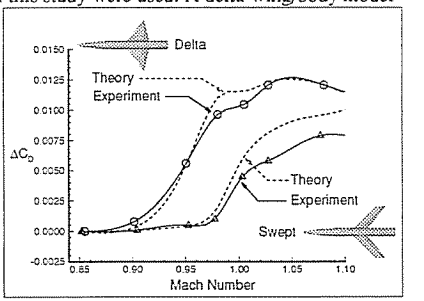
ABSTRACTS OF PAPERS
72nd Annual Meeting of the Virginia Academy of Science
May 18–20, 1994, James Madison University
Harrisonburg, VA

Aeronautical and Aerospace Sciences

AN EVALUATION OF THE PERCEIVED URGENCY OF AUDITORY WARNING SIGNALS. Jennifer L. Burt and J. Raymond Comstock, Jr.*, NASA Langley Research Center, Flight Deck Research Branch - Mail Stop 321, Hampton, Va. 23681-0001; Debbie S. Bartolome* and Daniel W. Burdette*, Lockheed Engineering & Sciences Company, 144 Research Drive, Hampton, Va. 23666. One significant concern pilots have about cockpit auditory warnings is that the signals presently used lack a sense of priority. The relationship between auditory warning sound parameters and perceived urgency is, therefore, an important topic of inquiry in aviation psychology. The present investigation examined the relationship among subjective assessments of urgency, reaction time, and brainwave activity with three auditory warning signals. Subjects performed a tracking task involving automated and manual conditions, and were presented with auditory warnings having various levels of perceived and task urgency. Subjective assessments revealed that subjects were able to rank warnings on an urgency scale, but rankings were altered after warnings were mapped to a task-related urgency scale. Reaction times differed between automated and manual task conditions, and physiological data showed attentional differences in response to perceived and actual warning urgency levels. This study shows that the use of physiological measures, in conjunction with behavioral and subjective measures, can lead to the development of more effective auditory warning systems.

COMPARISON OF USM3D AND EXPERIMENT: HOW WELL DOES AN EULER CODE PREDICT TRANSONIC DRAG RISE? Wayne D. Carlsen, Joint Inst. For Advancement of Flight Sciences, George Washington Univ./NASA, Hampton, Va. 23665-5225. This study presents wave drag comparisons of experimental and theoretical results. The applied theory, USM3D, was an unstructured-grid Euler code. The experimental results came from the 1956 report by Dr. Richard Whitcomb on the development of the sonic area-rule. Two different experimental models from this study were used: A delta-wing/body model and a swept-wing/body model. The theoretical wave drag results from these two models were compared with the experimental results through the Mach number range 0.85 to 1.10. As shown in the figure, the results corresponded well. The results were exceptionally good when considering that boundary layer effects were neglected. Also, the largest discrepancies occurred near Mach one where experimental results were of questionable value. The comparisons showed that Euler theory predicts the trends in wave drag with reasonable accuracy. (Completed at NASA Langley Res. Ctr. under grant NCC1-24)



FOREIGN COMPETITION IN HIGH-SPEED RESEARCH: CAN THE U.S. MAINTAIN THE TECHNICAL EDGE? Henri D. Fuhrmann, NASA Langley Research Center, Mission Analysis Branch, Mail Stop 406, Hampton, Va. 23681-0001. A review is presented of the unclassified literature concerning foreign high-speed research projects which pertain to the development of a High-Speed Civil Transport (HSCT). Motivation behind recent funding by Congress of HSCT development is the jobs, technology, and production potential of this expanding and lucrative market. If the United States can develop an economical HSCT that meets the environmental and regulatory constraints, the positive balance of trade resulting from the aerospace industry will be further bolstered. If indeed other countries are seriously pursuing similar ventures, it would be advisable to monitor technical and programmatic progress in order to gauge appropriately the level of investment required for this technology. The United States stands poised to meet the challenges and reap the benefits of the HSCT market. However, the U.S. must remain aware of foreign developments that may threaten the dominant position it has enjoyed in aerospace over the decades. (This work was completed as part of the George Washington University course requirements for a Master of Science Degree)

ON BI–GRID LOCAL MODE ANALYSIS OF SOLUTION TECHNIQUES FOR 3–D EULER AND NAVIER–STOKES EQUATIONS. S. O. Ibraheem and A. O. Demuren*, Dept. of Mech. Eng., Old Dominion Univ., Norfolk, VA 23529. A procedure is presented for utilizing the bi–grid stability analysis as a practical tool for predicting multigrid performance in a range of numerical methods for solving Euler and Navier–Stokes equations. For the Euler equations, bi–grid analysis is presented for three upwind difference based factorizations, namely Spatial, Eigenvalue and Combination splits, and two central difference based factorizations, namely LU and ADI methods. In the former, both the Steger–Warming and van Leer flux–vector splitting methods are considered. For the Navier–Stokes equations, only the Beam–Warming (ADI) central difference scheme is considered. In each case, estimates of multigrid convergence rates from the bi–grid analysis are compared to smoothing factors obtained from single–grid stability analysis. Effects of grid aspect ratio and flow skewness are examined. Both predictions are compared with practical multigrid convergence rates for 2–D Euler and Navier–Stokes solutions based on the Beam–Warming central scheme. In general, the bi–grid analysis gives better predictions of actual multigrid performance. (Supported by the NASA Lewis Res. Ctr. under Grant No. NAG–3–1329 with Dr. James Scott as Tech. Monitor. Computations were performed on supercomputers at NASA Lewis and NASA Ames Res. Ctr.)

COUPLED AND UNCOUPLED BENDING AND TORSIONAL VIBRATIONS OF VERTICAL TAIL BUFFETING. Osama A. Kandil and Steven J. Massey, Dept. of Aerospace Engineering, Old Dominion University, Norfolk, VA 23529. A simulation of tail buffet is presented for a delta wing-vertical tail configuration. Flow conditions are chosen such that the wing primary-vortex cores experience vortex breakdown and the resulting turbulent wake flow impinges on the vertical tail. The dimensions and material properties of the vertical tail are chosen such that the deflections are large enough to insure interaction with the flow, and the natural frequencies are high enough to facilitate a practical computational solution. This multidisciplinary problem is solved sequentially for the fluid flow, the elastic deformations and the grid displacements. The fluid flow is simulated by time accurately solving the laminar, unsteady, compressible, full Navier-Stokes equations using an implicit, upwind, flux-vector splitting finite volume scheme. The elastic vibrations of the tail are modeled by coupled bending and torsion beam equations. These equations are solved accurately in time using the Galerkin method and a five-stage Runge-Kutta-Verner scheme. The grid for the fluid dynamics calculations is deformed using interpolation functions to disperse the displacements throughout the computational domain. The results show that the vortex breakdown location is unsteady, asymmetric and sensitive to the vibrations of the tail. The addition of torsional vibration modes are seen to have a substantial effect on the tail response in comparison to the bending only case. The results also show that the deflections and loads of the coupled bending-torsion case are substantially lower than those of the uncoupled response case.

A WIND TUNNEL INVESTIGATION OF THE EFFECTS OF GURNEY FLAPS ON THE HIGH-LIFT CHARACTERISTICS OF A BUSINESS JET WING. Michelle T. Martuccio, The George Washington University, Joint Institute for the Advancement of Flight Sciences, NASA Langley Research Center, Mail Stop 355, Hampton, Virginia 23681-0001. Aircraft operations are both noisy and costly during the take-off and landing phases. High-lift systems can decrease the amount of airport noise and time to climb which saves fuel, as well as increasing overall payload and range. It is desired to have a simpler one- or two-element system that can achieve the same lift as a multi-element airfoil. Tests have been conducted in the NASA Langley 30- by 60- Foot Tunnel to determine the high-lift characteristics of .5%, 1% and 2%-chord Gurney flaps on a full-scale business jet. A Gurney flap is a small tab-like flap that extends perpendicularly down near a trailing edge surface, effectively increasing the camber of the airfoil. Flap settings of 10°, 20° and 30° were tested with the Gurney flaps both on and off. Comparing the longitudinal force data of these investigations show that the Gurney flap is an effective means of increasing lift; however, an increase in drag is noted in some circumstances.

