THE BINDING OF NICOTINE AT NICOTINIC CHOLINERGIC RECEPTORS. M. Dowd, M. Dukat, M. El-Zahaby, R. A. Glennon. Department of Medicinal Chemistry, School of Pharmacy, MCV/VCU; Richmond, VA 23298. Nicotine possesses significant therapeutic potential (anxiety, memory, appetite, neurological disorders) but is characterized by toxic side effects. In order to develop novel nicotinic ligands with reduced toxicity, we undertook a structure-activity study to identify what structural features are important for binding. In this process, we found that the 6-position is amenable to modification [Eur J Med Chem (1996) 31: 875]. Certain derivatives bind with higher affinity, and are more potent in functional assays, than nicotine itself. Hansch analysis and other QSAR studies suggest that both electronic (σ) and steric or lipophilic (π) properties of the 6-position substituent may contribute to binding. Further analysis reveals an internal correlation between these properties (σ and π) indicating that one may be more important than the other. Additional 6-substituted compounds were prepared and evaluated in order to evaluate proposed hypotheses. QSAR studies were repeated.



6-(R-substituted) Nicotine

DIFFERENTIAL DYNORPHIN B RELEASE BY VARIOUS CANNABINOIDS. Micah Eads, Susan Houser*, and Sandra P. Welch, Dept. of Pharm./Tox., Va. Commonwealth Univ., Richmond, VA 23298
Previous studies have examined the relationship of dynorphin A, dynorphin B, and the kappa-opiate receptor with the production of cannabinoid - induced antinociception. Our studies indicate that cannabinoids may exhibit differential binding to cannabinoid receptors. In this study, the levels of spinal dynorphin B and the relationship to the antinociceptive activity following exposure to various cannabinoids was investigated. Δ^9 - THC has been shown to release significant levels of dynorphin A and produce antinociception 10 minutes post administration. CP55,940 (CP55) and anandamide do not release dynorphin A. However, all the cannabinoids produce antinociception. Furthermore, after CP55 was administered into the spinal cord, significant levels of dynorphin B were released at 10 minutes post administration. Using spinal perfusion techniques and radioimmunoassay, spinal dynorphin B concentrations were measured. Animals treated with CP55 and anandamide produced significant antinociceptive activity at 10 minutes post administration, and Δ^9 -THC and CP55 produced significant antinociceptive activity at 30 minutes. Dynorphin B concentrations were significantly increased at 10 minutes post administration of Δ^9 - THC. CP55 induced release of dynorphin B was two-fold greater than vehicle. There were no significant changes in the dynorphin B levels at 30 minutes post administration of any of the cannabinoids. These results may indicate that there are two different binding sites for cannabinoids: one site where only Δ^9 - THC binds and releases dynorphin A and the other site where Δ^9 - THC and CP55 bind and release dynorphin B. This study was supported by NIH grants #'s K02 DA00186, DA03672, and DA05274.

PRELIMINARY STRUCTURE-AFFINITY STUDIES ON THE BINDING OF LOBELINE AT CENTRAL NICOTINIC RECEPTORS. D. Flammia, M. Dukat, M. I. Damaj, B. R. Martin, R. A. Glennon. Departments of Medicinal Chemistry, School of Pharmacy, and Department of Pharmacology and Therapeutics, MCV/VCU; Richmond, VA 23298. Lobeline, a naturally occurring alkaloid, binds at central nicotine receptors with an affinity comparable to that of nicotine itself. As such, it offers a new template for the development of novel nicotinic agents that might be useful in the treatment of memory impairment and various neurological disorders. Essentially nothing is known about what and how the various structural features of lobeline contribute to binding. Thus, we undertook a structure-affinity investigation. For example, we investigated stereochemistry; further, removal of the three-carbon unit forming the piperidine ring, and elimination of either of the arylalkyl arms (as in the appropriately substituted piperidine or the more simplified N,N-dimethylamines), reduces nicotine receptor affinity. Removal of both oxygen functions abolishes affinity. To date, it would appear that nearly all of the structural features of lobeline contribute to optimal binding.

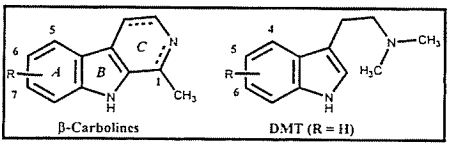


Lobeline

ARE SOME OF THE SEXUAL, BEHAVIORAL, AND PHYSIOLOGICAL EFFECTS OF PRENATAL STRESS (PS) DUE TO ALTERATIONS OF NEURONAL MORPHOLOGY IN MEDIAL PREOPTIC AREA (mPOA) NEURONS?. K. Gerecke, A. Jasnow, Kishore*, P. Quadros* & C.H. Kinsley, Dept. of Psych., Univ. Richmond, Virginia, 23173. PS males respond to sexually-receptive females with little or no luteinizing hormone release (Kinsley et al., 1992), and very low c-fos expression in mPOA (Humm et al., 1995) suggesting *functional* differences. We examined *structural* differences in mPOA neurons in PS and control male and female rats. Timed-mated rats were subjected to thrice-daily heat, light and restraint stress from days 14-21 of gestation. In adulthood PS and control (C) offspring (n=6 each) were killed and their brains removed, stained with Golgi-Cox and measured. Effects ($p < 0.06$-0.01) included: Basal dendritic length (C-females > C-males; PS-males > C-males; C-females > PS-females). Number of dendritic branches (C-females > C-males, C-females > PS-females). Apical dendritic branch number (C-females > PS-females). Apical dendritic length (C-female > PS-female). Perimeter of perikaryon (C-male < PS-male; C-female > PS-female). PS, then, may induce fundamental alterations of neuronal populations in specific brain regions involved in sexual behavior. Changes in neuronal structure can modify the information-processing capacity of the neuron, thereby vastly altering the "downstream" behavioral outputs. (Supported by NSF & U. of R. research funds.)

DISCRIMINATIVE STIMULUS EFFECTS OF GABA AGONISTS IN SQUIRREL MONKEYS TRAINED TO DISCRIMINATE PCP OR NPC 17742 FROM SALINE. Keith M. Golden, Jenny L. Wiley, and Robert L. Balster*, Dept. of Pharmacology & Toxicology, Va. Commonwealth Univ., Richmond, VA 23298. Previous studies have shown an overlap in the profile of behavioral effects of GABA agonists and NMDA antagonists. In drug discrimination studies, competitive NMDA antagonists fully substitute for pentobarbital in rats and mice trained to discriminate this GABA agonist from saline. In contrast, non-competitive phencyclidine(PCP)-like drugs do not substitute for pentobarbital. The present study investigated an array of GABA agonists in two groups of squirrel monkeys trained to discriminate either PCP (0.1 mg/kg) or the competitive NMDA antagonist NPC 17742 (3 mg/kg) from saline in a standard two-lever drug discrimination procedure under a fixed ratio 30 schedule of food reinforcement. This procedure has been used to predict the subjective effects of novel psychoactive drugs in humans. In the NPC 17742-trained group, the benzodiazepine diazepam elicited a slight increase in drug lever responding. Other GABA agonists, including muscimol, baclofen, pentobarbital, and valproic acid, failed to produce reliable substitution in either group of monkeys. Combined with the results of previous studies in which a GABA agonist was used as a training drug in drug discrimination, these results suggest that the subjective effects of competitive NMDA antagonists in humans would be more similar to GABA agonists than the effects of PCP-like NMDA antagonists; however, the fact that generalization between GABA agonists and competitive NMDA antagonists is asymmetrical suggests that there would also be differences in the subjective effects of these drugs. Hence, the overlap of behavioral effects of GABA agonists and NMDA antagonists is only partial. (Supported by NIDA grant DA-01442.)

SYNTHESIS/BINDING OF HALLUCINOGENIC β-CARBOLINES AT 5-HT_2 SEROTONIN RECEPTORS. B. Grella,[†] M. Dukat,[†] C. Smith,[‡*] M. Teitler,[‡*] R. A. Glennon.[† *] [†]Dept. of Medicinal Chemistry, School of Pharmacy, MCV/VCU; Richmond, VA 23298. [‡]Department of Pharmacology, Albany Medical College; Albany NY 12208. The β-Carbolines represent a large and essentially uninvestigated class of naturally occurring, semisynthetic, and synthetic hallucinogens. These agents may be viewed as conformationally restricted analogs of the tryptamine hallucinogens such as DMT. DMT-like and other classical hallucinogens are thought to produce their effects via interaction with 5-HT_2 receptors in the brain. If the β-carbolines act in the same fashion (a) they should bind at 5-HT_2 receptors, and (b) their structure-affinity relationships (SAFIR) should parallel those of DMT. Parallel modification of *A*-ring substituents R results in three families of β-carbolines depending upon the presence/absence of double bonds in the *C* ring (i.e., fully saturated, 3,4-dihydro, 1,2,3,4-tetrahydro; analogs of harman, harmalan, and tetrahydroharman, respectively). Various β-carbolines bind at 5-HT_2 receptors, but SAFIR does not parallel DMT SAFIR in a straight-forward fashion.



OCCURRENCE AND DISTRIBUTION OF UBIQUITINATED PROTEIN IN CATARACTOUS LENSES FROM RATS TREATED WITH SODIUM SELENITE. E.S. Gwynn and J.L. Hess, Department of Biochemistry, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061-0308. In many animals, formation of nuclear cataract correlates with proteolysis. Ubiquitin is involved in the regulation of protein turnover by covalently bonding to proteins that will be degraded. How ubiquitin conjugation may contribute to cataract formation is not understood. We investigated ubiquitin content in the soluble, urea-soluble, and urea-insoluble lens protein fractions from normal rat lens and cataractous lenses 96 hours after selenite treatment. Lenses were removed from preweanling rats, frozen in liquid N_2, and dissected into fractions enriched in cortex and nucleus. Proteins were transferred to a nitrocellulose membrane and detected with ubiquitin polyclonal antibody.(E. Beers, Virginia Tech, Blacksburg, VA) Ubiquitin consistently yielded greater antibody conjugation in the nuclear portion of the lens and primarily in the urea-soluble and urea-insoluble fractions. Ubiquitin conjugation was found to be greater in lenses from selenite-treated rats and may contribute to the mechanism of cataract formation.

THE INHIBITION OF PDGF-INDUCED SMOOTH MUSCLE CELL MIGRATION BY DEHYDROEPIANDROSTERONE. C. Huynh, S. Gallik, & K.E. Loesser, Dept. of Biol. Sci., Mary Washington Coll., Fredericksburg, VA 22401. Atherosclerosis is a major health problem characterized by gradual thickening of the arterial wall resulting in a narrowed lumen. Although angioplasty is a commonly used procedure to treat atherosclerosis, it is not effective long-term due to the rapid reocclusion of the lumen (restenosis) with smooth muscle cells. Most scientists agree that the mechanism for both atherosclerosis and restenosis involves growth factors. One such factor, platelet-derived growth factor (PDGF), has been shown to be a smooth muscle cell chemoattractant. Recent evidence suggests that the steroid hormone dehydroepiandrosterone (DHEA) has anti-atherosclerotic effects. The purpose of this study was to determine whether DHEA exerts these effects by inhibiting PDGF-induced smooth muscle cell migration. Boyden blind-well chambers containing PDGF only, DHEA only, or PDGF plus varying concentrations of DHEA in the bottom well, and 30,000 smooth muscle cells in the top well were incubated for 4 hours and the number of migrated cells was quantified. Our data demonstrates that DHEA in varying concentrations inhibits smooth muscle cell migration, suggesting that this is one of DHEA's anti-atherogenic effects.

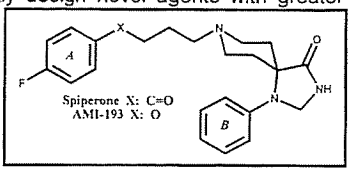
POSSIBLE MODIFICATIONS OF NITRIC OXIDE SYNTHASE (bNOS) ACTIVITY IN MEDIAL PREOPTIC AREA (mPOA) OF ACTIVITY-STRESSED (AS) MALE RATS. A. Jasnow, K. Gerecke, E. Mueller*, P. Quadros*, M. McElroy*, G. Esterhai*, R. Trainer*, K.G. Lambert* & C.H. Kinsley, Depts. of Psych., U. of Richmond & *Randolph-Macon Coll., Va. Stress exerts deleterious effects on the sexual capacity and behavior of animals (Sapolsky, 1994). The role of bNOS in the expression of male sexual behavior is becoming clear. Too little, or blockade of its synthesis, and sexual behavior is disrupted (Benelli et al., 1995; Bialy et al., 1996). The A-S paradigm, characterized by housing rats in activity wheels and feeding them for one hour per day (which results in a marked increase in voluntary activity), elevates corticosterone and produces ulceration in gastric corpora. We, therefore, examined the influence of AS on bNOS in the mPOA, a brain region that regulates male sexual behavior. Brains were obtained (n=3 each) from AS, pair-fed (PF) and non-stressed (NS) males and processed for bNOS immunohisto-chemistry. Image analysis was performed to count bNOS immunopositive neurons and the area of selected perikarya. AS rats had significantly less bNOS in mPOA compared to both PF and NS (which did not differ). Further, perikaryon area was larger in AS neurons compared to PF and NS. AS, and stress in general, may disrupt sexual behavior, in part, through depletion of, and/or effects on, bNOS neurons in mPOA. (Supported by NSF, Univ. of Richmond & R-MC research funds.)

INDUCTION OF APOPTOSIS IN THYMOCYTES OF MICE EXPOSED TO 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN (TCDD) CORRELATES WITH ALTERED EXPRESSION OF T CELL RECEPTOR AND OTHER ADHESION MOLECULES. A. B. Kamath[1], H. Xu[1*], P. S. Nagarkatti[2], and M. Nagarkatti[1]. [1] Dept. of Biomed. Sciences and Pathobiology, Va-Md Regional Col. of Veterinary Med.; [2] Dept. of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. TCDD is a highly toxic environmental pollutant and is well known for inducing thymic atrophy in mice although the exact mechanism of its action remains unclear. Studies in our lab. revealed that administration of 50 μg/kg body weight of TCDD into C57BL/6 mice i.p. triggered significant apoptosis in thymocytes at 8-12 h after the treatment and was not detected later on, upto 120 h. The apoptosis was demonstrable using the TUNEL method and analyzing the cells flow cytometrically as well as using the JAM test in which thymocytes from TCDD-treated mice labeled with ^{3}H-thymidine exhibited increased DNA fragmentation when compared to the controls. Recently, thymocytes undergoing natural apoptosis were shown to upregulate the T cell receptor as well as exhibit altered expression of a number of adhesion molecules. In the current study we analyzed the expression of a variety of adhesion molecules on TCDD-treated thymocytes. Interestingly, in TCDD-treated thymocytes undergoing apoptosis, there was a significant increase in the expression of CD3, αβTCR, CD44 and IL-2R and a decrease in the expression of J11D, CD4 and CD8 molecules, when compared to the controls. Thymocytes undergoing spontaneous steroid-induced apoptosis in culture were also shown to downregulate CD4, CD8 and J11D while upregulating TCR and IL-2R expression. We noted similar alterations *in vivo* following TCDD treatment thereby corroborating that apoptosis constitutes an important mechanism of TCDD-induced immunotoxicity.

BENZO(A)PYRENE INDUCED SUPPRESSION OF THE SECONDARY HUMORAL IMMUNE RESPONSE. G. Craig Llewellyn and Kimber L. White Jr., Dept. of Pharmacology and Toxicology, Med. Col. of Va., Va. Commonwealth Univ., Richmond, VA 23298. The environmental contaminant benzo(a)pyrene (BaP) has been shown to suppress the humoral immune response in man and animal models. The immune suppression is thought to be mediated by a diol-epoxide metabolite of BaP, and the macrophage is the only resting splenic cell type capable of producing BaP diol-epoxide. While previous studies have focused only on the primary IgM response, the objective of these studies is to determine the mechanism responsible for BaP induced suppression of the secondary IgG response. BaP administered dermally for 14 days to female B6C3F1 mice (0 to 40 mg/kg) dose-dependenfly decreased both the IgM and IgG response to the T-dependent antigen sheep red blood cell (sRBC). Also, the total serum concentration of all four IgG subclasses (1, 2a, 2b, and 3) was decreased by approximately 50%. *In vitro* evaluation of the T-dependent antibody response by Mishell-Dutton assay revealed the antibody-forming-cells/10^6 spleen cells response was decreased by BaP above 0.1 mM. The *in vitro* mitogen driven spleen cell culture production of IL-2, IL-4, and IL-6 were suppressed by BaP (l0 mM). However, production of IFNγ and the polyclonal IgM response were not affected. In order to examine the effects of BaP on the IgG response, mice were sensitized with SRBC and allowed to generate an IgM response prior to 14 days of dermal BaP exposure. During the BaP dosing, the mice were resensitized with SRBC, and the IgG response was not suppressed. Similarly, the IgG response elicited *in vitro* was not altered. Thus, generation of the IgG response is not suppressed by BaP following the production of immunologic memory. Current and future studies will focus on the production of BaP metabolites and expression of P4501A1 mRNA in activated B and T-cells and the production of memory B and T-cell populations. Supported in part by NIEHS contract ESO 9522 and training grant ESO 7087.

THE EFFECT OF ACUTE INTRATHECAL ADMINISTRATION OF Δ^9-THC ON SPINAL DYNORPHIN A (1-8) CONCENTRATION. David J. Mason and Dr. Sandra Welch, Department of Pharm. and Tox., Va. Commonwealth Univ., Richmond, Va. 23298. The mechanism by which Δ^9-THC induces antinociception has been of intense study in this laboratory. Previous studies have strongly implicated significant kappa opiate system involvement. Studies in these laboratories and others have demonstrated cross tolerance between Δ^9-THC and the selective kappa agonist CI-977 in tail - flick latency. Recently we have demonstrated that acute intrathecal administration of Δ^9-THC induces the release of dynorphin A 1-17, an endogenous kappa ligand, capable of inducing antinociception. The release of dynorphin A 1-17 correlated with the induction of antinociception, but did not appear to be involved with the increased antinociceptive behaviors seen at later time points. We hypothesized that dynorphin A 1-17, released following intrathecal administration of Δ^9-THC, is metabolized to nonimmunoreactive fragments capable of inducing antinociception at the later time periods in which dynorphin A (1-17) concentrations decrease. To further investigate this hypothesis spinal concentrations of an active dynorphin A (1-17) metabolite, dynorphin A (1-8), were measured. Male Sprague Dawley rats were administered Δ^9-THC intrathecally and tail - flick latency assessed at periods of 10 and 30 minutes post administration. Simultaneously, the thoracolumbar cavity was rapidly perfused with artificial cerebrospinal fluid and the eluting fluid collected and subjected to radioimmunoassay to determine dynorphin A (1-8) concentration.

AZASPIRODECANONES: STRUCTURE-AFFINITY RELATIONSHIPS FOR 5-HT_2 SEROTONIN RECEPTOR BINDING. K. Metwally, M. Dukat, R. A. Glennon. Department of Medicinal Chemistry, School of Pharmacy, MCV/VCU; Richmond, VA 23298. 5-HT_2 serotonin receptors play a role in schizophrenia, depression, and cardiovascular disorders. This family of receptors consists of 5-HT_{2A}, 5-HT_{2B}, and 5-HT_{2C} subpopulations. Although there is an abundance of 5-HT_2 antagonists, very few are selective for one subpopulation over another. Spiperone and AMI-193, two of the very few agents that are selective for 5-HT_{2A} versus the other subpopulations, unfortunately also bind at 5-HT_{1A} and dopamine D_2 receptors. The purpose of our present work is to identify those structural features that account for affinity and selectivity and to subsequently design novel agents with greater subpopulation selectivity. Opening of the 5-membered ring results in retention of 5-HT_{2A} affinity but in loss of selectivity. The aryl-***B*** ring can be replaced with non-aryl substituents, and such agents retain affinity and selectivity. KML-019 (Ki: 5-HT_{2A} = 6.9 nM; 5-HT_{2C} > 10,000 nM) is one of the most selective agents described to date.



PUBERTAL DEVELOPMENTAL CHANGES IN THE MOUSE ANTERIOR PROSTATE: A HISTOLOGICAL VIEW. Roman J. Miller, Dept. of Biol., Eastern Mennonite Univ., Harrisonburg, Va. 22801. To advance our understanding of accessory sex gland growth and function, developmental changes were quantified from Swiss mouse anterior prostates at postnatal ages of 20, 30, 40, 50, 60, 90, and 120 days. Tissue samples were processed for histological analysis and morphometrically quantified. Biochemical analyses of tissue DNA and RNA content were spectrophotometrically determined and compared with histological data. Histological and biochemical data revealed a biphasic growth period within the sampled time, where 20-40 days showed a rapid growth spurt, 40-60 days moderate growth, and post 60 days a growth plateau. Based on percent volume density values, stromal tissues were elevated during early development and then declined as glandular and lumen components rapidly increased in days 30-50. Day 40 was a pivotal day, when epithelial cells were the largest (day 40 cross-sectional area = 240 μm^2; day 20 = 70 μm^2; day 120 = 135 μm^2), nuclei profiles were the largest (day 40 = 50 μm^2; day 20 = 35 μm^2; day 120 = 25 μm^2), and lumen secretions were first seen. Based on these data, puberty onset occurs at day 30 and lasts through day 50, after which early sexual maturity is seen in these mice. Supported by D.B. Suter Endowment.

LOW MOLECULAR WEIGHT HEAT SHOCK PROTEINS IN RAT MYOCARDIUM. B. Molyneux & K.E. Loesser, Dept. of Biol. Sci., Mary Washington Coll., Fredericksburg, VA 22401. The induction of heat shock proteins following a period of myocardial ischemia has been shown to reduce the myocardial infarct size and result in increased post-ischemic recovery of the myocardial tissue. It has been shown that the small molecular weight heat shock protein ubiquitin plays a role in myocardial protection following heat shock by taking part in the ubiquitin-mediated pathway of protein turnover and degradation. The specific goals of this research project were to show that ubiquitin was present in the myocardial cells of heat shocked rats. In order to show this, rats were heat-shocked for 40 minutes and the hearts frozen at varying time intervals afterwards. The myocardial proteins were separated using polyacrylamide gel electrophoresis, then the gels were blotted onto nitrocellulose filters and reacted with monoclonal ubiquitin antibodies to show the presence of ubiquitin. The results of this experiment showed that ubiquitin was present in all of the heat shocked samples, as well as in the non-heat shocked control sample. However, ubiquitin was found bound to some large molecular weight protein. The presence of ubiquitin in these myocardial tissues implies that ubiquitin-dependent protein degradation does occur in heat shocked myocardial cells.

IMPACT OF SODIUM SELENITE ON LEVELS OF MEMBRANE INTRINSIC PROTEIN (MIP) IN THE NUCLEUS AND CORTEX OF THE RAT LENS. GREGORY D. MORISHIGE AND JOHN L. HESS, DEPT. OF BIOCHEMISTRY, VIRGINIA POLYTECHNIC INST. & STATE UNIVERSITY. Nuclear cataracts, induced in 10- to 14-day-old rats, 96 hours after a subcutaneous injection of sodium selenite, are accompanied by proteolysis. The membrane intrinsic protein (MIP26, aquaporin 0) is a member of the aquaporin family of transmembrane channels, and is present in fiber cells of the vertebrate lens. Our objective was to characterize how MIP content relates to cataract formation in lenses of selenite-treated rats. SDS-PAGE was used to analyze membrane fraction proteins and amounts of MIP in lenses from selenite-treated rats. Membrane fractions were isolated from lenses of control and treated rats, and dissolved directly in SDS-sample buffer. Dominant proteins, visualized by silver staining, were observed at 21kD and at 26kD. To observe changes in MIP more clearly, membrane fractions were washed in 0.5N NaOH to remove residual proteins, before dissolving in SDS. The 26kD protein, putative MIP, was less prevalent in the treated nucleus, while remaining unaffected in the cortex. These results suggested that MIP was cleaved selectively in the nucleus, which corresponds to the region of cataract. The 21kD protein was at least as dominant as MIP and did not appear to be affected by selenite treatment. Since membrane proteins are not uniformly affected by proteolysis, the specific effect on MIP26 may contribute to a loss of ion homeostasis in fiber cells of a cataractous lens.