A REFINED FIRST-ORDER, SHEAR-DEFORMATION THEORY AND ITS JUSTIFICATION. Yunqian 'Tim' Qi and Norman F. Knight, Jr., Dept. of Aerospace Engineering, Old Dominion Univ., Norfolk, VA 23529-0247. Using Pagano's exact solution for cylindrical bending problem of crossply laminated plates, the distribution of transverse shear strain is obtained which shows diversity, and discontinuity at dissimilar interfaces, through the thickness. In that sense, neither traditional first-order shear-deformation theory (FSDT) which takes transverse shear strain as a constant, nor most of the higher-order theories which are either based on or lead to continuous shear strain distribution, are adequate to account for actual response. A refined first-order, shear-deformation theory which retains the FSDT displacement assumption is proposed. The transverse shear strain derived from the FSDT displacement assumption, referred to as the nominal constant shear strain, is shown to be the stress-weighted-average shear strain through the thickness based on equivalent shear strain energy. Actual variational distribution of transverse shear strain is modeled which agrees with the stress distribution by constitutive relation pointwise. Without losing the simplicity of FSDT displacement assumption, the proposed refined theory not only shows improvement on predicting deflections, but also accounts for the actual variational distribution of transverse shear strain, for the first time, within the first-order shear-deformation theory. In addition, all boundary conditions, constitutive relations and equilibrium equations are satisfied.

APPLICATION OF A HIGHER-ORDER THEORY TO ORTHOTROPIC AND LAMINATED BEAMS. Christine C. Schleicher and Norman F. Knight, Jr., Dept. of Aerospace Engineering, Old Dominion Univ., Norfolk, VA 23529-0247. A higher-order theory and an associated finite element formulation are developed for analysis of laminated planar beams in bending. The higher-order theory incorporates both transverse normal stress and transverse shear stress, and is developed using two approaches. The first approach is based on assuming the transverse normal strain distribution to be a cubic function through the beam thickness, while the second approach is based on assuming the transverse normal stress distribution to be a cubic function through the beam thickness. In both approaches, the transverse shear strain distribution is assumed to be a quadratic function through the beam thickness. Theoretical and finite element results for these higher-order theories are presented isotropic, orthotropic and laminated beams in various loading conditions, and are compared with two-dimensional elasticity solutions. The higher-order theory produces accurate results for orthotropic beams in which the ratio of the longitudinal to transverse elastic moduli is less than five. Accurate transverse normal stresses are obtained provided the transverse elastic modulus is nearly constant through the thickness of the beam.

AN INBOARD-WING CONCEPT AS A HIGH-CAPACITY AIRPLANE. M. Leroy Spearman. NASA Langley Research Center, Hampton, VA 23681. The proposed concept consists of twin-bodies connected by an inboard wing. There are no outboard cantilevered wing panels as is the case for conventional designs. This arrangement provides for essentially doubling the passenger capacity of a typical single-body design for the same body length and for a width considerably less than the span of a single body design with outboard wing panels. It is anticipated that the wing, being a simple end-supported beam bounded by the bodies, would not be likely to bend or to twist and, as a result, might be much lighter than a conventional cantilevered wing with the same area. In addition, the wing chord could be much greater than that for a conventional wing and, for the same thickness ratio, could be much thicker. With this possibility, the wing could provide space for submerged engines or volume for fuel or cargo. This paper presents the results of a theoretical study of the aerodynamic characteristics of the concept for a Mach number of 0.80 with several variations in the wing span and chord for a constant wing area. Initial results appear favorable with lift-to-drag ratios being comparable to those for lower-capacity single-body designs.

PASSIVE CONTROL OF RANDOM RESPONSE OF SYMMETRICAL COMPOSITE PANELS USING SHAPE MEMORY ALLOYS AT HIGH TEMPERATURES. Z.W.Zhong, Center for Structural Acoustic and Fatigue Research, Department of Aerospace Engineering, Old Dominion University, Norfolk,Va 23529–0247. An investigation on reduction of random response of symmetrically laminated orthotropic plates with embedded shape memory alloy(SMA) fibers at high temperatures is presented. Stress-strain relations for a thin composite lamina with reinforced SMA fibers are derived. Governing equations including shape memory effects based on the classic continuum method are presented. The interesting buckling behavior that composite plates with SMA fiber reinforcement have two critical temperatures is revealed. Three types of analyses are performed, they are the thermal buckling, thermal postbuckling, and random vibration of thermally buckled composite laminates. The results of a simply supported rectangular panel demonstrate that the SMA fibers can completely eliminate the thermal postbuckling deflection and significantly reduce the random response at elevated temperatures.

Agriculture, Forestry and Aquaculture Science

NEW LEGUME CROPS FOR VIRGINIA. Harbans L. Bhardwaj, A. Mohamed, and M. Rangappa. Agricultural Research Station, Box 9152, Virginia State University, Petersburg, VA 23806.

In order to diversify Virginia's agriculture, a component of agricultural research at Virginia State University is focusing on development of new food, feed, and industrial use crops. Under this program, pigeonpea, chickpea, and mungbean are being evaluated as new legume crops to provide nutritious food for humans and animals and also for their nitrogen-fixing capabilities. During 1993, chickpea seed yields varied from 876 to 1400 kg/ha for eight *desi* types whereas the yield of 12 *kabuli* types varied from 307 to 1082 kg/ha. Chickpea also has potential as a vegetable crop, the green immature seeds are considered a delicacy by many people of Asian origin. Research conducted during 1992 indicated that determinate pigeonpea lines can yield upto 2042 kg/ha of mature seed. The average yield of three determinate lines (1751 kg/ha) was significantly higher than that of three indeterminate lines (721 kg/ha). The pigeonpea also has potential as a vegetable crop yielding upto 15,696 kg/ha of green (82.4% moisture) beans. The shelling percent of pigeonpea green beans varied from 52 to 55% with protein content of green seed varying from 18 to 21%. The evaluation of eight mungbean lines during 1993 indicated a considerable yield potential for this crop with yield varying from 1189 to 2068 kg/ha. These preliminary evaluations indicate that chickpea, pigeonpea, and mungbean have potential as new and alternate crops for Virginia.

TEMPORAL AND SPATIAL GENETIC VARIATION WITHIN AMERICAN SHAD (*Alosa sapidissima*) POPULATIONS OF MID-ATLANTIC RIVERS. B.L. Brown and T.C. Muller. Department of Biology, Virginia Commonwealth University, Richmond, VA 23284. Restriction endonuclease analysis of mitochondrial DNA was used to assess genetic variation of 649 American shad sampled from the Connecticut, Delaware, James, and Pamunkey Rivers (in CT, NJ, VA and VA, respectively) during 1991-1993. Haplotypes were incorporated into a Chi-Square analysis, using a Monte Carlo technique. Paired comparisons were made and genetic variation was not observed for some rivers within a given year, particularly 1991 and 1992 and genetic variation was observed in many rivers between years suggesting that sampling strategies are important when studying the spatial and temporal variations in a migratory species, such as the American shad.

MEAT GOATS: POTENTIAL FOR DIVERSIFICATION IN VIRGINIA AGRICULTURE. Terry A. Gipson & Stephan Wildeus, Agricultural Res. Station, Va. State Univ., Petersburg, Va. 23806. The demand for goat meat has risen dramatically over the last decade. Goat meat is very popular among the increasing ethnic populations in the United States. It has also attracted health conscious consumers who want to lower their dietary fat and still eat red meat. In the last ten years, the number of goats slaughtered in the United States has seen a substantial increase. However, domestic goat production is inadequate to meet the growing demand. The amount of chilled or frozen goat meat imported into the United States has seen a 70% increase over the last three years. Goats are growing in popularity with farmers who wish to diversify their operations, utilize marginal land or have limited resources. Goats have been used to control multiflora rose, kudzu, cedars, briars and other undesirable plant species in cattle pastures. This is because goats complement cattle in their grazing patterns with very little dietary overlap. The dietary preference of goats is 30% grass, 10% forbs and 60% browse. In contrast, cattle prefer 70% grass, 15% forbs and 15% browse. Thus, income may be improved by adding goats to a cattle operation. This may be true for some sheep enterprises too, because the grazing patterns of sheep and goats differ slightly. Sheep prefer 50% grass, 30% forbs and 20% browse. In addition to providing a desirable product for an ever expanding market, meat goats are valued for their contributions to nonchemical pasture renovation, multispecies diversification and low input farming.

EFFECTS OF FOOD PROCESSING ON THE NUTRITIONAL VALUE OF LEGUMES. Ali I. Mohamed. Agricultural Research Station, Virginia State University, Petersburg, Va 23806. Legume seeds are concentrated sources of protein with a particular value for direct utilization in the diet. Generally, the nutritional status of legume seeds are limited by poor digestibility, deficiency in lysine or sulfur containing amino acids and poor functional properties such as long cooking times and hard seeds. The objective of these studies is to determine the effects of several food processing on the nutritional value of faba bean which is considered to be one of the most consumed bean in third world countries. Dehulling process of faba bean seeds had no effect on protein content (26.9%). Total hydrolyzable carbohydrates was increased by dehulling (from 61.9% to 63.9%), while crude fiber was significantly decreased from 7.13% to 0.7%. By dehulling, tannin was significantly decreased from 139.18 to 64.49 mg/100 g. Phytic acid was increased by dehulling from 316.8 to 380.48 mg/100 g. Protein and carbohydrate digestibility was significantly increased by dehulling from 37.8 and 23.3% to 78.5 and 36.7% respectively. Glutamic acid was the predominant Non-Essential AA (18.34%) while lysine and leucine were the predominant significantlyEAA (7% and 8.67%). The effect of cooking on the chemical composition of faba bean seeds was also studied. Cooking decreased crude protein and total hydrolyzable carbohydrates due to leaching process. Cooking significantly increased protein and carbohydrate digestibility, from 73.8 and 23.3% to 88.04 and 56.49% respectively.

POND PRODUCTION OF CATFISH IN VIRGINIA. Scott H. Newton and M. David Crosby. Cooperative Extension Service, Virginia State University. Petersburg, VA 23806. During the 1992 and 1993 warm water production seasons, open pond culture of channel catfish, (Ictalurus punctatus), was examined in 0.25 acre research ponds located in Chesterfield County. The primary objective was to develop information on pond culture of catfish for the Mid-Atlantic Region. Both years, catfish were stocked similarly in triplicated ponds and fed once daily 116 of 151 days and 126 of 159 days, respectively. Fish stocking rates were 1500 and 3000 per acre in 1992 and 3000, 5000, and 8000 in 1993. In 1992, harvested catfish averaged 1.6 pounds, while 1993 average fish sizes were 1.2 for the 3000 and 5000 densities and 1.0 for the 8000 fish density. Gross harvest yields averaged 2175 pounds per acre for the 1500 fish per acre stocking, 4421 and 3372 pounds, respectively, for the two seasons with the 3000 per acre density, and 5328 and 6840 pounds per acre for the 5000 and 8000 stocking densities, respectively. Water quality management included aeration of ponds based upon monitored oxygen and other physicochemical parameters. Recommendations for pond catfish culture in the Mid-Atlantic Region are based upon management strategies and market sales outlets.

MEAT GOATS: MANAGEMENT CONSIDERATIONS FOR THE PRODUCTION OF MEAT. Stephan Wildeus & Terry A. Gipson, Agricultural Res. Station, Va. State Univ., Petersburg, Va. 23806. Goat production for meat differs from that for milk or for fiber in its reduced production intensity and increased emphasis on reproductive efficiency, kid growth rates and meat confirmation. Most of the goat breeds in the U.S. have been selected for either dairy production (Nubian, La Mancha, Swiss breeds) or mohair production (Angora), while neglecting maternal ability, and growth rate/muscling, respectively. Currently, the only true meat breed is the South African Boer goat that has recently been imported in the U.S. The Spanish goat, developed under extensive range conditions, the Tennessee Wooden-legged goat and the Pygmy goat are all smaller breeds, but have meat-type conformations and potential as components in a meat-producing crossbreeding scheme. For meat goat production to be efficient and profitable, animals must perform well under a forage-based system with limited inputs of harvested feeds. Females should be capable of giving birth to multiple litters with minimal assistance and successfully raise kids to weaning. Although goats generally are seasonal breeders, meat-type goats should ideally have extended breeding seasons or breed throughout the year. This would allow a decrease in kidding interval and allow breeding to produce kids for specific markets opportunities (i.e. Easter). No grading standards are currently adopted for goats and carcasses are marketed whole, but kids with good meat confirmation generally command higher prices. Hence selection and management for meat-type conformation and high growth rates should be pursued. To this end research is needed to characterize the meat production capacity of selected breeds and their crosses under Virginia production conditions and to refine meat goat management systems.

Archaeology

THE EXCHANGE OF COPPER DURING THE LATE WOODLAND PERIOD WITHIN VIRGINIA'S LOWER PIEDMONT AND RIDGE AND VALLEY: A CHANGE IN DIRECTION. Michael B. Barber, Preservation Technologies, Inc., P.O. Box 7825, Roanoke, VA 24019. Recent investigations at one site in the southern Piedmont and 2 sites within the Ridge and Valley of Virginia have indicated that European copper, as well as glass and shell beads and limited amounts of iron, was an important exchange item between the English Colonials and the Native Americans. Likely the local Indians would trade deer skins through a middleman arrangement for a limited array of European goods plus additional non-local Native American products. Although copper was an important indicator of Native American social status during the Late Woodland on the coastal plain of Virginia, there is little to suggest equal importance within the interior. Copper may have flowed from the interior to the coast during late prehistoric times but the trade was in the opposite direction at contact. Electron microprobe studies will be used to suggest possible copper sources.

A GUILFORD COMPONENT (ca. 3500-2200 B.C.) OF RHYOLITE AT FAIRWOOD HORSE CAMP NEAR MT. ROGERS, GRAYSON COUNTY, VIRGINIA: REVISITED. Eugene B. Barfield, Jefferson National Forest, Roanoke, VA 24019. Fairwood Horse Camp (44GY18) lies just over 4 miles northeast of the highest peak in Virginia, Mount Rogers, at 5,725 feet above sea level. The site itself is approximately 3,360 feet above sea level on a low valley interior stream floodplain. Over 90% of this lithic artifact assemblage is rhyolite and 91% of the diagnostics are Guilford (ca. 3500-2200 B.C.) representing the Late Middle Archaic. Quality comparisons will be made of this igneous material with other samples from the Middle Atlantic as well as a study of Middle Holocene ecological factors that may suggest the purpose of this weapon/tool manufacturing site in the subsistence scheme of the Late Middle Archaic Culture Period.

THE SMITH MOUNTAIN SITE: A DEEPLY STRATIFIED PALEOINDIAN OCCUPATION IN THE SOUTHWESTERN PIEDMONT OF VIRGINIA. William A. Childress, P. O. Box 124 Canal St. Sta., New York, N. Y. 10013. The Smith Mountain Site is a multicomponent Paleoindian/Early Archaic site located on the south floodplain of the Roanoke River near its constriction at Smith Mountain Gap. A hydroelectric complex created by the impoundment of Smith Mountain and Leesville Lakes in the 1960's has resulted in considerable erosion of alluvial features below the dam at Smith Mountain where two lithic concentrations have been exposed at the head (44PY7) and foot (44PY152) of a natural levee located on what is now the margin of Leesville Lake. This levee documents a sedimentary buildup throughout the Holocene and is underlain by a cobble lens(es) apparently representing late Pleistocene point bar deposits upon which the earliest recognized occupation of the site commenced. Lithic forms representing virtually the entire range of Paleoindian tool types including fluted points have been recovered on the sites' lower levels with transition Paleoindian and Early Archaic projectile points occurring somewhat higher. Auger tests have confirmed an early occupation zone from 1.5-1.95 m at 44PY7 and 1.8-2.5 m at 44PY152. Recoveries of cultural material in the matrix at considerably lower levels suggest even deeper stratification. The Smith Mtn. site is the most deeply buried fluted point site recorded for Va. and perhaps for the Southeast as well. As the first Paleoindian residential site recorded for southwest Va., it may be indicative of a riverine oriented settlement focus in the region. Similar sites may be more common on higher order streams in the piedmont than has been realized. The dispersed and numerous sources of the assemblage's high quality lithic materials and substantial use of coarser local lithics for expedient tools at Smith Mtn. may modify some of Va.'s quarry weighted models of Paleoindian reliance on cryptocrystallines.

THE LANDSCAPE DESIGN AT EPPINGTON PLANTATION: THE INTERSECTING SPHERES OF BLACKS AND WHITES. Garrett R. Fesler, James River Institute for Archaeology, Inc., 2080 Jamestown Road, Williamsburg, Va. 23185. Recent archaeological excavations at Eppington plantation in Chesterfield County have revealed new information about a distinctive late 18th-century plantation landscape. Francis Eppes began building Eppington in the early 1770s and continued to modify his house and surrounding grounds until his death in 1808. In its heyday Eppington was the most productive plantation in Chesterfield County with over 40 slaves living and working on the property. Supplemented by several important documentary accounts, and comparative data from Monticello, Mount Vernon and elsewhere, archaeological excavations have uncovered a dynamic plantation landscape design at Eppington intended to function both as an economically efficient estate and as a purposefully ornate symbol of power and community authority. Although Eppes attempted to conceal the working world of his slaves from view, archaeological work has allowed them to reclaim their place on the Eppington landscape. Archaeological findings demonstrate that Eppes was unable to segregate the earmarks of daily toil from his carefully shaped aesthetic landscape.