TAXOL ADMINISTRATION MODULATES NITRIC OXIDE BUT ENHANCES INTERLEUKIN-12 PRODUCTION BY TUMOR-DISTAL MACROPHAGES *IN VIVO*. David W Mullins and Klaus D. Elgert, Dept. of Biology, Virginia Tech, Blacksburg, VA 24061-0406 Tumor-induced macrophages (Mφs) mediate immunosuppression, in part, through overproduction of nitric oxide (NO) and underproduction of Interleukin-12. Because taxol differentially regulates normal host and tumor-bearing host (TBH) Mφ NO *in vitro*, we assessed Mφ NO production following *in vivo* administration of taxol. Using a murine fibrosarcoma model, taxol was administered in doses approximating human antitumor chemotherapies (30-60 mg/kg). At intervals following administration of taxol, splenic (tumor-distal) Mφs were harvested and cultured with various doses of interferon-γ (IFN-γ) and the triggering agent LPS. Taxol treatment enhanced normal host Mφ NO production; in a clinically more-relevant scenario, taxol administration downregulated NO production by tumor-induced Mφs, in agreement with our *in vitro* findings. Concurrently, taxol stimulated Mφ production of the proimmune cytokine interleukin-12. The success of taxol as an anticancer agent may partly derive from these immunotherapeutic activities that reverse tumor-induced Mφ suppressor functions and stimulate cell-mediated antitumor immune responses.

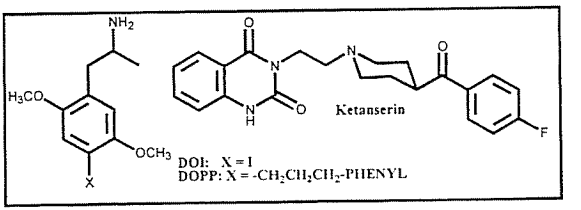
SYNTHESIS AND TESTING OF PYRIDYL DERIVATIVES OF BENZALDEHYDE AS POTENTIAL ANTISICKLING AGENTS. Ijeoma N. Nnamani[1], Anne B. Criss[2]*, Eugene P. Orringer[2]*, & Donald J. Abraham[1]. [1]Dept. of Medicinal Chemistry, Va. Commonwealth Univ., Richmond, Va. 23298, & [2]Div. of Hematology, School of Medicine, Univ. of North Carolina, Chapel Hill, NC 27599. Sickle cell anemia is a genetic disease caused by the substitution of glutamic acid by valine at the sixth position of the β chain of hemoglobin (Hb). Due to this mutation, deoxygenated sickle Hb (HbS) aggregates within the red cells into polymers and this leads to sickling of red cells. Sickled red cells block blood flow through the capillaries causing "painful crises," ankle ulcers, and organ damage. With the aid of X-ray Crystallography, our group recently showed that introduction of small molecules with electronegative ions into the central water cavity of Hb stabilizes the deoxygenated (T -tense) state of hemoglobin thereby causing a decrease in oxygen affinity of Hb. This is because these negative ions form salt bridges with opposite subunit residues such as Arginine 141α in the central water cavity (*Biochemistry* 1995, *34*, 15006). Perutz (*J. Mol. Biol.* 1994, *239*, 555) postulated that increasing the electropositivity of the water cavity will destabilize the T-state of Hb. Therefore we decided to explore Perutz's postulate in order to obtain compounds that will increase the oxygen affinity of Hb. Zaugg et al (*J. Biol. Chem.* 1977, *252*(23), 8542) reported that pyridoxal increases the oxygen affinity of Hb similar to vanillin but it modified Hb to a lesser degree than vanillin. This is because pyridoxal exists predominantly in a cyclic hemiacetal form that can not form a Schiff base with Hb. Thus, we decided to synthesize pyridyl derivatives of benzaldehydes such as vanillin. Oxygen equilibrium and ektacytometric results show that these compounds have potential antisickling and antipolymerization properties. These compounds are therefore promising agents for exploration in the treatment of sickle cell anemia.

CHARACTERIZATION OF SPINAL AND SUPRASPINAL EFFECTS OF NICOTINE IN MICE. Gray S. Patrick, M. Imad Damaj, and Billy R. Martin, Dept. of Pharmacology and Toxicology, Medical College of Virginia-Virginia Commonwealth University, Richmond, VA 23298-0613. Nicotine has a wide range of pharmacological effects including hypothermia, decreased locomotor activity, and antinociception. Previous studies have shown interesting differences between subcutaneous and intrathecal administration of nicotine and nicotinic agonists, suggesting different nicotinic mechanisms in the spinal and supraspinal regions. Using male ICR mice, antinociception was measured using the tail-flick test following administration of nicotine both intrathecally (i.t.) and intracerebroventricularly (i.c.v.). Although the peak effect occurred 5 minutes following each type of administration, it took twice as long for i.c.v. nicotine to dissipate (60 minutes) than did the i.t. nicotine (30 minutes). In addition, dose response curves showed i.t. nicotine to be slightly more potent than i.c.v. nicotine with ED50s of 10μg and 14μg/animal, respectively. Furthermore, mecamylamine and DBE, classical nicotine antagonists, blocked antinociception in a dose dependent fashion. Finally, a rank order of affinity of several nicotinic agonists, such as epibatidine, lobeline, and nor-nicotine, exhibited differences between i.t. and i.c.v. administration. Our results suggest that nicotine receptors are functionally different in the spinal and supraspinal regions. (Supported by DA-0527)

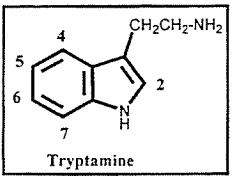
BENZYLAMIDINES AS NOVEL 5-HT_{1D} SEROTONIN RECEPTOR LIGANDS T. Prisinzano,[†] H. Law,[†] M. Dukat,[†] D. Lee,[‡] R. Kamboj,[‡] R.A. Glennon,[†] [†]Department of Medicinal Chemistry, School of Pharmacy, MCV/VCU, Richmond, VA 23298; [‡]Allelix Biopharmaceuticals, Ontario, Canada. Serotonin (5-HT) receptors are divided into major families (5-HT_1 - 5-HT_7); several consist of subfamilies. For example, 5-HT_1 includes 5-HT_{1A}, 5-HT_{1B}, 5-HT_{1D} (5-$HT_{1D\alpha}$ / 5-$HT_{1D\beta}$), 5-HT_{1E} and 5-HT_{1F}. The prototypical 5-HT_{1D} agonist, sumatriptan, was recently introduced for the treatment of migraine. Because sumatriptan lacks selectivity between 5-HT_{1D} receptor subpopulations, and because its 5-$HT_{1D\beta}$ agonist actions may account for some of its side effects, there is a need for newer agents. Novel entities are in clinical trials but nearly all bear structural resemblance to sumatriptan, and none show subtype selectivity. To achieve selectivity an entirely new class of agents may be required. A very early study identified the α-adrenergic agonist oxymetazoline as a 5-HT_{1D} agonist. We investigated the structure-affinity relationships of this agent to determine what is important for 5-HT_{1D} binding, while attempting to remove those features that impart adrenoceptor affinity. Several novel agents (particularly ALX-1329, ALX-1417, ALX-1449, ALX-1465) have been developed that bind at 5-$HT_{1D\alpha}$ / 5-$HT_{1D\beta}$ receptors with modest to high affinity, and with up to 100-fold selectivity.

HYALURONATE-CD44 INTERACTIONS CAN INDUCE MURINE B-CELL ACTIVATION. Asimah Rafi, Mitzi Nagarkatti and Prakash Nagarkatti, Dept. of Biol. and Dept. of Biomedical Sciences, VA Tech Blacksburg, VA 24060. CD44 is a widely distributed cell surface glycoprotein whose principal ligand has been identified as hyaluronic acid (HA), a major component of the extracellular matrix (ECM). Recent studies have demonstrated that activation through CD44 leads to induction of effector function in T cells and macrophages. In the current study, we investigated whether HA or mAbs against CD44 would induce a proliferative response in mouse lymphocytes. Spleen cells from normal and nude but not severe combined immunodeficient (SCID) mice, exhibited strong proliferative responsiveness to stimulation with soluble HA or anti-CD44 mAbs. Furthermore, purified B cells but not T cells were found to respond to HA. HA was unable to stimulate T cells even in the presence of antigen presenting cells (APC) and was unable to act as a costimulus in the presence of mitogenic or submitogenic concentrations of anti-CD3 mAbs. In contrast, stimulation of B cells with HA *in vitro*, triggered increased expression of Ia and led to B cell differentiation as measured by production of IgM antibodies. The fact that the B cells were responding directly to HA through its binding to CD44 and not to any contaminants or endotoxins was demonstrated by the fact that $F(ab)_2$ fragments of anti-CD44 mAbs could completely inhibit the HA-induced proliferation of B cells. Also, HA-induced proliferation of B cells was not affected by addition of polymixin B and B cells from LPS-unresponsive C3H/HeJ strain responded strongly to stimulation with HA. Furthermore, HA but not chondroitin-sulfate, another major component of the ECM, induced B cell activation. It was also noted that injection of HA intraperitoneally, triggered splenic B cell proliferation *in vivo*. Together, the current study demonstrates that interaction between HA and CD44 can regulate murine B cell effector functions and that such interactions may play a critical role during normal or autoimmune responsiveness of B cells.

PHENYLISOPROPYLAMINES AS A NOVEL CLASS OF 5-HT_2 SEROTONIN RECEPTOR ANTAGONISTS. C. L. Schieck,[†] M. Dukat,[†] B. Roth,[‡] R. A. Glennon.[†] [†]Department of Medicinal Chemistry, School of Pharmacy, MCV/VCU; Richmond VA and [‡]Department of Psychiatry, Case Western Reserve University; Cleveland OH. The neurotransmitter serotonin influences behavior through various receptors; 5-HT_{2A} receptors are involved in psychotic behavior and hallucinosis. Hallucinogenic phenylisopropylamines such as DOI are 5-HT_{2A} agonists; ketanserin (KET) is a 5-HT_{2A} antagonist. Site-directed mutagenisis studies suggest that phenylalanine (Phe) 340 is involved in the binding of DOI whereas Phe-339 is involved in the binding of antagonists such as KET. DOPP, a phenylisopropylamine analog, acts as a 5-HT_{2A} antagonist and raises the question: does DOPP bind in a manner resembling DOI-like agonists or KET-like antagonists. Synthetic studies and binding at Phe-mutant receptors were used to address this question.



CoMFA ANALYSIS OF THE BINDING OF TRYPTAMINE AND RELATED ANALOGS AT 5-HT_6 SEROTONIN RECEPTORS. C. L. Schieck,[†] B. Roth,[‡] R. A. Glennon.[†]
[†]Department of Medicinal Chemistry, School of Pharmacy, MCV/VCU; Richmond VA 23298; [‡]Department of Psychiatry, Case Western Reserve University; Cleveland OH. The neurotransmitter serotonin (5-HT) is known to play a role in a variety of physiological and neuropsychiatric processes and its effects are mediated by different populations of 5-HT receptors. The functional role of a newly cloned population of 5-HT receptors — 5-HT_6 receptors — remains to be fully elucidated. 5-HT_6 receptors are somewhat unique in that they display high affinity for a structurally diverse group of agents, including typical and atypical antipsychotics and antidepressants. The present study investigates the binding of one class of agents, the tryptamines (n = 24); Ki values ranged from 1 to > 10,000 nM. CoMFA analysis resulted in a relating equation with high predictive value (q^2 = 0.31); there is a significant correlation between calculated and observed receptor affinities (r^2 = 0.94). It should now be possible to use the results of the CoMFA study to design novel 5-HT_6 receptor agents.



Tryptamine

EFFECTS OF PRENATAL NICOTINE ON POSTNATAL DEVELOPMENT. John J. Shacka and Susan E. Robinson*, Dept. Pharmacology and Toxicology, MCV/VCU, Box 980613, Richmond, VA 23298-0613. Previous studies in our laboratory have shown that rats exposed prenatally to nicotine (N) exhibited increased fetal mortality, decreased postnatal weight gain and altered postnatal behavior. This study determined the effects of prenatal N exposure (2 mg/kg/day) in rats via s.c. osmotic minipumps, gestational days 7-22, on postnatal development of neuronal nicotinic receptor (nNR) α4, α7 and β2 subunit mRNA. Northern analysis of postnatal day (P)1, P7, P14 and P28 hippocampal/septal and cortical total RNA using α-^{32}P-dCTP-labelled α4, α7 and β2 cDNA probes identified a single (5.7 kb) α7 mRNA, three (2.4, 3.8 and 8.0 kb) α4 mRNAs, and four (3.7, 5.0, 7.5 and 10.0 kb) β2 mRNAs. In comparison to prenatal saline, prenatal N produced several significantly higher (age X treatment) mRNA levels (cortical 5.7 kb α7, 2.4, 3.8 and 8.0 kb α4, 10.0 kb β2; hippocampal/septal 2.4 and 8.0 kb α4); these increases occured mostly but not exclusively on P14 (Fisher's plsd, $p < 0.025$). Collapsing the data for sex and age, a significant effect of treatment indicated that prenatal N produced significantly higher hippocampal/septal and cortical 8.0 α4 kb mRNA and 10.0 kb β2 mRNA in comparison to prenatal saline (Fisher's plsd, $p < 0.05$). This is the first study indicating that prenatal N produces alterations in developing postnatal rat nNR mRNA levels, and further implicates the teratogenic potential of N in postnatal neuronal development. (Supported by NIDA T32DA07027)

CLOZAPINE FAILS TO ATTENUATE PHENCYCLIDINE'S DISCRIMINATIVE STIMULUS EFFECTS IN RATS. J.E. Slemmer, Dept. Of Psychology, Univ. Of Richmond, VA, 23173, J.M. Hyman, J.L. Wiley, A.D. Compton, & R.L. Balster, Dept. of Pharmacology & Toxicology, Med. Col. Of VA, VA Commonwealth Univ., Richmond, VA, 23284. Antipsychotics, commonly used for schizophrenia, are currently the only available treatment for phencyclidine (PCP) intoxication. Typical antipsychotics, such as chlorpromazine, differ from the atypicals in their motor side effect profiles, and in their ability to treat certain treatment-resistant schizophrenics; their abilities to antagonize PCP induced behavior may also vary. The present study utilized the two lever drug discrimination paradigm with food reinforcement in order to measure the discriminative stimulus effects of PCP in rats using clozapine, an atypical antipsychotic. A PCP dose-response curve (doses: 0.5, 1, 2, 4 mg/kg) was determined, followed by a clozapine curve (doses: 0.3, 1, 3, 5.6 mg/kg) using PCP training dose (2 mg/kg). Results indicated that clozapine did not attenuate the PCP discriminate cue. Further study is required to indicate whether there are other atypical antipsychotics that may attenuate PCP's discriminative stimulus effects.

THE EFFECTS OF ACUTE AND CHRONIC CANNABINOID ADMINISTRATION ON NITRENDIPINE BINDING IN THE MOUSE SPINAL CORD. Anubha Tripathi, David J. Mason, and Sandra P. Welch, Dept. of Pharmacology and Toxicology, Va. Commonwealth Univ., Richmond, Va. 23298. Dynorphin A is an endogenous ligand of the kappa-opioid receptor. Like CI977, a selective kappa agonist, it produces potent antinociception via a mechanism involving the L-type calcium channel. Delta 9-THC has been associated with an increase in spinal levels of Dynorphin A. The hypothesis tested was that Δ9-THC-induced acute and chronic effects involved modulation of L-type calcium channel number or affinity. To compare the effects of Δ9-THC with those of CI977, male ICR mice were treated acutely with intrathecal administration of saline, CI977, DMSO, or Δ9-THC. The effects of Δ9-THC and CI977 on ^{3}H nitrendipine binding were determined by performing radioligand binding assays to the L-type calcium channel. Acute administration of CI977 and Δ9-THC did not significantly alter L-type calcium channel site number or receptor affinity, although Δ9-THC exhibited a trend toward decreased receptor affinity. The effects of chronic administration of the drugs were also evaluated.

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TRANS-RESVERATROL: A NATURAL PHYTO-ANTIESTROGENIC AGENT, R.L. Williams and Mark Elliott, Old Dominion University Enological Research Facility, Dept. of Chem./Biochem., Old Dominion Univ., Norfolk, Va, 23529. Based on preliminary research in this labortaory, trans-resveratrol, can now been described as a natural phytoestrogen found in a variety of different plants including the skins of grapes and wine. It has recently been shown to have anti-estrogenic activity in human breast cancer cells in culture. The structural similarity of trans-resveratrol to trans-Tamoxifen will be explored. This paper will describe the relative cytotoxicity of trans-resveratrol and it's geometric isomer cis-resveratrol in two human breast cancer cell lines in culture (MCF-7, estrogen receptor positive and MDA-231, estrogen receptor negative cells). Comparisons will be drawn regarding the cytotoxicity of the two resveratrol isomers to Tamoxifen and the phytoestrogen known as Genestein. Cis-resveratrol appears to exhibit some rather unusual activity compared to the trans isomer and the effect of these two compounds on cell growth of MCF-7, MDA-231 and human fibroblast cells in culture will described.

Microbiology and Molecular Biology

ANALYSIS OF *MIA* EXPRESSION IN *STREPOMYCES COELICOLOR* AND *STREPTOMYCES LIVIDANS*. Gary L. Brown, Jed Ross, Dept. of Biol., Mary Washington Col., Fredericksburg, Va. 22407, & Wendy Champness*, Dept. of Microbiology, Michigan State Univ. E. Lansing Michigan 48824. *Streptomyces coelicolor* and *S. lividans* both produce four known antibiotics. A fragment of S. coelicolor DNA (*mia*) has recently been isolated that in high copy number has the ability to block the synthesis of all four antibiotics in *S. coelicolor* and *S. lividans*. A deletion analysis has trimmed the active *mia* region to 120 bp and indicates that a 48 bp inverted repeat with in the region is required for *mia* activity. An analysis of strong *mia* expression from a low copy number vector implicates an RNA transcript in *mia* activity.

RECOGNITION SITE DNA SCREENING OF λGT11 EXPRESSION LIBRARIES OF VARIOUS DEVELOPMENTAL STAGES OF *Dictyostelium*. C. Chanchao, B. Col*, R. Favis* and C.L. Rutherford, Dept. of Biol., Va. Polytechnic Inst.&State Univ., VA 24061. A critical event during the life cycle of *Dictyostelium discoideum* is glycogen turnover. This process is catalyzed by *glycogen phosphorylase-2 (gp-2)*. Since *gp-2* expression is first induced during the transition from growth to differentiation, understanding how this gene is controlled may provide some insight into the process of differentiation. In order to identify the *trans*-acting factors responsible for activating *gp-2* expression, three techniques are used: 1) *in vitro* footprint analysis to identify the *cis*-acting elements; 2) generation of λgt11 expression libraries for recognition site screening; and 3) southwestern analyses to confirm the feasibility of isolating developmentally regulated *trans*-acting factors from the expression libraries. For this approach to succeed, high quality cDNA libraries are essential. RNA quality and the fidelity of the time points were determined by RT-PCR using several marker genes. The cDNA was assessed for complexity and full-length synthesis by PCR and radioactive primer extension, respectively. We have generated cDNA for 3 stages of development: amoeba (when *gp-2* is not transcribed), 8h (when *gp-2* is first transcribed) and 12h (when *gp-2* is highly transcribed). λgt11 expression libraries were generated for amoeba ($2.5X10^5$ and $2.75X10^5$ pfu/ml). The libraries will be next screened with *cis*-acting elements from the *gp-2* promoter identified through footprint analysis. To date, we have identified a developmentally regulated footprint spanning two C-rich elements. When this region is used to probe a southwestern blot, three peptides (84, 78 and 62 kD) are recognized exclusively in nuclear extract derived from differentiated cells. This result indicates that recognition site screening may be a feasible approach for isolating the genes encoding these potential transcription factors.

THE EFFECTS OF METHYLCELLULOSE ON THE FINE STRUCTURE OF *NAEGLERIA GRUBERI*. Carol A. Ditmore, Kathryn Loesser, and Stephen Gallik, Dept. of Biol., Mary Washington Col., Fredericksburg, VA 22401. *N. gruberi* cells exhibit increased adhesion to tissue culture plastic following 7 days in culture media made hyperviscous through the addition of methylcellulose (MC). MC is a nonionic, water-soluble polymer that not only enhances the viscosity of solutions, but also exhibits surfactancy in aqueous solutions. Considering MC has surfactant characteristics, adsorption of MC to the cell surface might have some role in the increased adhesion of *N. gruberi* following 7 days of MC exposure. In the first of a series of electron microscopic investigations designed to study the surface features and adhesion structures of *N. gruberi* bathed in MC, we set out to examine whether MC could be detected on these cells with transmission electron microscopy and to study the basic effects of MC on the ultrastructure of these cells. Results show no structural differences among cells of the various experimental groups and no striking evidence of accumulation of anything extraordinary on the surface of or within the cells. The questionable ability of electron microscopic stains to detect MC prevents us from drawing any firm conclusions about the presence of adsorbed MC and any possible role adsorbed MC might play in the increased adhesiveness displayed by these cells.

BACTERIOPHAGE ATTACHMENT TO *BACILLUS SPHAERICUS* S-LAYERS. Faith A. Love and Lynn O. Lewis, Dept. of Biol. Sci., Mary Washington Col., Fredericksburg, VA 22401. Many bacteria have a layer of protein or glycoprotein outside their cell wall called a surface layer (S-layer). The protein subunits are arranged in lattices that cover the entire cell. The structure of these S-layers has been well characterized, but their function is still unknown. Members of the *Bacillus stearothermophilus* species exhibit an S-layer which has been shown to change its lattice and subunit molecular weight when oxygenation conditions change. *Bacillus sphaericus* also exhibits an S-layer. This heterogeneous species is strictly aerobic, and contains a group of strains that are pathogenic to mosquitos. Some of these strains have been shown to change the molecular weight of their S-layer proteins under oxygen limitation. It has also been shown that the S-layer of these strains provides a specific binding site for bacteriophages. Therefore, bacteriophage attachment studies can be used to assess deviations in the structure of S-layers. Molecular weights and bacteriophage attachment studies were done to determine if the S-layers of *B. sphaericus* strain 2362 were altered under oxygen limited conditions. Preliminary results showed differences in molecular weights and phage neutralization abilities of the protein under oxygen limitation.

CLONING AND EXPRESSION OF *CHLOROBIUM* UROPORPHYRINOGEN III SYNTHASE GENE IN *BACILLUS SUBTILIS*. Victoria Ndivo & Debabrata Majumdar, Dept. of Biol.,Norfolk St. Univ.,Norfolk, Va. 23504. We previously reported the DNA sequence and expression of the *Chlorobium vibrioforme* glutamyl-tRNA reductase gene (*hem*A) and recently identified (Curr. Microbiol., 34, 258-263,1997) the porphobilinogen deaminase gene (*hem*C) downstream of *hem*A. This clone (pYA1) containing the *hem*A and *hem*C gene was introduced into the *hem*D auxotroph, Sz34, of *Bacillus subtilis*, by protoplast transformation. Owing to *hem*D-like sequence downstream of *hem*C and complementation of the *B.subtilis* auxotroph to fast-growing prototroph, the sequence was identified as the URO-S gene. Secretion, by Sz34 cells, of large amounts of uroporphyrin and resulting pink fluorescence under UV was reversed by transformation. URO-S enzyme assay with cell lysates revealed that the accumulation of uroporphyrin by Sz34 is significantly decreased by pYA1 transformation.

DETERMINING THE MINIMUM ZINC REQUIREMENTS TO PROVIDE OPTIMAL GROWTH FOR *Cryptococcus neoformans*. Judy H. Niehaus and Beth Chagaris, Dept. of Biology. Radford Univ., Radford, Va. 24142. *Cryptococcus neoformans* is a pathogenic yeast cell which will cause serious infection for patients with weakened immune responses. Zinc is one requirement for growth of these cells. The purpose of this study was to determine zinc concentrations required to obtain optimal growth. This was accomplished by varying zinc concentration levels and measuring growth based on optical density. An initial experiment showed that at least 0.5mM zinc was needed for observable growth. The next experiment tested a more narrow range of zinc between 5 and 11mM. Rather than being proportional to zinc concentration, the maximum optical density was approximately the same for all zinc concentrations. Zinc, however, appeared to affect the rate of growth. To further test this hypothesis, growth rate was measured at zinc levels between 7 and 45mM. Again, the maximum optical density was similar for all zinc levels. Zinc concentration affected either the lag period or the growth rate. These data could be explained by some type of zinc uptake mechanism that is triggered at low zinc concentrations.