PASPAHEGH ARCHAEOLOGY: REPORT ON INVESTIGATIONS AT SITE 44JC308, A PROTOHISTORIC/EARLY CONTACT NATIVE AMERICAN VILLAGE IN JAMES CITY CO., VA. Mary Ellen N. Hodges and Charles T. Hodges, James River Inst. for Archaeology, Inc., 2080 Jamestown Rd., Williamsburg, Va. 23185. Recent areal excavations conducted within a 2.1-acre section of site 44JC308 documented 48 structural patterns and 25 human mortuary features associated with a Native American village occupied during the late 16th/early 17th centuries, likely by the Paspahegh Indians. Diverse lines of evidence have been used to define the internal structure of the settlement and the nature of socio-political organization, ideological systems, health, and subsistence within the local population. The multi-disciplinary investigation involved ethnobotanical and zooarchaeological analysis of subsistence debris, biocultural and stable isotope analysis of human osteological remains, identification of the composition and fabric structure of organic materials associated with the burials, and compositional and metallographic analysis of copper-base funerary artifacts. Site 44JC308 is located about six miles upriver from Jamestown, the first permanent English settlement in North America, and is significant for determining the consequences of European contact for the native inhabitants of the Virginia Coastal Plain during the early years of colonial settlement in the Chesapeake region.

AN ARCHAEOLOGICAL ASSESSMENT OF THE J.E.B STUART BIRTHPLACE PATRICK COUNTY, VIRGINIA. Clifton A. Huston, William and Mary Center for Archaeological Research, College of William and Mary, P.O.Box 8795, Williamsburg, VA 23187. During the month of November, 1993, an archaeological assessment was conducted at the property that is believed to have been the birthplace of General J.E.B. Stuart, in Patrick county, VA. This assessment was performed for the J.E.B. Stuart Birthplace Trust, located in Stuart, VA. The project included mapping, controlled surface collection and limited subsurface investigation of a disced agricultural field located on a ridge overlooking the Ararat River. Two previously unknown archaeological sites were located during this assessment. 44PK112 is an Early and Middle Archaic lithic site, and 44PK113 is a multicomponent site that contains an Archaic occupation that is overlain by the historic Stuart housesite. Surface collection of this site produced artifacts and data that point to the location of two structures, one of which appears to have been destroyed by fire, in the same manner as the Stuart house in the winter of 1847-1848.

"THE RUDIMENTS OF A SCIENTIFIC APPROACH:" ROLAND WELLS ROBBINS AND THE DEVELOPMENT OF METHODOLOGY IN HISTORICAL ARCHAEOLOGY. Donald W. Linebaugh, Dept. of Anthro., Col. of William and Mary, Williamsburg, Va. 23185. Roland Robbins presents an enticing study of the disciplinary evolution of historical archaeology, through an extraordinary career that began with the excavation of Thoreau's cabin in 1945 and expanded to include sites throughout the northeastern U.S. Understanding historical archaeology's development as a discipline is very important when reevaluating the work of previous archaeologists. Current scholars, by dismissing early figures like Robbins because of their "imperfect techniques and antiquarian goals," have overlooked valuable archaeological evidence. For instance, Robbins work at Saugus Ironworks, Philipsburg Manor Upper Mills, Shadwell, and particularly the John Alden House, is remarkable for the way in which Robbins's techniques and methodology resembled those of the burgeoning discipline of historical archaeology. He used grid systems for horizontal control, probe or shovel testing for site survey, and refined artifact provenience controls. Perhaps most surprising was his early use of special analytical studies, such as c14, soil analysis, bone analysis, tree ring dating, materials analysis, and artifact conservation. These studies, it seems, gave Robbins confidence and legitimacy in the face of increased pressure from the academic community.

SITE BURIAL FOR DATA PRESERVATION. Craig Lukezic and Antony Opperman, Virginia Department of Transportation, 1401 East Broad Street, Richmond, Virginia 23219. Site Burial is a controversial alternative to excavation for mitigation of construction impacts. As a community, archaeologists of Virginia are wary of the long term effects of site burial as unintentional site burial has damaged fragile and organic artifacts in the past. Currently, the Virginia Department of Transportation is developing a procedure to minimize data loss and enhance site preservation through intentional site burial.

THE ARCHAEOLOGICAL INVESTIGATION OF A LATE-NINETEENTH/EARLY-TWENTIETH CENTURY AFRICAN-AMERICAN SITE IN MONTGOMERY COUNTY, VRIGNIA. Cara Harbecke Metz, P.O. Box 1191, Williamsburg, Va. 23187. The Phase II archaeological evaluation of Site 44MY463 in Montgomery County, Virginia, was conducted by the William and Mary Center for Archaeological Research in the spring of 1993 under an agreement with the Virginia Department of Transportation. This investigation resulted in the recovery of data regarding the material life of a Post-Bellum, African-American tenant family. Documentary and ethnohistorical research provided additional information regarding the occupants of the site as well as data regarding life in an African-American community in the New River Valley of Virginia. The results of this investigation will be discussed and the broader issues regarding the study of late-nineteenth/early-twentieth century archaeological sites will be addressed.

"IN THE HILLY COUNTRIES BY SMALL RIVERS": DOCUMENTING THE ARCHAEOLOGY OF VIRGINIA'S NORTHERN PIEDMONT. Carole L. Nash, Dept. of Soc./Anth., James Madison Univ., Harrisonburg, Va. 22807. Since 1990, the Madison Archaeology Project (MAP), the first county-wide public archaeology program in rural Virginia, has recorded 300 prehistoric and historic sites in Madison, Greene, and Rappahannock Counties. From its western boundaries of 4000' a.s.l. Blue Ridge peaks, to its eastern boundaries of 300' a.s.l. Triassic Basin floodplains, this region is characterized by impressive environmental diversity whose use is reflected in Native American settlement choices. Sites ranging in age from the Paleo-Indian through the Late Woodland periods have been documented in this first systematic archaeological study of the northern inner Piedmont. The preliminary culture history developed out of this work raises questions about the association of Native American populations of the inner Piedmont to those of the larger Central Virginia and Shenandoah Valley regions.

I SEE WONDERFUL THINGS BENEATH THE FILL: PHASE II TESTING AT A LATE WOODLAND VILLAGE (44MY7) ON THE NEW RIVER, MONTGOMERY COUNTY, VIRGINIA. Stevan C. Pullins, Ctr. for Archaeological Res., Col. of William and Mary, P.O. Box 8795, Williamsburg, VA 23187-8795. Construction at the Radford Army Ammunition Plant has impacted a Late Woodland village on the New River. Phase II testing revealed that significant portions of the site are still present beneath thick layers of fill and spoil, including pit features, posthole and structure patterns, and midden deposits. Extensive faunal and floral remains were recovered from midden deposits and feature fill. The ceramic assemblage was comprised of Radford, Dan River, and New River types. Radiocarbon dates from carbonized maize indicated that the primary occupation of the site took place during the 13th and 14th centuries A.D.

THE DOGUE RUN SURVEY: SEARCHING FOR GEORGE WASHINGTON'S SIXTEEN-SIDED BARN. Suanna C. Selby, Dept. of Archaeology, Mount Vernon Ladies' Association, Mount Vernon, Va. 22121. A survey to locate and define the site of the 16-sided barn built by George Washington at his Dogue Run Farm in 1792-94 was completed in the summer of 1993. In conjunction with plans to implement an agricultural interpretive program centering on a reconstructed barn, the Mount Vernon Ladies' Association Department of Archaeology performed the intensive survey to answer specific questions about the structure. Now located outside the present boundaries of the Mount Vernon estate, the barn was identified in a neighboring residential area. Computer manipulation of several historic maps enabled pinpointing of the site to within a two-acre area. Systematic excavation of shovel test pits and test units revealed two concentrations of overfired and underfired brick fragments. One heavy concentration, containing a stratum of brick rubble, is interpreted as a brick clamp. The second concentration, in an area with the highest probability for containing the site, is located next to a house and swimming pool. The available evidence suggests that the barn and barnyard are concealed by the modern features of the neighborhood.

PROTON MAGNETOMETER AND GRADIOMETER SURVEYS OF 3 HISTORIC CEMETERIES. Michael A. Strutt Corporation For Jefferson's Poplar Forest. P.O. Box 419 Forest, Va. 24551. The usefulness of the proton magnetometer and gradiometer in archeological survey have been amply demonstrated in the past few decades. But the instruments are still not widely used by archeologists. The advantage of this remote sensing technique to non-invasive survey and the time saving capabilities should not be overlooked. The relative inexpensiveness of the instruments and ease of use, make them ideal for survey. When the magnetic situation is not suitable for the magnetometer because of modern disturbances, the gradiometer can filter out the detrimental effects of the disturbances. These concepts will be demonstrated by the presentation of three surveys showing the various types of magnetic anomalies created by historic graves and how they can be detected, even when utilities and automobiles are in the magnetic field area.