A RAPID SCREEN FOR THE DETECTION OF RANDOM POINT MUTATIONS IN SUBCLONED SINDBIS VIRUS GLYCOPROTEIN GENES. Darcy Russell, Suzanne Wirth*, Anne Van Auken*, Elizabeth Bahn*, Amy Shaw*, Jonathan Small* and Anthony Mazzarelli*, Dept. of Biol., Washington and Lee Univ., Lexington, VA. 24450. In our laboratory we are interested in asking questions about the earliest interactions between Sindbis virus and the cells of its host, the neonatal mouse. The two viral glycoproteins involved in this interaction are E1 and E2. It has been shown that single mutations in either of these two proteins can affect the course of pathogenesis of this virus. The goal of this paper was to begin to construct a library of random point mutations throughout these genes. Once this library has been constructed we will use it to examine the effect(s) that these mutations have on the biology of the virus/host interaction. To date the genes encoding these proteins have been subcloned from a full-length cDNA clone of the viral RNA genome into a plasmid vector pGEM3Z+ (Promega) by Elizabeth Bahn, Jon Small and Anthony Mazzarelli. One of these subclones (pG1228) was then transformed into mutator *E. coli*, reisolated and screened for mutation using a slightly modified protocol of the Ambion Mismatch Detect system by Anne Van Auken, Amy Shaw, Elizabeth Bahn and Suzanne Wirth. To date, two mutations have been isolated and characterized, one in the E2 gene (Wirth) and one in the signal peptide for the E1 gene (Russell). Another of the clones (pG723) has been transformed into *E. coli* mutator cells and potential mutants are currently being screened (Small and Mazzarelli).

mRNA CAP METHYLATION: SUBUNIT STRUCTURE OF THE GUANINE-7-METHYLTRANSFERASE. Gerald L. Snider, Charles E. Rose, Christy J. Morgan, and Thomas O. Sitz, Dept. of Biochemistry, Virginia Tech, Blacksburg, VA 24061. The methylation of the 7-position in the guanine base in the cap structure found at the 5'-end of eucaryotic mRNAs is essential for ribosome binding and translation. When the enzyme that methylates this site (guanine-7-methyltransferase) was purified to homogeneity it was found to have a subunit molecular weight of 46,000. However, another enzyme preparation was found to have two subunits by active site labeling with radioactive RNA (46,000 and 38,000 molecular weight). This enzyme preparation had been stored at -20° for over one year as a crude tissue extract. We purified another batch of enzyme and characterized its subunit structure by active site labeling. The active site was radioactively labeled by binding a ^{32}P-labeled unmethylated capped RNA to the enzyme and covalently cross-linking the RNA to the protein by exposure to short-wave length UV light. Only a single band was found on the SDS-polyacrylamide gels with a molecular weight of 46,000. Therefore the 38,000 mw subunit was generated by protein degradation during storage or isolation.

LIGAND BINDING STUDIES OF THE HEMOGLOBIN OF *NOSTOC COMMUNE* UTEX 584 (CYANOBACTERIA). M.V. Thorsteinsson, D. R. Bevan, and M. Potts*, Dept. of Biochemistry, Virginia Tech, Blacksburg, VA, 24061 & R. F. Eich* and J. S. Olson*, Dept. of Biochemistry and Cell Biol., Rice Univ., Houston, TX, 77005. The diazotroph *Nostoc commune* UTEX 584 (Cyanobacteria) synthesizes a 12.5 kD hemoglobin, termed cyanoglobin, under reduced nitrogen and oxygen deplete conditions. Cyanoglobin accumulates at the inner membrane of nitrogen fixing heterocysts, but is not absolutely required for the active nitrogenase complex (Hill, et al. (1996) *J. Bacteriol.*,178:6587-6598). Rates of gaseous ligand association to cyanoglobin are extraordinarily fast, whereas the rates of ligand dissociation are moderately fast when compared to sperm whale myoglobin and leghemoglobin *a*. The oxygenated form of cyanoglobin rapidly auto-oxidizes to the met-form. Cyanoglobin also coordinates the "bulky" ligands azide, imidazole, and nicotinate. The above data suggest that the heme moiety in cyanoglobin is highly accessible to ligands and supports the model that cyanoglobin binds oxygen and presents that oxygen to a microaerobically-induced terminal oxidase under diazotrophic, microaerobic growth conditions.

TRANSCRIPTIONAL REGULATION OF THE *GLYCOGEN PHOSPHORYLASE- 2* GENE DURING DEVELOPMENT IN *DICTYOSTELIUM DISCOIDEUM*. Nikita Warty, Ian McCaffery*, Wen Wu* and Charles L. Rutherford, Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. *Dictyostelium discoideum* is a model system for the analysis of regulatory processes that control cellular differentiation and morphogenesis. These processes are known to be directed by the action of extracellular morphogens such as cAMP and DIF-1, which regulate prespore and prestalk differentiation respectively. Glycogen phosphorylase-2 (GP-2) plays an important role in *Dictyostelium* development by generating glucose precursors that are essential for cell differentiation. Transcription of the gene is non cell-type specific and is regulated by cAMP and DIF-1, suggesting that the gene is independently regulated in the two cell types. Using 5' deletion analyses, several regions within the *gp-2* promoter were identified that regulate expression of the gene during differentiation. This preliminary promoter analysis was used to design site directed mutagenesis experiments, and we present here the identification and definition of two cAMP regulatory sequence elements, CB-1 and CB-2. These elements contain a common C-rich motif that is found in regulatory regions of several cAMP-regulated genes. Mutation of either element results in a large drop in levels of transcription. In the case of the CB-2 mutation, the mutant promoter was no longer cAMP-responsive. Expression of the gene still occurred in the correct temporal manner during differentiation; this basal activity may be pre-stalk specific and we propose experiments to test this hypothesis. Additional regulatory and cAMP-responsive elements are being investigated by site-directed mutagenesis. The precise function of these elements in transcriptional regulation is not yet known and we aim to define these in future experiments. Of particular interest is the identification of a DIF-1-responsive element and other cell-type specific elements. (Supported by grants from the NIH to C.L.R. and VAS, SICB, Sigma Xi and GRDP to N.W.)

Natural History & Biodiversity

AQUATIC STUDIES BY THE GOVERNOR'S SCHOOL AT DABNEY S. LANCASTER COMMUNITY COLLEGE: 1994-1996. H. S. Adams, D. S. Lancaster Cmnty. Col., Clifton Forge, VA 24422, E. J. DeGroot, Alleghany H. S., Low Moor, VA 24457, S. K. Evans, S. W. Hiner, and W. VanWart, Dept. of Entomology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Three small aquatic studies of certain chemical, physical, and biotic factors were conducted by the 1994, 1995, and 1996 Governor's School participants at DSLCC: (1) the Cowpasture River in Bath County, Virginia, several kilometers upstream from its confluence with the Jackson River; (2) the Jackson River in Bath and Alleghany Counties immediately above and below Lake Moomaw; and (3) any effect of leachate from the KimStan landfill in Alleghany County on a small stream and the Jackson River. From these investigations, participants concluded: (1) the Cowpasture River is relatively unimpaired, appearing to be an average stream with good water quality for streams that have been assessed in the Central Appalachian Ridges and Valleys ecoregion; (2) Lake Moomaw has had a negative effect on the ecological balance of macroinvertebrate populations in the Jackson River immediately below the Gathright Dam, although a reasonably well-balanced macroinvertebrate community has become re-established several kilometers further downstream; and (3) leachate from KimStan runoff has perturbed the macroinvertebrate community in the unnamed stream into which it drains, and possibly even on the Jackson River after it receives the leachate from that stream. (These studies were supported in part by grants from the: Cowpasture River Preservation Association, Virginia Environmental Endowment, Chesapeake Bay Restoration Fund, and Virginia Department of Education.)

EFFECTS OF ENVIRONMENTAL CHANGES ON FRESHWATER MUSSELS IN SOUTHWESTERN VIRGINIA. Braven B. Beaty and Richard J. Neves, Dept. of Fisheries and Wildlife Sciences, Virginia Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Freshwater mussels (Unionidae) comprise one of the most imperiled faunal groups in the world. There are approximately 297 known species and subspecies of unionids, with over half of these identified as endangered, threatened, or special concern under the endangered species act. Of the 73 species occurring in the state of Virginia, there are 18 federally endangered mussels, with an additional 16 state endangered or threatened species. The majority of these occur in the Upper Tennessee River Basin in southwestern Virginia. Throughout the Tennessee River system, impoundments have had the largest impact on mussel communities, although few of these are in Virginia. Agricultural practices have also adversely affected mussel populations through alteration of habitat, sedimentation, and chemical runoff. Industrial impacts have included accidental spills and chronic inputs and have resulted in the loss of mussels from many river miles. Other activities that have resulted in the decline of mussels include logging, urban and residential development, and ineffective sewage treatment. Life history factors that make mussels especially susceptible to environmental perturbations include a complex life cycle, sedentary existence, and filter feeding. Mussels are also more sensitive to metals than most aquatic fauna and are limited in ability to metabolize some organic toxicants. Due to these factors, freshwater mussel populations are usually more severely affected than most other aquatic fauna.

FORAGING ECOLOGY OF THE MADAGASCAR FISH-EAGLE, *HALIAEETUS VOCIFEROIDES*. James Berkelman & J. D. Fraser*, Dept. of Fisheries & Wildlife Sciences, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061, & R. T. Watson*, The Peregrine Fund, 566 W. Flying Hawk Ln., Boise, ID 83709. With fewer than 100 pairs remaining, the Madagascar fish-eagle (*Haliaeetus vociferoides*) is one of the world's most endangered birds of prey. In an earlier study we determined that fish abundance and species diversity are important predictors of habitat suitability for breeding fish-eagles. In this study, we examined prey preference and the relationship between foraging success and fish availability in the Madagascar fish-eagle. From May to August 1996, we observed resident fish-eagles foraging at nine lakes in western Madagascar. We observed eagles throughout daylight hours and recorded fish species captured, foraging rate, and foraging success. We also sampled the fish population at each lake using gill nets and recorded fish weights and species. We recorded 67 fish-eagle foraging events, including 60 instances when eagles caught fish over open water, 3 instances when eagles scavenged dead fish, and 4 instances of piracy from black kites (*Milvus migrans*). Male fish-eagle foraging success was positively correlated with number of fish ($P = 0.05$), total fish weight ($P = 0.01$), and number of fish species ($P = 0.0007$). The introduced cichlids *Oreochromis spp.* and *Tilapia spp.* made up the majority of both the gill net (66.3%) and fish-eagle catch (64.7%) in similar proportion. We conclude that, although the Madagascar fish-eagle does not appear to require native freshwater fish species in its diet, it is likely to be adversely affected by general declines in the fish population.

SEASONAL ACTIVITY AND MOVEMENT PATTERNS BY BOG TURTLES, *CLEMMYS MUHLENBERGII*, IN SOUTHWESTERN VA. Shawn L. Carter, Dept. of Fisheries and Wildlife, Va. Polytechnic and State Univ., Blacksburg, Va. 24061; C. A. Haas, Dept. of Fisheries and Wildlife, Va. Polytechnic and State Univ., Blacksburg, Va. 24061 & J. C. Mitchell, Dept. of Biology and Sch. of Continuing Studies, Univ. of Richmond, Richmond, Va. 23173. Thirty adult bog turtles were monitored from May 1995 to December 1996 using radiotelemetry. We used consecutive distance measurements, scatterplots, and threadspooling to examine turtle activity and movement patterns. Consecutive distance measurements for 1995 and 1996 averaged 14 m and 23 m for males and 15 m and 20 m for females, respectively. Scatterplot techniques we employ suggest a random pattern of movement by bog turtles for up to 7 days between distance measurements. Threadspooled distances (n=13) averaged 6.4 times greater than consecutive distance measurements for the same individuals. Eighty-six percent of all consecutive distances (n=824) were less than 30 m, while only 2% were greater than 100 m. No sexual differences in activity or movement were observed. Results suggest large-scale movements by bog turtles are infrequent and consecutive distances may underestimate turtle activity. Consequently, extant populations may be prone to isolation if habitat loss continues at historic rates.

TAIL LABILITY IN THE SMOKY SHREW (*SOREX FUMEUS*). Jeffrey D. Ferguson and John F. Pagels, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284. During field collection, smoky shrews were observed to have variable tail characteristics including length and degree of hair. In order to verify these observations, ninety-four fluid preserved whole specimens were randomly sampled from the Mammal Collection at Va. Commonwealth Univ. External characteristics and measurements, toothwear, and reproductive condition were investigated for each. Variance and covariance were analyzed for all characteristics to determine significance and contribution to tail variation. Results suggest that age classification is significant in predicting the ratio of tail to body length. Tail/body ratios are lowest when individuals are immature and increase with aging. Additionally, tail hairiness significantly correlates with the age classification of the individual. The younger the individual, the greater amount of hair present on the tail. These patterns would account for the unverified variations noted in field observations.

BIRD ARTISTS IN VIRGINIA'S HISTORY. David W. Johnston, 5219 Concordia St., Fairfax, Va. 22032. In 1585 John White, accompanying Sir Walter Raleigh's voyage to "Virginia," drew birds seen at or near the Roanoke Colony, as well as birds at sea. Soon thereafter illustrations of "Virginia birds" were found in the publications of Aldrovandus (1599), Topsell (1614), Willughby (1676). Mark Catesby (1712-1719), William Bartram (1790), Alexander Wilson (1809), and John James Audubon (1840) all spent some time in the state, but we have no record of their having painted birds in the state. Francis Lee Jaques painted birds at Dyke Marsh in the 1940s, and Roger Tory Peterson painted birds while stationed at Ft. Belvoir in the 1940s. Federal Duck Stamp paintings were made by Virginia bird artists including Walter Weber (1944), Jackson Abbott (1957), and Ed Bierly (1970), while Bob Hines painted waterfowl for several books in the 1960s.

ESTABLISHMENT AND PHENOLOGY OF *GALERUCELLA CALMARIENSIS* (L.) AND *G. PUSILLA* (DUFT.), COLEOPTERA: CHRYSOMELIDAE) BIOLOGICAL CONTROL AGENTS OF PURPLE LOOSESTRIFE, *LYTHRUM SALICARIA* L. (LYTHRACEAE), IN SOUTHWEST VIRGINIA. T. J. McAvoy and L. T. Kok, Dept. Entomol., Virginia Tech, Blacksburg, Va. 24061, *Galerucella calmariensis* and *G. pusilla,* released for the biological control of purple loosestrife (*Lythrum salicaria*), have both been recovered for four consecutive years and are well established at Coeburn, Virginia. The highest number of eggs per stem per year recorded was 8.3, 5.5, 11.7 and 14.9 in 1993, 1994, 1995 and 1996, respectively. *L. salicaria* plants with one or more life stages of *Galerucella* spp. significantly increased from 43% in 1993 to 67% in 1995 but dropped to 39% in 1996. Dispersal, as measured by the area of *L. salicaria* infested with *Galerucella* spp., increased from 92 m^2 in 1993 to 720 m^2 in 1996. An equal number of *G. calmariensis* and *G. pusilla* were found in 1993. In 1994, 98% of the beetles were G. *calmariensis* while only 2% were *G. pusilla.* However in 1995 and 1996 approximately 30% of the beetles were *G. calmariensis* and 70% were *G. pusilla*. Both species have one generation per year. Overwintering adults begin feeding and ovipositing eggs in early May followed by egg hatch in late May and larval development through mid-June. The F_1 adults emerged and fed briefly in late June and early July before going into diapause.

WATERFOWL USE OF NATURAL SEASONAL PONDS IN YORK COUNTY, VIRGINIA DURING A "WET" YEAR. 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. The rare plant and animal species occurring at Grafton Ponds have been the focus of considerable research, but waterfowl use of this area has received little attention. During 1995, ducks were scarce at Grafton because the ponds were dry for much of the year. In 1996, however, most ponds retained water throughout the year, which led to increased waterfowl use. This study documented the extent and distribution of waterfowl use, and sought to explain why some ponds were preferred over others. Counts were made at 35 ponds on seven occasions from October, 1996 to May, 1997. Ducks were observed at 21 of the ponds, and a total of 370 duck observations were made, consisting of 356 Wood Ducks, 13 Mallards, and one Black Duck. Two ponds were especially important, yielding 232 of the duck observations, and averaging 17.7 and 15.4 Wood Ducks per count. These two ponds were large, remote, relatively shallow, and supported a savanna-like growth of oak (*Quercus* spp.) trees. By April 3, most ducks departed the area, suggesting that these were primarily over-wintering individuals. A management plan of the Grafton Ponds Natural Area Preserve will recommend minimal disturbance to these ponds.

EFFECTS OF PROLONGED FLOODING ON THE HERBACEOUS FLORA OF NATURAL SEASONAL PONDS IN YORK COUNTY, 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. Resampling of 170 permanent vegetation plots at 35 seasonal ponds near Grafton revealed major changes in floristic composition, attributable to sustained high water levels in 1996. Mean vascular plant species richness per plot declined from 13.0 in 1995 to 9.5 in 1996. Most of the 26 herbaceous species absent in 1996 were annuals which require draw-down conditions for germination. Nine other herbaceous species had greatly reduced frequency in 1996. Three species appearing for the first time in 1996 were *Azolla caroliniana, Utricularia radiata,* and *Monotropa uniflora. Utricularia biflora* increased from two plots in 1995 to 23 plots in 1996. Plots representing the temporarily flooded *Pinus taeda - Quercus phellos / Ilex opaca / Chasmanthium laxum* Association experienced a slight decline in species richness, from 15.1 to 14.6. In contrast, species richness in semipermanently flooded plots of the *Lindernia dubia - Eragrostis hypnoides - Panicum dichotomiflorum* Association declined dramatically, from 14.9 to 2.9. Understanding the dynamics of seasonal pond vegetation requires a research effort sustained over several years. Resampling is planned again for 1997.

THE PINEY WOODS OF VIRGINIA, A VISION FOR A SELF-SUPPORTING BIOPRESERVE. Philip Sheridan and Bill Scholl, Meadowview Biological Research Station, 8390 Fredericksburg Tnpk., Woodford, VA 22580. Southeastern Virginia is characterized by a fire-dependent flora which has suffered significant degradation due to fire suppression, drainage of wetlands, and farm and timber practices. Several plant species have been extirpated while only a few populations are extant for a number of others. Botanical investigations of a fire-maintained quail plantation in south Georgia resulted in the discovery of healthy populations of several rare plant species which are experiencing serious population declines in surrounding regions. These results indicate that existing quail management practices in south Georgia may be consistent with preservation of rare and endangered plant species. Losses of bobwhite quail populations in Virginia have resulted in the Virginia Dept. of Game and Inland Fisheries producing a management plan which advocates increased use of prescribed burns to restore quail habitat. We recommend the establishment of a pilot quail plantation in southern Virginia based on the Georgia model and the reintroduction of historical, extirpated or rare plant species. We suggest that quail plantations may serve as financially self-supporting biopreserves for both quail and Virginia's fire-dependent flora.

STATUS, ECOLOGY AND CONSERVATION OF THE NILGIR TAHR IN THE MUKURTHI NATIONAL PARK, S. INDIA. Stephen Sumithran and James D. Fraser*, Department of Fisheries and Wildlife Sciences, Virginia Tech, Blacksburg, VA 24061-0321. The Nilgiri tahr (*Hemitragus hylocrius*) is a rare and endangered mountain ungulate that is endemic to the Western Ghats in South India. We studied this species in the Mukurthi National Park in the Nilgiri District. We estimated the population size at 200 animals and this is lower than an 1976 estimate of 450 individuals. Microhistological analysis of tahr fecal pellet suggest that tahr consume 64% grasses, 15% forbs, 14& sedges and 7% shrubs. Tahr used areas that are closer to cliffs, further form human disturbance, commercial forestry plantations and shola forests. Loss of habitat due to extensive commercial plantations of wattle (*Acacia* sp.) and blue gum (*Eucalyptus* sp.) on the grasslands, hydroelectric projects, and human disturbance, especially from feature movie makers, threaten this tahr population.

LIFE HISTORY CHARACTERISTICS OF TWO FEDERALLY ENDANGERED FRESHWATER MUSSELS (FAMILY UNIONIDAE). Brian T. Watson and Richard J. Neves. Virginia Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0321. Population assessments and fish host identifications were completed in 1996 for two federally endangered freshwater mussel species, tan riffleshell (*Epioblasma florentina walkeri*) and purple bean (*Villosa perpurpurea*), in the Clinch River watershed, Virginia. Both species exhibited high degrees of host specificity in laboratory tests, with results similar to those of previously examined congeneric mussel species. Host fish for *E. walkeri* were limited to the banded and/or mottled sculpin (*Cottus carolinae* and/or *bairdi*) and several percids; greenside darter (*Etheostoma blennioides*), redline darter (*E. rufilineatum*), fantail darter (*E. flabellare*), and snubnose darter (*E. simoterum*). Fish hosts identified for *V. perpurpurea* were also the banded and/or mottled sculpin and two percids; the greenside darter and redline darter. The tan riffleshell population in Indian Creek, Clinch River system, is the largest and perhaps only reproducing population of this species. Size class structure of the population ranged from 19.9 mm to 53.3 mm (males) and 26.2 mm to 49.4 mm (females), with approximately 27% of the population below the mean reproductive age of five years. The purple bean population is considerably less abundant with limited evidence of reproduction. Size class structure of the population ranged from 22.9 mm to 66.7 mm, with approximately 16% of the population less than the mean reproductive age of five years.

Psychology

DELAYED NON-MATCH TO SAMPLE OLFACTORY DISCRIMINATION IN RATS. Berry Blankinship, Dept. of Psych., Washington and Lee Univ., Lexington, Virginia 24450. **Recent studies have shown that the hippocampal system may not necessarily be the initial site of short-term memory or long-term memory, but rather an intermediate-term memory. Because the exact hippocampal area involved in this intermediate-term memory is still uncertain,the present experiment has attempted to design an effective delayed non-match to sample task guided by olfactory stimuli in order to utilize this intermediate term memory and ultimately locate the exact hippocampal structure involved. The results of this study show that the subjects are, in fact, capable of learning the non-match to sample task. However, because the subjects did not maintain the learning criterion of the non-match to sample task for a long enough period of time, the subjects did not necessarily perform the same in the DNMS task as they would have with a longer period of criterion maintenance. Additionally, due to time constraints, the delayed non-match to sample task was only run for a period of five days, hardly enough time to acquire data as impressive or accurate as that obtained from a longer duration of time.**

SUPERVISORY BEHAVIORS THAT INFLUENCE NEWCOMER RELATIONSHIP BUILDING. Victoria L. Cole & Debra Major, Dept. of Psych., Old Dominion Univ., Norfolk, VA. 23517. This study examined how supervisory behaviors influence leader-member exchange (LMX) and friendships between supervisors and newcomers to organizations. It was hypothesized that there would be a positive correlstion between supervisory behaviors and LMX and between supervisory behaviors and friendship. Also, because the multidimensionality measure of LMX contains an affect scale, friendship was expected to be correlated with LMX. How supervisory behaviors might individually correlate with LMX and friendship was also examined. The participants of this study were 115 newcomers to two large organizations. The correlational analyses performed found support for the hypotheses regarding the global measures of supervisory behaviors, LMX, and frindship. In addition, the majority of the individual supervisory behaviors were found to be correlated with LMX and friendship.

IMAGERY IN MNEMONIC DEVICES: THE EFFECT OF VISUALIZATION INSTRUCTIONS ON FREE RECALL OF MATCHED SERIAL WORDS AND PICTURES. Christine C. Cubitt, Richard L. Shortt, T. Scott Bennett, and James P. O'Brien, Social Sciences Div., Tidewater Cmnty. Col., Virginia Beach VA 23456. The relationship between verbal and pictorial memory was explored in a 2x2x2 design. Randomized stimuli were either 20 pictures (P) or their 20 word-names (W) drawn from Snodgrass & Vanderwart's (1980) lists such that all 20 pictures were perfect on name agreement measures (100% & H=0.00) but 10 words were high in Image Agreement (HIAg) and 10 were low (LIAg). Half of the groups received a mnemonic instruction which included imagery (I) and half received a mnemonic instruction without imagery (X). While the picture superiority effect was demonstrated, the HIAGxWxI condition yielded free recall scores equivalent to those of P under any condition. Automatic processing appears to be similar to instructed processing for pictures but not for all types of words (XW<XP&IP; IW=XW&XP&IP).

EFFECTS OF CONTEXTUAL INTERFERENCE ON MULTIPLICATION SKILL ACQUISITION. Todd M. Eischeid, D. S. McNamara, & B. C. Hayes, Dept. of Psyc., Old Dom. Univ., Norfolk, VA 23529. The present study examined the effects of three different presentation orders, or training methods (blocked, serial, random), for multiplication problems. Retention was measured by two different test conditions (serial, random). Performance was measured by reaction time and accuracy for solving the problems. Results show that high contextual interference resulted in lowest performance during training, but superior retention of the problems on posttest measures. Conversely, low contextual interference elicited the best performance during training, but poor retention of the problems on the posttest. Also shown was high retention for problems when testing method was similar to training method, supporting the concept of encoding specificity. No significant effects were found on a retention test given to all subjects one week later.

TOUCH DURING MOTHER-INFANT INTERACTIONS: THE EFFECTS OF PARENTING STRESS, DEPRESSION AND ANXIETY. Emily L. Fergus and Jeffrey Pickens, Dept. of Psychology, James Madison Univ., Harrisonburg, VA 22807. This study investigated non-verbal behavior during mother-infant play interactions, and its relationship to maternal reports of symptoms of depression, stress and anxiety. N = 65 mother-infant dyads (mothers' M age = 30.2 yrs.: 36 male and 29 female infants, M age= 164.1 days) were observed engaging in normal play for 3 minutes. Videotaped interactions were coded with a scale that rated both frequency and quality of touch. No relationship between touch scores and maternal stress or anxiety were observed. However, mothers in this sample who reported more depressive symptoms were observed to touch their infants more than non-depressed mothers. Depressive mothers appeared to be overstimulating their infants by engaging in higher rates of poking and tickling. This contrasts with prior reports that suggest that depressive mothers are typically withdrawn and understimulating with their infants. The present data suggests that analysis of non-verbal behaviors, such as the pattern of maternal touching, is useful for characterizing mother-infant interaction syles.