HIGHWAYS AND BRIDGES, BRIDGES AND HIGHWAYS: A REVIEW OF CULTURAL RESOURCE ACTIVITIES IN THE VIRGINIA DEPARTMENT OF TRANSPORTATION'S RICHMOND DISTRICT. J. Mark Wittkofski, VDOT, Richmond District Environmental Section, P.O. Box 3402, Colonial Heights, Va. 23834-9002. This paper presents an overview of archaeological research which has been conducted on transportation-related projects during the last 28 years in the 14 central and south-central Virginia counties and the city of Richmond which comprise the VDOT Richmond District. A total of more than 125 studies have been completed, however, time restrictions have limited the scope of this presentation to the discussion of only a handful of recent projects. These projects include research conducted both by VDOT staff and consultants. The studies presented in this paper include research from prehistoric Native American Early Archaic period camp sites, dating to ca. 7500 B.C., to post-Civil War Anglo-American urban communities and free black-occupied rural farmsteads. This VDOT-sponsored archaeological research has contributed a tremendous amount of data which continue to be analyzed and synthesized in order to present a more accurate and complete understanding and interpretation of Virginia's cultural past.

Astronomy, Mathematics and Physics

MODELING AIR FRICTION IN PROJECTILE MOTION. Richard L. Bowman & David L. Pugh*, Dept. of Physics, Bridgewater College, Bridgewater, VA 22812. Theoretical models for air friction on projectiles in free fall and in two-dimensional trajectories are developed using *Mathematica*'s capabilities in plotting, curve fitting, algebra and calculus. The two models examined are for friction depending linearly on the speed of the projectile and depending on the square of the speed. Experimental data for a steel ball and a cork ball are compared to the results obtained from applying the theoretical models. Air friction appears to be a significant factor in the cases presented.

A HIGH SCHOOL PHYSICS TEACHER WORKSHOP AND STUDENT OLYMPICS IN CHINA. D. Rae Carpenter, Jr., Dept. of Physics & Astronomy, Va Military Inst., Lexington, VA 24450. Nanjing Normal University, Nanjing, Peoples' Republic of China, offers a summer workshop for junior and senior high school teachers followed by a day-long olympics with local students in Grade 6-9 plus another day for Grade 10-12. Following the U.S.-Japan-China Conference, supported by AAPT, in Zhaoqin, CHINA, the author accompanied another conference participant, Prof. Liu Bingsheng, to Nanjing and participated in Liu's workshop- olympics for a week in August. Much of the teacher workshop is built around demonstrations using simple materials readily obtained in China. The program included a video session and a commercial exhibit. Demonstrations were presented by Carpenter, Liu and some of the participants. The academic portion of the student olympics was done in game show format by 6-12 competing teams from different schools with 6 persons per team. The teams viewed about a dozen live and taped demos and answered questions about each, some of which required the drawing of a diagram. The latter part of the morning was devoted to construction of devices to be used in the afternoon competition. Slides will illustrate teacher activities and examples of both junior and senior olympics. While some of the events were similar in concept to ones done in the U.S., the lack of sophisticated materials provided challenging variations. The teachers, the students and the physics were outstanding, but done under very trying economics conditions.

CHARACTERIZATION OF SOME MIXED LIGHT-METAL HYDRIDES. C. M. Castevens and S. L. Herr, Department of Physics, Virginia Commonwealth University, P.O. Box 842000, Richmond, Va. 23284-2000. Recently it was suggested that $LiBeH_3$ and Li_2BeH_4 may have properties similar to the properties of the proposed metallic and superconducting phase of hydrogen, and as such they may be candidates for high temperature superconductivity. Since then, several researchers have chosen to study $LiBeH_3$ with cluster calculations. Though the papers disagree with each other on both atomic and electronic structures, all have agreed that $LiBeH_3$ is an insulator. More recent calculations suggest that replacing beryllium with other elements would turn $LiBeH_3$ from an insulator to a metal, which has lead to theoretical studies of Li_3AlH_6, Li_3BH_6, and other hydrides. We have characterized several hydrides by vibrating sample magnetometry and temperature dependent ac susceptibility to determine their magnetic properties, several for the first time. Attempts at making the new compound Li_3BH_6 are also described.

MICROSTRUCTURAL PROPERTIES OF HIGHLY NITROGENATED MECHANICALLY ALLOYED IRON POWDER. Desmond C. Cook and James C. Rawers*, Department of Physics, Old Dominion University, Norfolk, VA 23529. *U.S. Bureau of Mines, Albany Research Center, Oregon 97321. Iron powder has been mechanically alloyed for up to 250 hours in a nitrogen gas environment in order to investigate the microstructural changes due to nitrogen infusement. The same powder was also alloyed in an argon gas environment in order to isolate the microstructural changes due purely to cold working from those due to the interstitial nitrogen. Samples were analyzed for particle size distribution and nitrogen concentration. This was followed by x-ray analysis to identify the phases present, lattice parameters and internal strain. Mössbauer analysis was performed to study the microstructural magnetic properties and to identfy the phases present. We have determined that nanocrystalline bct Fe-N martensite has formed from the bcc-Fe after 50 hours of mechanical processing. For the first 50 hours of processing both the internal strain and interstitial nitrogen concentration increased linearly. At 50 hours, the crystallite size was reduced to about 100Å and the highly strained nanocrystalline structure contained several atomic percent of nitrogen. Additional mechanical alloying resulted in a supersaturated, highly strained nitrogen bcc-Fe structure. This locally induced strain was suddenly reduced by formation of the bct Fe-N martensite through local redistribution of some of the highly mobile nitrogen atoms.

DETECTOR DEVELOPMENT AT JAMES MADISON UNIVERSITY. Darren Ellis. Dr. Kevin Giovanetti. Department of Physics, James Madison University, Harrisonburg, Va. 22807. Operation of an automated calibration system requires that the system be interfaced to some type of computer control. The calibration system being developed at JMU for the forward electromagnetic calorimeter at CEBAF will be interfaced within the framework set forth by the data acquisition and slow controls being developed for the CLAS detector. A brief overview of the slow controls and a discussion of the design issues that we face in interfacing our calibration system will be given.

IDENTIFICATION OF THE IRON-ZINC PHASES IN COMMERCIALLY PRODUCED GALVANNEALED STEEL. R.G. Grant and D.C. Cook, Old Dominion University.
A recently compiled data-base of the lattice and Mössbauer parameters of the pure Fe-Zn intermetallic phases has aided in the study of many commercially produced galvanneal coatings using XRD, conversion electron (CEMS), and transmission Mössbauer spectroscopy. The results show that different amounts of the four Fe-Zn phases are present in each coating depending on the production conditions. Also, a layering of the phases in the coatings was observed with predominantly the ζ or δ phase at the surface and a high iron concentration Γ phase forming as a very thin layer at the steel-coating interface. Comparing coatings produced with Al added to the Zn bath with those produced in Al-free baths show that the Al suppresses the formation of the ζ and low iron δ phase. We have also fractured many coatings in order to investigate the failure point within the coatings. CEMS of these coatings has shown that, following coating fracture, no Fe-Zn phases are left on the steel substrate. These observations are of industrial importance and warrant further study into the powdering characteristics of each phase to determine if steel surface preparation prior to galvannealing affects the coating adhesion and longevity. (Supported by International Lead Zinc Research Organization, Inc. grant ZM-403 and Virginia's Center for Innovative Technology grants MAT-92-007 and MAT-93-018.)

THE LORENTZ EQUATIONS: DERIVATION AND SOLUTION. R. Douglas Hyman, Department of Mathematics, Virginia Union University, Richmond, VA 23220. A numerical experiment has been conducted on the Lorentz model which describes the interrelation of temperature variation and convective motion in a fluid. The Lorentz equations governing "roll" convection between two surfaces maintained at a constant temperature difference are derived. A numerical method for solutions from an initial condition is given. These solutions for a fixed Prandtl number and variable normalized Rayleigh numbers are displayed graphically in phase space and exhibit the behavior common to dissipative dynamical systems, namely the convergence of all trajectories towards an attractor.

FLUID MECHANICAL EFFECTS OF TORTUOSITY IN ARTERIAL BLOOD FLOW. Kenneth C. Jacobs, Dept. of Physics, Hollins Col., Roanoke, VA 24020. Working during 1992 and 1993 with Dr. Bruce A. Young (Biology), Mr. Robert H. Hansen (Computer Science), and four Hollins undergraduates, we constructed and experimentally verified a theoretical model to examine the influence of different arterial configurations (tortuosity) upon blood pressure rise and arterial extensibility. I will present the model equations, which cover both laminar and fully-turbulent flow, as well as our parameterization of geometrical tortuosity. Results will be summarized for multiple bends, loops, and helices. The experimental setup to verify the model will be described and critiqued. This is one example of interdisciplinary biophysics research underway at Hollins College.