CLASSIFYING LABORATORY TEAM TASKS: A DEMONSTRATION OF A METHOD. A. Fitzgibbons & R.M. McIntyre*, Dept. of Psyc., Old Dominion Univ., Norfolk, VA 23529. The current study attempted to trial test a method for classifying simulated and laboratory tasks so they can be compared to real world team tasks. This method was based on Yanuskefski's (1995) team classification system. Using the TIDE^2 task, seven teams of four completed 20 decision trials and completed an interview. This interview was the basis for the data analysis. The results indicate that laboratory tasks may be similar to environmental conditions of some teams yet the process (behavioral) variables are more similar to other types of teams. Therefore, there is only a limited set of conclusions researchers can make about real world teams based upon the findings of this laboratory setting. Questions pertaining to future methodology are raised. Future research is called for to establish a comprehensive classification system of laboratory tasks.

AN ANALYSIS OF NON-VERBAL BEHAVIOR DURING PARENT-CHILD PLAY INTERACTIONS. Jennifer Floam and Jeffrey Pickens, Dept. of Psychology, James Madison University, Harrisonburg, VA 22807. **This study examined non-verbal behavior during parent-child play, and its relationship to parenting stress reported on the Parenting Stress Index (PSI). N = 48 parent-child dyads (39 mothers & 9 fathers, M age =36.5 yrs.: 26 male and 22 female children, range 3 - 14 years, M age=6.8 yrs) were observed engaging in a series of play tasks using the Marschak Interaction Method. Parent-child affect, proximity, as well as reinforcing, orienting and affectionate categories of touch were coded from videotapes. Dyads classified as "high stress" versus "low stress" (according to published cutoff scores for the PSI) differed in non-verbal interaction quality. Parents who scored high in parenting stress had less optimal interactions with their children, showing more negative affect and less touching. In contrast, low-stress dyads stayed in closer proximity and touched one another more during play. These results suggest that parenting stress negatively affects the quality of parent-child interactions as reflected in the pattern of nonverbal behavior exhibited during play.**

HIPPOCAMPAL HILAR AND CA3 CELLS: ANATOMY AND BEHAVIOR. T. J. GrandPre, K. S. Berland*, & L. E. Jarrard, Dept. of Psychol., Washington & Lee Univ. The role of the hippocampus in learning and memory was studied by investigating the effects of selective bilateral lesions of the CA3 cell field and the hilus of the dentate gyrus. In Exp. 1, the behavior of 11 rats (five experimental, six controls) was monitored in an Activity, Eating, and Drinking System for 14 days. Analysis of the data revealed a significant difference in terms of frequency of eating but not drinking or activity. Further, there was no significant difference in amount of food or water consumed. In Exp. 2, a Morris Water Maze was used to test spatial learning and memory. The resulting data revealed a dramatic spatial memory impairment in the experimental animals that was greater that what is found when all of the hippocampus is removed. Examination of the histology revealed a complete loss of the hilar cells with slight sparing of the CA3 region in the ventral-posterior extent of that field. In the lesioned rats, cell loss was also found in the amygdala and entorhinal cortex; presumably, this loss was the result of seizure activity. This pattern of results seems to indicate that hilar and CA3 lesions could provide a good animal model to study the behavioral effects of seizure activity.

DEPRESSION AND THE EMOTIONAL STROOP TASK: AN INVESTIGATION OF THE SIGNIFICANCE OF ERRORS. Janice E. Halecki, Robin J. Lewis, Kathryn K. Drury, Dept. of Psych., Old Dominion Univ., Norfolk, Va. 23529. The significance of errors made on an emotional Stroop task was investigated in this study. Ninety undergraduate students (44 male, 46 female, ages ranging from 18-25) from Old Dominion University participated. Participants performed a modified Stroop task using 16 letter string control words, 16 neutral words, 16 positive words, and 16 negative words as stimulus words. The task was administered on a 386sx personal computer using Micro Experimental Laboratory 2.0 software and a response box with voice key and microphone. An audio recording of the session was made to detect errors. Participants completed a series of surveys after completing the task, including two measures of dysphoria (BDI, and CES-D), and the Shipley Institute of Living Scale for measurement of intellectual impairment. Participants also completed a stimulus rating form (to rate the emotionality of the stimulus words), and a stimulus frequency form (to rate the frequency that events suggested by the words had occurred). The results of a 2 X 4 (dysphoria X word-type) ANOVA revealed no main effect; however the interaction was significant. The interaction revealed that, within word types, positive words resulted in a greater difference in errors across dysphoria groups. These results suggest a new model of depressive schemata, one in which the concepts of success and social approval are strongly linked with depressive neural networks.

THE EFFECTS OF CD-ROM VERSUS TEXT-BASED INSTRUCTION ON RECALL AND COMPREHENSION IN YOUNG CHILDREN. Chelsy Harris and Jeffrey Pickens, Dept. of Psychology, James Madison Univ., Harrisonburg, VA 22807. **This study investigated the effects of computer vs. text-based instruction on recall and comprehension in children. Together with a teacher, 26 children (M age=5.7 yrs., Range 4 - 9 yrs.) read a story-book, and worked with an interactive computer-based story, in a counterbalanced design. Following each story, children were asked a series of questions to determine their recall of story details. Although the text and CD-ROM stories were equated for length and content, children spent more time with the computerized format, and generally recalled more of computer-presented materials. There was no difference in recall between computer vs. text versions of a short/easy story, but there was a clear superiority of recall for computer presentation of a longer story. The results suggest that the graphic and interactive nature of computerized presentations can maintain children's interest and contribute to better recall for some materials. This suggests that computer-assisted instruction may be helpful in homes and classrooms as instructional tools to enhance learning for young children.**

EFFECT OF COMBINATION OF EPHEDRINE AND CAFFEINE ON SPONTANEOUS MOTOR ACTIVITY IN THE RAT. M. E. Jones, Jr., M. C. Mann*, and P. M. Duncan, Dept. of Psychology, Old Dominion Univ., Norfolk, VA 23529. Caffeine and ephedrine are relatively common drugs that are used by many people. The purpose of this experiment was to determine what effect caffeine and ephedrine have on locomotor activity in rats, and if there is any interaction between them when used in combination. Eight male rats of the Sprague-Dawley strain were given varying doses of caffeine and ephedrine. Their locomotor activity levels were then measured. The hypothesis was that both caffeine and ephedrine would have an effect, and that there would also be an interaction. The data were analyzed using a two-way ANOVA. There was a dose-related increase in activity for both drugs. However, no interaction effect was observed.

ACTIVITY, EATING, AND DRINKING FOLLOWING LESIONS OF HIPPOCAMPUS AND ENTORHINAL CORTEX. J. R. Leitch, E. W. Smith, S. E. Schultz*, and L. E. Jarrard, Dept. of Psychology, Washington & Lee Univ., Lexington, Va. 24450. The effects of excitotoxic lesion of the hippocampus and aspiration lesion of the entorhinal cortex on activity, eating, and drinking behavior in the rat were examined. These behaviors were monitored by a computer that sampled at 5-second intervals throughout the 24-hour day for three days preoperatively and fourteen days postoperatively. Rats with hippocampal lesions were found to be significantly more active nocturnally throughout the postoperative period and during the day for the first three postoperative days. Daytime activity in hippocampals was found to return to a level more consistent with entorhinal cortex lesioned and control rats following the third postoperative day. Hippocampal food and water consumption instances increased consistently and significantly postoperatively with respect to both entorhinal cortex lesions and controls. No significant differences were found between entorhinal cortex lesioned animals and controls. Since the entorhinal cortex provides the main cortical inputs into the hippocampus, it is interesting that these basic behaviors are not affected when the entorhinal cortex is removed. The results suggest that the reciprocal connections of the hippocampus to subcortical structures through the fimbria-fornix must be involved in the motivation of these behaviors. This finding has implications for all experiments in which hippocampus lesioned rats are tested in a task that could be influenced by significantly higher basic motivation.

IDENTIFYING AND SORTING KEY CONCEPTS: IMPROVING TEXT COMPREHENSION AND ASSESSING READER UNDERSTANDING. Stephanie A. Rosenacker & Danielle S. McNamara, Dept. of Psych., Old Dominion Univ., Norfolk, VA 23529. Undergraduates read a biology and a history text and either performed a keyword identification task or reread each text. They then performed a keyword sorting task and answered comprehension questions (i.e., textbased or situation model levels). Subjects comprehended the biology text better in the reread condition than those in the keyword identification condition. We suspect that there was an advantage for the reread condition because subjects did not process the text at a deep level when performing the keyword identification task. However, for the history text, there was no difference between the conditions. In general, subjects with a high level of background knowledge comprehended both texts better than those with a low level of background knowledge for the textbased questions, situation model questions, and situation model sorting task. For those who completed the keyword identification task, their level of knowledge did not have an effect on their scores. We suspect that if subjects do not take situation model task seriously (i.e., keyword identification task), then their comprehension scores would be lower than those who completed textbased tasks (i.e., rereading the text).

ON THE HIPPOCAMPUS AND CONTEXTUAL LEARNING. E. W. Smith, J. R. Leitch, S. E. Schultz*, and L. E. Jarrard, Dept. of Psychology, W & L. , Washington and Lee Univ., Lexington, VA. 24450. The hippocampus has been continuously implicated as a mediator in contextual learning paradigms. In the past, the primary means utilized to explore the role of the hippocampus in contextual conditioning has been aversive fear conditioning. In an attempt to further elucidate these data we examined hippocampectomized rats using simple appetitive Pavlovian training to remove confounding factors. Experiment 1 examined acquisition of contextual cues using the presentation of a Us, in this case, food. The results suggest that hippocampal rats demonstrate a significant difference in behavior manifested in increased activity within a novel environment. Experiment 2 consisted of two different trial settings involving spatial-dependent appetitive conditioning. Interpretation of these studies was inconclusive with regard to the rats' ability to demonstrate a conditioned preference, however, it did reinforce previous findings that demonstrate hippocampals' inability to extinguish in learning tasks. It can be suggested as a result of both experiments that the hippocampus plays a dynamic role in the inhibition of learned behaviors.

DOES PARENTING STYLE PREDICT ANTISOCIAL AND PROSOCIAL BEHAVIOR IN BOYS WITH AND WITHOUT ATTENTION-DEFICIT-HYPERACTIVITY DISORDER? Kathleen M. Smith, Laurel S. Baker, LaShaun Y. Stubbs, Dawn M. Powers, & Michelle L. Kelley, Department of Psychology, Old Dominion University, Norfolk, Va. 23529-0267. The purpose of the present research was to examine the degree to which mothers disciplinary practices and parenting styles predicted antisocial and prosocial behavior in ADHD and non-ADHD boys. Participants were 46 mother-ADHD son dyads and 53 mother/non-ADHD son dyads. A more authoritative parenting style negatively predicted children's antisocial behavior, whereas permissive parenting positively predicted children's antisocial behavior. More authoritative parenting during a videotaped interaction predicted children's prosocial behavior. Additionally, authoritarian, permissive, and disengaged parenting were negatively related to children's prosocial behavior. These findings provide some support that children's behavior is dependent on the parent's style of interaction with the child and that perhaps, some parents and children do engage in coercive interactions, however, these patterns appear to hold for both ADHD and non-ADHD mother-son dyads.

ATTACHMENT, STRESS, ANXIETY, COPING AND RELATIONSHIP SATISFACTION AS A FUNCTION OF SEXUAL ORIENTATION. Julie M. Stark & Michelle L. Kelley, Department of Psychology, Old Dominion University, Norfolk, VA, 23529. The purpose of the present research was to investigate the relationship between attachment style and stress, anxiety, coping mechanisms and relationship satisfaction as a function of sexual orientation. Comparisons were made between 65 heterosexual males, 71 heterosexual females, 61 homosexual males, and 70 homosexual females based on self-report measures of attachment, stress, anxiety, coping and relationship satisfaction. The percentages of individuals endorsing each attachment type significantly differed as a function of sexual orientation. Secure and dismissing individuals reported less stress and anxiety than either preoccupied or fearful attachment types. Individuals endorsing the secure style of attachment reported higher problem-focused coping and greater relationship satisfaction than insecure attachment types. Gays and lesbians reported significantly higher problem-focused coping than heterosexuals reported. Contrary to previous research, gays and lesbians reported greater relationship satisfaction than heterosexuals.

THE RELATIONSHIP OF AGE, EDUCATION, AND PERSONAL EXPERIENCE WITH THE ELDERLY TO KNOWLEDGE OF AGING AMONG COMMUNITY COLLEGE STUDENTS. James P. Taormina, Richard W. Hardee, Leeann M. Patton, and James P. O'Brien, Social Sciences Div. Tidewater Cmnty. Col., Virginia Beach VA 23456. Community college students (N=189) were surveyed; more non-traditional students are included in this population so it is more likely to resemble the general public than previously reported samples. Palmore's (1990) FAQI items were used with the addition of a "Don't Know" response for each item as recommended by Courtenay & Weidemann (1985) to reduce effects of guessing. No significant correlations were found between knowledge of aging scores (% accurate & % correct) and age, educational level (sem. hr. taken), years of experience with the elderly in subjects' homes, years of volunteer or paid work or number of contacts with the elderly per week. Those who had resided with an elderly person were more accurate in responses than those who had not ($t=2.36$, $P=.01$); those who had volunteered or worked with the elderly scored higher than those who had not ($t=1.72$, $P=.04$). It appears that the typical American who will have to make decisions about the care of elderly loved ones is, in general, poorly informed about aging.

Statistics

STUDYING GROUP EFFECTS ON CIRCULAR-LINEAR RELATIONSHIPS. Christine M. Anderson-Cook, Department of Statistics, Virginia Tech, Blacksburg, Va. 24061-0439. Circular-Linear data are bivariate responses where one component is measured by an angle or a location on a unit circle, and the other is a linear or scalar quantity. Applications for this kind of data arise in a number of diverse disciplines including engineering, biology, and meteorology. Wind direction and velocity would be a common example of this type of response. A common interrelationship to consider between components is that a single cosine can adequately describe the conditional distribution of the linear response given the circular one. Two complementary approaches to extending the method to incorporate group effects are presented. One approach considers reducing the number of groups by determining which curves describing the relationship are significantly different for each other, while the other finds common parameters within the curve across all of the groups. An engineering example is shown to illustrate the results.

CANONICAL VARIATE ANALYSIS WITH LONGITUDINAL DATA. Michael Beaghen, Dept. of Statistics, Virginia Tech, Blacksburg, VA 24061. A method is described for performing canonical variate analysis with longitudinal data. Canonical variates that are stable over time are hypothesized and estimated using maximum likelihood methodology. A likelihood ratio test is presented to test the hypothesis of stable canonical variates over time. The positions of the group means on the canonical variates are also estimated, and a hypothesis test of their equality over time is introduced. An example is given where measurements relating to "math anxiety" are made on male and female students before and after an introductory calculus course.

CAUSATION IN THE LAW: NECESSITUDE AND SUFFICITUDE, I.J. Good, Dept. of Statistics, Virginia Polytechnic Inst. & State Univ., Blacksburg, Va. 24061-0439. We can define a strict necessary or sufficient cause F of an event E in terms of logical implication. To generalize to tendency to cause, simply replace implication by weight of evidence W, the logarithm of a Bayes factor (which is the factor by which prior odds are multiplied to obtain posterior odds and is equal to a Bayesian likelihood ratio). We thus arrive at additive definitions of necessitude and sufficitude, Q_{nec} and Q_{suf}, in terms of the probabilities $P(E|F\&U)$ and $P(E|\overline{F}\&U)$ where $\overline{F}$ denotes the negation of F and U denotes the state of the universe just before the occurrence of either F or $\overline{F}$. Conversely these probabilities can be expressed in terms of Q_{nec} and Q_{suf}. Thus probability and causality are seen to be two sides of the same coin. It took me 31 years to make that simple discovery! This unification of the two topics would be impossible without explicating both necessitude and sufficitude. Necessitude and sufficitude pertain directly to *ethical* responsibility when the physical probabilities are replaced by the actor's subjective probabilities. More generally, in legal matters physical probabilities have to be estimated subjectively. (We are all Bayesians in the sense of using subjective probabilities, at least implicitly.) For example, an attempted murder might be ethically even worse than actual murder. But in human law, as distinct from "divine law", an actual murder is regarded as more deserving of REVENGE, politely call *retribution*. There are degrees of responsibility. An interpretation of "legal responsibility" is mentioned and is a plausible meaning for the degree to which F *actually* (physically) was necessary or sufficient to cause E on a specific occasion. For more details and references see Tech. Rep. 97-1, Jan. 97 to be published in *Machine Intelligence 15* (edited by F. Kurukawa, D. Michie, and S. Muggleton; Oxford Univ. Press).

ANALYSIS OF FAMILIAL TYPE DATA UNDER CIRCULAR COVARIANCE. Andrew M. Hartley & Dayanand N. Naik, Dept. of Mathematics and Statistics, Old Dominion Univ., Norfolk, VA 23529. Circular covariance matrices play an important role in modeling phenomena in numerous epidemiological, communications and physical contexts. In this article, we propose a parsimonious, "autoregressive" type of circular covariance structure which, similar to AR(1) time series models, involves only two parameters. We specify the ML estimator of these parameters, and implement two techniques for model selection between spherical, autoregressive circular, and general (unrestricted) circular covariance. We also derive an estimator for the autoregressive parameter which is superior to the MLE when the sample size is small, and present a comparison of the mean squared error of this estimator with that of the MLE using computer simulations. Finally, we discuss a case in which the measurements (which can be called "siblings'" scores) which have an autoregressive circular covariance structure, are equicorrelated with some other measurement (such as a "parent's" score). We consider estimation of the parent-sibling interclass correlation.

CONSTRUCTION OF LINEAR TREND-FREE FACTORIAL DESIGNS. Kiho Kim & Klaus Hinkelmann, Dept. of Stat., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. A sequential application of treatment combinations for a factorial design to experimental units over time and space is called a run order of that design. In some situations, the homogeneity assumption among experimental units may not be appropriate and hence a randomized run order may not be applicable. When the experimental units have a linear trend over time or space and the responses may be affected by such a trend, a systematic run order instead of a randomized run order may be preferred in order to reduce the effect of the trend. Factorial designs which have a systematic run order so that the properties of the ordinary analysis of variance for treatments and block sums of squares are preserved from a linear trend, are called linear trend-free factorial designs. In some practical situations where minimizing the cost of conducting an experiment is important along with "linear trend-freeness", systematic run orders which have small number of level changes may be preferred in order to reduce the cost incurred by changing the levels of factors. The generalized foldover scheme (GFS) introduced by Coster and Cheng (1988) is a construction method of systematic run orders for factorial designs. In the GFS, a unique run order is constructed by a given generator matrix. The intention is to find a generator matrix for a factorial design so that a systematic run order generated by the GFS with respect to that generator matrix provides the linear trend-freeness and then minimizes the number of level changes. A systematic construction method of generator matrix based on the selection of foldover vectors (SFV) is presented.

DETECTING OUTLIERS WITH COOK'S D STATISTIC. Donald R. Jensen, Dept. of Statistics, Virginia Polytechnic Institute, Blacksburg, Va. 24061, & Donald E. Ramirez, Dept. of Mathematics, University of Virginia, Charlottesville, Va. 22903. We introduce a generalized F distribution, and we show how to compute numerically p-values for this family of distributions. Natural versions of Cook's D statistic are distributed as such distributions. We apply these techniques to determine the statistical outliers (for single observations and joint observations) for the Intercountry Life-Cycle Savings Data from Belsley, Kuh, and Welsch.

NEAR-SATURATED TWO-STAGE DESIGNS WITH DISPERSION EFFECTS. D'Arcy P. Mays, Dept. of Math. Sciences, Va. Commonwealth Univ., Richmond, Va. 23284-2014. Many experimental processes are quite expensive, and traditional factorial or central composite design experiments are beyond the scope of the experimental budget. Situations in which calibrated equipment must be purchased or batches of material created are two examples. In situations like these, experimenters prefer to use saturated or near-saturated response surface designs, such as Koshal designs, hybrid designs, or small composite designs, to reduce the cost of the experimental process. Applications of such near-saturated designs are abundant, but most are applied to processes that assume homogeneous process variance throughout the design region. However, in many situations the assumption of homogeneous process variance is violated, and instead a unknown heterogeneous variance structure must be considered. Traditional statistical procedures involve the application of weighted least squares to analyze the data from such an experiment. This analysis considers the application of a two-stage experimental design procedure developed by Mays and Myers (1993) to the near-saturated designs in cases in which heterogeneous variance exists. The first stage of the two-stage procedure involves an equal replicate design that produces data used to estimate the heterogeneous variance structure. This estimated variance structure is then used to determine a second stage design that augments the first stage design to create a highly efficient total design. A simulation analysis shows that there are situations in which one would want to use a near-saturated design and the two-stage experimental design procedure is superior to a one-stage equal replicate application of the near-saturated designs.

SMOOTHING CONSIDERATIONS IN NONPARAMETRIC AND SEMIPARAMETRIC REGRESSION. James E. Mays, Dept. of Math. Sciences, Va. Commonwealth Univ., Richmond, VA 23284-2014, & Jeffrey B. Birch, Dept. of Statistics, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061-0439. There are two classical approaches to fitting a regression line to a scatter of points. If the form of the underlying model is considered known, then parametric procedures (such as least squares) are useful. With no information about the underlying model, nonparametric procedures (such as kernel or local-linear regression) are needed. Considered here also are two new semiparametric (model-robust) techniques which combine parametric and nonparametric techniques when there is partial information present about the underlying model. The nonparametric portions of these procedures use the data itself to obtain the fitted values at particular locations, by giving more weight to locations close to the point being fit and less weight to points farther away. The rate at which these weights decrease is determined by the bandwidth (or smoothing parameter). Discussed are the underlying motivations behind bandwidth selection, several typical techniques, the problems with these techniques, and the development of a new criterion. Of special interest is observing how well this new selector maintains the beneficial mean squared error properties of the new semiparametric methods.

USING COVARIATE INFORMATION TO INCREASE THE ACCURACY OF MARK-RECAPTURE ESTIMATES Steven R. Rein, Dept. of Math. Sciences, Va. Commonwealth Univ., Richmond, VA 23284-2014.& Ray J. White, Trout Habitat Specialists, Edmonds, WA 98020*. In fisheries, size selectivity is a well known difficulty in mark-recapture experiments. Other variables, such as habitat conditions, may also influence sampling efficiency, thus biasing population and biomass estimates. Following the method of Anderson (1995), a method for incorporating covariate information into such estimates is suggested. An additive model relating the logit of the chance of capture to smooth functions of covariates is assumed. Once this model is fit, the chance of capture for each fish is estimated then used as a weighting factor for population and biomass estimates. This approach will be illustrated using data on brown trout *Salmo trutta* and habitat conditions in the Paintbranch stream system in suburban Maryland. Comparisons will be made with the standard Chapman-Petersen estimates via simulation.

THE ANALYSIS OF SERIALLY CORRELATED DATA USING QUASI-LEAST SQUARES. Justine Shults, Ctr. for Pediatric Research, EVMS, Norfolk, VA 23510, and N. Rao Chaganty, Dept. of Stat., Old Dominion University, Norfolk, VA 23529. Quasi-least squares (QLS), a marginal statistical method first described in the balanced setting by Chaganty (1997, *J. Stat. Plan. Inf.*, to appear), allows for application of a wide range of correlation structures. We propose a non-asymptotic criterion for correlation model selection that is based on the QLS approach. We then present the advantages of using QLS to analyze small samples of unbalanced and unequally spaced longitudinal data using three correlation models- the first order auto-regressive (AR(1)), the Markov, and the generalized Markov structure described by N'unez-Anton and Woodworth (1994, *Biometrics* 50, 445-456). The Markov and generalized Markov structures cannot be easily employed when using the generalized estimating equation (GEE) approach of Liang and Zeger (1986, *Biometrika* 73, 13-22) because GEE Markov correlation parameter estimates are often infeasible and it is difficult to obtain consistent moment estimates of the correlation parameters for the generalized Markov structure. We conduct simulations for the AR(1) and Markov correlation structures to show that use of QLS can lead to reduced mean square error of the regression parameter estimates and to demonstrate the benefit of using QLS when the generalized Markov structure is correctly specified. An analysis of some medical data is also presented, to demonstrate the use of QLS in selecting a suitable working correlation structure and identifying important covariates.