MOSSBAUER AND X-RAY STUDY OF THE IRON NITRIDE, Fe_4N. Tae H. Kim, Desmond C. Cook and James C. Rawers*, Department of Physics, Old Dominion University, Norfolk, VA 23529. *U.S. Bureau of Mines, Albany Research Center, OR 97321. Nitrided steels are well known for their very hard and wear-resistant characteristics. One nitride that is commonly observed in high nitrogen steels is ferromagnetic Fe_4N which is found to precipitate as a result of the low nitrogen solubility in steel and other iron alloys. X-ray diffraction measurements on pure Fe_4N shows it to have a face-centered cubic arrangement of iron atoms with nitrogen at the body-center position. Its lattice parameter has been calculated to be 3.79A. Mossbauer spectra recorded at 300K and 78K show that there are three iron sites (Fe I, Fe II-A and Fe II-B) in Fe_4N. The relative alignment of the magnetic hyperfine field and electric field gradient at each site will be presented.

ELECTRONS, PHONONS, AND PHOTONS IN SOLID-STATE HETEROSTRUCTURES AND OTHER FABRICATIONS. Peter A. Knipp, Dept. of Physics and Comp. Sci., Christopher Newport Univ., Newport News, VA 23606. To study the fundamental excitations of structures such as semiconductor nanostructures, electromagnetic waveguides, or concert halls, it is necessary to solve their equations of motion. This involves solving equations of the form of either Helmholtz's equation or Laplace's equation, along with appropriate boundary conditions at interfaces separating different media. Except for highly symmetrical shapes these equations are "nonseparable" and hence cannot be solved analytically. I show that these can be simplified using Green's function techniques and that the resulting integral equation can be solved straightforwardly using matrix methods. The present method is contrasted with the more versatile but less efficient "finite elements" method. The electromagnetic modes of a microwave cavity are calculated and shown to be in excellent agreement with the results of a recent experiment. I also show results for the electronic states of a "modulated-barrier" quantum wire and the vibrational states of an acoustic waveguide. (Collaboration with T. L. Reinecke. Supported in part by the U. S. Office of Naval Research.)

PREPARATION, PROPERTIES AND APPLICATIONS OF ZnO-SiO_2 THIN FILMS. David J. Lawrence , ISAT Program, James Madison Univ., Harrisonburg, VA 22807. $(ZnO)_x(SiO_2)_{1-x}$ thin films were prepared on a variety of substrates by metalorganic chemical vapor deposition, using silane, dimethylzinc and oxygen as the reactants. The film compositions were determined by Rutherford backscattering spectrometry. The films were also characterized by x-ray diffraction, UV-visible spectrophotometry and ellipsometry. $(ZnO)_x(SiO_2)_{1-x}$ films were used as diffusion sources in the fabrication of light emitting diodes, photodiodes and laser diodes. For these applications, $(ZnO)_x(SiO_2)_{1-x}$ was deposited on semiconductor wafers. Heating the coated wafers to 600-800°C caused zinc to diffuse from the $(ZnO)_x(SiO_2)_{1-x}$ film into the underlying semiconductor, producing a p^+ doped layer.

THE CHALLENGES OF PHYSICS TEXTBOOK PHOTOGRAPHY. Jim Lehman, Department of Physics, James Madison University, Harrisonburg, Virginia, 22807. Color textbook photography is primarily a trial and error process. Involved are experimental front lighting, back lighting, the general background and color considerations. Action shots must use short exposure times and techniques such as fluorescent paint flooded with black light or strobe techniques. Optics shots call for rays illuminated by colloidal dispersion or smokebox techniques. There is a need for good communication between the photographer and the publisher. At times the people working with text setup with the publisher have little understanding of the illustrative material.

AN INTRODUCTION TO FERMAT'S LAST THEOREM. J. Larry Lehman , Department of Mathematics, Mary Washington College, Fredericksburg, Va. 22401. This presentation is designed as a general introduction to the mathematical background needed for Andrew Wiles' recently announced proof of Fermat's Last Theorem—elliptic curves, modular forms, and Galois representations—along with a broad outline of the strategy of Wiles' proof.

MATHEMATICA, CALCULUS AND REFORM AT VIRGINIA TECH; A STATUS REPORT FROM A GRADUATE STUDENT'S PERSPECTIVE. Xiaoguang Li and Robert F. Olin, Department of Mathematics, Virginia Tech., Blacksburg, VA 24061-0123. During the last year, the mathematics department has incorporated the use of Mathematica into several of its calculus classes. Some classes are taught in a computer lab, while others are given in rooms equipped with multi-media capability. The presenter along with his adviser have incorporated this technology in the multi-variable and series course. Some observations and comments from a graduate student's perspective will be given, as well as some of the examples being used in the class.

THE GREENBANK TELESCOPE. Dr. Felix J. Lockman, NRAO, POBox 2, Green Bank WV 24944. The Green Bank Telescope (GBT), now under construction at the National Radio Astronomy Observatory in Green Bank, WV, will be the world's largest fully steerable radio telescope upon its completion in early 1996. This talk will provide an overview of the GBT project, from its inception in the ruins of the collapsed 300-foot telescope, to a description of the experiments that the telescope will most likely perform. The GBT is unique in many aspects: it is an offset reflector to minimize scattered radiation; its surface is under active control to maintain a precise reflector shape; the telescope will operate over a larger range of frequencies than any other radio, infrared or optical telescope. Among the technical challenges of this project is the need to make the >2 acre surface conform to a parabolic shape within an rms error of <0.5 mm, and the need to control telescope positioning and tracking to within 1" under ambient weather conditions. The Green Bank telescope is expected to make major advances in our understanding of pulsars, interstellar chemistry, and cosmology.

CALIBRATING THE ELECTROMAGNETIC CALORIMETER FOR THE CEBAF LARGE ACCEPTANCE SPECTROMETER. Dustin E. McNulty, Dr. Kevin Giovanetti, Department of Physics, James Madison University, Harrisonburg, Va. 22807. The electromagnetic shower calorimeter (EMC) is a large detector covering the forward regions of the CEBAF Large Acceptance Spectrometer (CLAS detector). The EMC will employ photomultiplier tubes (pmt's), together with plastic scintillators, to measure the energy of particles involved in high energy collisions at CEBAF. The ability to measure reliably the energy of these particles is linked directly with the stability of the pmt response. To ensure the reliability of energy measurements, the calorimeter must be routinely monitored. The method of monitoring and calibrating the EMC will employ real events in conjunction with a calibrating/monitoring system. The calibrating/monitoring system consists of a pulsed UV laser and a network of optical fibers. This system is designed to deliver a measured light pulse to certain detector components and will be employed to regularly monitor these components. By combining the response of the components from both real events and calibration events, the absolute detector response can be determined.

HOW STANDARD DEVIATION OF DATA DEVIATES FROM STANDARD DEVIATION OF THE MEAN", Joseph D. Rudmin, Physics Dept., Univ of Virginia 22904 & Joseph W. Rudmin, Physics Dept., James Madison Univ., Harrisonburg, 22807. The standard deviation of the mean for combined data sets, S=sqrt(1/ sum(1/s(i)^2)), does not take into account variation in the means of the data sets. As a result, the standard deviation of the data can be significantly larger than the standard deviation of the mean. This paper presents a simple exact formula for the standard deviation of the data, explains how the derivation of the standard deviation of the mean differs, and explains why the standard deviation of the mean is usually quoted instead of the standard deviation of the data.

ASTEROID HUNTING WITH A 14-INCH TELESCOPE AND A SMALL-SOLID-ANGLE CCD. Joseph W. Rudmin and Geoffrey Williams, Physics Dept., James Madison Univ., Harrisonburg, VA 22807. The JMU Physics Dept. has acquired a Lynx Charge-Coupled Device (CCD) for installation on the 14-inch Telescope at the department's observatory at Stokesville, VA. The CCD is an array of photodetectors which can deliver a high resolution image displayable on a computer monitor. This talk will present the feasibility of using the CCD and telescope to search for previously unclassified asteroids. The sensitivity and estimated discovery rate will be discussed. A necessary part of the project is to compute the trajectories of known asteroids. The approached used will be the implementation of the Picard iteration developed by Edgar Parker and James Sochacki of the JMU Mathematics Dept. (Supported by the LaRose Fellowship awarded by the James Madison University Foundation.)

DISCHARGE CIRCUIT IMPROVEMENT FOR HARD-CORE FLASHLAMP BLUE-LASER SYSTEM[1] Jae Tae Seo, Kwang. S. Han and Ja H. Lee,[2] Dept of Physics, Hampton University, Hampton, VA 23668. An attempt has been made to improve a Hard-Core-Flashlamp (HCF)-pumped blue laser system. The operating conditions of the HCF were following: the input electrical energy to HCF was 289 J, argon fill gas pressure 600 torr. The concentration of Coumarin 460 dye was 1.25×10^{-4} mole/liter in the ethyl alcohol. The peak current and its risetime in the HCF were improved to be 25.5 kA and 0.42 μs with the input energy of 144 J as compared with the previous values 16.6 kA and 1.22 μs, respectively. The pump pulse had a halfwidth of 2.68 μs, and a risetime of 0.68 μs. The output laser pulse (451± 2.4 nm) had a halfwidth of 1.38 μs, and a risetime of 0.16 μs. The system improvement was mainly made by reducing the inductance of the transmission line and adapting a multipin triggered inverse pinch switch. The use of the HCF-pumped Coumarin 460 laser for bathymetry and underwater laser communication links is discussed.

[1] Work is supported by ONR grant N00014-89-1653

[2] Adjunct Professor, Sr. Scientist, NASA Langley Research Center

PREPARATION OF THIN FILMS BY LASER ABLATION. T. S. Sherwood, S. L. Herr, D. P. Pappas and C. M. Castevens, Va. Commonwealth Univ., Dept. of Physics, P.O. Box 842000, Richmond, Va. 23284-2000. The objective of this project is to produce thin films of $YBa_2Cu_3O_{7-x}$ (Y123) and other high temperature superconductors using the laser ablation technique. This technique will incorporate the use of an existing high vacuum chamber and a pulsed Xe-Cl excimer laser. We have designed internal modifications of the chamber for this application. Thin film deposition will be accomplished by utilizing a Y123 ceramic pellet as the target of the laser which will be incident at 45 degrees. The ablated stoichiometric material will condense on heated $SrTiO_2$ or MgO substrates located directly above the target. Prepared samples will be characterized and tested for use in future bolometric measurements to investigate optical and electronic properties near the superconducting transition temperature.

LATE 19TH CENTURY WORLD'S FAIRS: AN INTRODUCTION FOR LATE 20TH CENTURY STUDENTS TO PHYSICS, AND TO ITS PROMISE AND PROBLEMS.
Jane C. Webb and George R. Webb. Dept. of Physics and Computer Science, Christopher Newport University, Newport News, VA 23606. Charlotte Webb, Science Studies, Virginia Polytechnic Institute & State University, Blacksburg, VA 24060.
World's Fairs of the late 19th century were the first places many citizens encountered the dramatically emerging science of physics, and for many of them what they saw changed their lives. American families traveled from all over the country to the World's Columbian Exposition in Chicago in 1893 and stood in awe in front of the huge machines that were the centerpieces of the Electricity Building and gave evidence to these citizens of the power of their new nation. Henry Adams, overwhelmed by what he saw at the Great Exposition of 1900 in Paris, wrote of his new vision. The transforming power of the dynamo was to replace the spiritual idealism represented in the power of the Virgin Mary. The excitement generated by these scientific and technological artifacts of the end of the 19th century teaches today's students about the interconnections between advances in science and the spirit of the times; understanding of the operation of the artifacts themselves assists in creating excellent illustrations for physical theories.

SECOND HARMONIC GENERATION OF DIODE LASER PUMPED Nd:YAG LASER WITH KTP CRYSTAL. Jie Zhou and In H. Hwang, Physics Department, Hampton University, Hampton VA 23668. An experiment was performed to generate the second harmonic radiation from a diode laser end-pumped Nd:YAG laser. A semiconductor diode laser of output power up to 1 W at 791 nm was used to pump the Nd:YAG laser rods of length 10 mm and 15 mm. Two different lengths of KTP crystal were used for the second harmonic experiment. When the 10 mm long KTP crystal was inserted in the laser cavity in series with the 10 mm long Nd:YAG crystal, the second harmonic output power of 2.3 mW was measured at 532 nm. The detailed experimental setup and results will be presented. (Work supported by NASA grant NAGW-1-2929)

Biology

CHROMOSOMAL COMPARISONS IN TWO POPULATIONS OF *CLETHRIONOMYS GAPPERI*. M. Josephine Babin[a] and Ralph P. Eckerlin[b], [a]George Washington University Hospital, Wilson Genetics Unit, Ross Hall, Room 455, 2300 I St. NW, Washington DC 20037; [b]Natural Sciences Division, Northern Virginia Community College, Annandale, VA 22003. Specimens from two populations of *Clethrionomys gapperi* were karyotyped, G-banded, and analyzed for differences in banding patterns. The resolution achieved was not sufficient to reveal subtle variations and did not yield any major differences. Both animals had a modal number of 56 which is the diploid number characteristic for the genus. One each of male and female metaphases were suitable for karyotyping. Improved karyotypes are necessary to determine if the two populations differ at the cytogenetic level.

COMPARISON OF WING MORPHOLOGY OF BATS ON DOMINICA. Oliver Bauer, Biology Department, Shenandoah University, Winchester, VA 22601. Twelve species of bats have been reported from the Caribbean island of Dominica. These species differ in their diet, most being either insectivorous or fructivorous. My observations in the field suggested that insectivores had narrow, pointed wings while fruit-eating species had broader, less pointed wings. Differences in wing morphology were tested for four insectivorous and two fructivorous species. Over a three week period, 386 bats were captured by hand, butterfly net, and mist net. Five measurements and a wing tracing were taken to calculate aspect ratio and wing loading. ANOVA tests were performed to test the differences in aspect ratio and wing loading between the two groups. Differences in aspect ratio were found to be significant ($p<0.05$). No significant difference was found for wing loading between the two groups. My finding indicate that there exists a difference in wing morphology but continued study related to the aspect ratio is needed.

SAPROLEGNIACEOUS FUNGI PARASITIC IN EGG MASSES AND LARVAE OF MIDGES (CHIRONOMIDAE). Dana Calabrese and W. Wallace Martin, Dept. of Biol., Randolph-Macon Col., Ashland, Va. 23005. A number of saprolegniaceous fungi were isolated from egg masses and young larvae of various chironomid species collected from a local pond. Isolates were obtained in unifungal culture on CMA and YPSS agars and they were subsequently used to inoculate hempseed, adult fly, and larval chironomid substrata. Morphological, cytological, and developmental studies of vegetative, asexual, and sexual stages produced by the fungi on these substrata were carried out. Each isolate was characterized by the shape, dimensions, and developmental patterns of hyphae, appressoria, zoosporangia, zoospore cysts, oogonia, oospores and antheridia. The isolates were found to represent single species of *Leptolegnia*, *Aphanomyces*, and *Saprolegnia*. Preliminary studies indicate that the *Leptolegnia* isolates may represent a new species most closely related to *L. chapmanii* and *L.caudata*. These studies have also revealed that the *Aphanomyces* and the *Saprolegnia* isolates are most closely related to *A. laevis* and *S. diclina*, respectively. All isolates were observed to produce appressoria in both *in vivo* and *in vitro* culture.

AN EVALUATION OF KIN RECOGNITION IN LARVAL FOUR-TOED SALAMANDERS *HEMIDACTYLIUM SCUTATUM* (Caudata: Plethodontidae). Carrie A. Carreno, Tomalei J. Vess*, and Reid N. Harris, Dept of Biology, James Madison Univ., Harrisonburg, VA 22807. Larvae of the four-toed salamander, *Hemidactylium scutatum*, were investigated to determine their ability to recognize and discriminate between related and familar conspecifics. Six aggressive and submissive behaviors were used as measures of recognition. In order to distinguish between kin recognition and familiarity, a two factor design was used yielding four treatments: familiar siblings, unfamiliar siblings, familiar non-siblings, unfamiliar non-siblings. *Hemidactylium* larvae did not show significant kin recognition ability or the ability to recognize conspecifics based on familiarity. These results are consistent with the larval ecology of these organisms.

SMALL MAMMAL POPULATION DYNAMICS AT MT. LAKE BIOLOGICAL STATION. Jack A. Cranford and Deborah S. Fortune, Mt. Lake Biological Station, Biology Dept, Univ. of Virginia, Pembroke, VA. Small mammal population studies and habitat analysis were initiated in 1992 with the establishment of three study grids. In 1993, four additional grids were established and three will be added to the study in 1994. Chipmunk burrow placement and habitat structure were evaluated in 1993 and were significantly associated with dense, complex habitat proximate to large diameter living and dead trees. *Peromyscus* population densities at mid-summer were between 8-14/ha, food supplements added to three areas resulted in breeding initiation three weeks earlier on these grids. Meadow voles reached peak densities of 125/ha. but, in the fall and winter of 1993-1994 meadow vole densities declined to low levels and during this period the area was colonized by bog lemmings. Ice storm damage was extensive and the result of that major habitat change will be evaluated this summer.

THE EFFECTS OF DIETARY NITROGEN ON NITROGEN FIXATION (ACETYLENE REDUCTION) RATES IN RETICULITERMES (ISOPTERA: RHINOTERMITIDAE). Anthony D. Curtis & Deborah A. Waller, Dept. Biol. Sci., Old Dominion University, Norfolk, Va. 23529. Termites are able to fix atmospheric nitrogen (N) by means of their hindgut bacteria. Variation in N fixation rates may be related to food quality. We used the acetylene reduction bioassay to measure nitrogenase activity in Reticulitermes workers in relation to the N content of the host log. Ten Reticulitermes colonies were assayed for nitrogenase activity from July 1993 through January 1994 in a tidal wetland forest in Brownsville, Virginia. N content (% dry biomass) of wood infested by the termites was examined in July, October and January. Log N varied significantly within a collection period, but there was no clear seasonal pattern, and there was no association between log N content and termite nitrogenase activity. Seasonal variation in nitrogenase activity was related to temperature in both laboratory and field experiments, with optimal rates at moderate temperatures and decreased rates at both high and low temperatures.

PREVALENCE AND GEOGRAPHIC DISTRIBUTION OF THE RACCOON NEMATODE, BAYLISASCARIS PROCYONIS. Ralph P. Eckerlin, Natural Sciences Div., Northern VA Comnty. Col., Annandale, VA 22003. Baylisascaris procyonis (Stefanski and Zarnowski, 1951) Sprent, 1968 is a common nematode parasite of the small intestine of raccoons, Procyon lotor, throughout much of the United States. There are few reports from Virginia and those studies suggested that B. procyonis was rare or absent from non-mountainous portions of Virginia. Twentytwo raccoons from northern Virginia, namely from the counties of Arlington, Fairfax, and Fauquier, were examined. Eleven raccoons from Fairfax County and one from Fauquier County were infected with B. procyonis. The prevalence of infection was 55%, range of infection 1-112, and the mean intensity of infection was 23.0. Female worms outnumbered males slightly. A female B. procyonis has been reported to release about 215,000 eggs per day and the eggs persist in the soil for many months. These eggs, when ingested by homeothermic animals, hatch out and cause visceral larva migrans, often with fatal results.

AKINETE DIFFERENTIATION IN ANABAENA. I. STRUCTURAL AND MOLECULAR CHARACTERIZATION. Robert W. Fisher, Peter A. Reavey, and Muralidhar Nannapaneni, Department of Biology, Virginia Commonwealth University, Richmond, Virginia 23284-2012. Akinetes are dormant cells which differentiate in some species of cyanobacteria when growth conditions become stressful. We are characterizing the structural, biochemical, and molecular genetic changes which take place during akinete differentiation. We can induce akinete differentiation in Anabaena by subculturing log phase stock cultures into growth medium lacking phosphate. Log phase cells placed in induction medium have a reduced septation rate, become enlarged, form thicker cell walls, and accumulate numerous cyanophycin granules. Several water soluble proteins can be resolved using SDS-PAGE which appear to be akinete specific. DNA has been isolated from both induced and not induced cell types and is currently being compared using restriction enzyme profiling combined with PCR amplification. (Supported in part by the Grant-in-Aid Program for Faculty at Virginia Commonwealth University)

BURROW USE AND BURROW STRUCTURE OF PEROMYSCUS SPECIES AT MT. LAKE BIOLOGICAL STATION. Deborah S. Fortune and Jack A. Cranford, Mt. Lake Biological Station, Biology Dept, Univ. of Virginia, Pembroke, VA. Burrows were located by visual observation upon animal release and by the string tag method. Visual observation worked through the non-vegetative months and early spring but string tags permitted easy burrow location during all seasons. Burrows were permanently marked and were monitored for activity. Animals utilized ground burrows throughout the year and burrows were classified as multiple or single usage structures. Animal associated with burrows were recorded by species, age, sex and reproductive condition. Twenty burrows of each usage type were fully excavated, mapped and measured. Multiple use burrows had significantly larger entrances, more entrances, larger nest chamber sizes, longer total tunnel lengths, more tunnel direction changes, and more cached food types and volumes, Tunnel entrances were directed away from prevailing weather patterns.

DETERMINING THE OPTIMAL DETERGENT FOR BONE MARROW SOLUBILIZATION. Kevin Gates and Lloyd Wolfinbarger Jr. Center for Biotechnology, Old Dominion University, Norfolk Va. 23529. Human bone allografts are extensively used in a variety of clinical applications. With today's technology, human cadaver bone can be successfully implanted into a patient in order to replace damaged and/or deteriorated bone or to correct a person's posture and alignment. However the bone marrow in bone is immunogenic and can cause an immunological response in the recipient of the allograft tissue. Removal of the bone marrow in the allograft before implantation will reduce the risk of an immune response in the recipient. Bone marrow can be successfully removed by flushing the allograft with a detergent solution. The objective of this experiment was to evaluate which detergent was most effective in solubilizing the cellular material in the bone matrix. Porcine femurs were obtained from Gwaltney Packaging Plant in Smithfield, Va. Bone cores were randomly bored from bisected femur heads, then weighed and placed into test tubes. The weight of the bone cores varied between 0.30 to 0.08 g with an average weight of 0.22 +/- .034 g. Each core was placed into separate test tubes. A constant volume of 10 ml of different concentrations of detergent was added to each test tube. The bone cores were allowed to solubilize for 24 hours and a Lowry protein assay was performed in order to measure the amount of protein solubilized from the cores. The results were inconclusive due to the heterogeneous distribution of bone marrow throughout the femur head. Furthermore, because of a detergent's potential inability to effectively solubilize bone marrow above the critical micellar concentration, it is not feasible to determine the optimal detergent without having the critical micellar concentrations of each detergent. Further research that includes the critical micellar concentration of each detergent will aid in determining the optimal detergent for use in bone marrow solubilization.

FORENSIC TECHNIQUES FOR THE EXAMINATION OF FEATHERS AND PRACTICAL APPLICATIONS. Roxie C. Laybourne[a]* and M. Josephine Babin[b], [a]NHB E 605, MRC 116, National Museum of Natural History, Washington DC 20560; [b]George Washington University Hospital, Wilson Genetics Unit, Ross Hall, Room 455, 2300 I St. NW, Washington DC 20037. Feathers collected in the field can be a source of information about interspecific associations and species presence, as well as a tool for systematic studies. Presented here are basic techniques used for effective identification of feathers: The preparation of the feather material, both pennaceous and plumulaceous, for macroscopic and microscopic examination, the collection of relevant data, and the use of museum specimens for comparison.

A STUDY OF THE EFFECTS OF VARIOUS PH LEVELS ON THREE GENERA OF OLIGOCHAETES: AEOLOSOMA, DERO, AND PRISTINA. Rebecca Halloran, Elsa Q. Falls, and Arthur F. Conway, Department of Biology, Randolph-Macon Col., Ashland, VA 23005. In some previous investigations of water pH changes, certain species from Class Oligochaeta have been identified for potential use as indicator species. In this study, three genera of freshwater oligochaetes, Aeolosoma, Dero, and Pristina,were subjected to a range of pH's to determine effect on mortality and asexual reproduction. The worms were cultured at room temperature in petri dishes of spring water adjusted to the following pH levels: 4.0-4.7, 5.0-5.5, 6.2-7.0, 8.5-9.0, and 9.5-10.0; observations were made once every 24 hours for 72 hours. The three genera survived at all pH levels, although mortality rates were higher the lower the pH. Asexual reproduction by budding was more common at higher pH levels, particularly in Pristina. The data indicate that these three genera should not be considered as good indicator species because of their tolerances to wide variation in pH.

NEW STATE RECORDS AND BIOLOGICAL NOTES ON TURKEY MALLOPHAGANS IN VIRGINIA, AND OBSERVATIONS OF TURKEYS. James M. Hill, Dept. of Biology, Randolph-Macon Col., Ashland, VA 23005 and Ralph P. Eckerlin, Dept. of Biology, Northern Virginia Cmnty. Col., Annandale, VA 22003. Wild turkeys were found to be abundant on the Northern Neck of Virginia in fall 1993- spring 1994, with flock sizes ranging from 15-100 birds. Three turkeys collected in Northumberland Co., VA were inspected for head lice. Three species of chewing lice were found on a sub-adult male, 74 *Chelopistes meleagridis*, 20 *Oxylipeurus p. polytrapezius*, and 14 *O. corpulentus* with the latter two species being new Virginia records. Daily monitoring of study skins disclosed that the subadult male had lice still alive until 17 days after dying. The adult male had no lice. Conservation status and ectoparasites of the Meso-American Ocellated turkey and general future research needs are discussed.

STATUS AND DISTRIBUTION OF THE ALLEGHENY WOODRAT IN VIRGINIA WITH NOTES ON ECOLOGY. James E. Kenney, Michael T. Mengak and Janet Holland, Environmental Science Program, Life Sciences Department, Ferrum College, Ferrum, VA 24088. The Allegheny Woodrat (*Neotoma magister*) has been located in 17 counties in Virginia with 39 active sites (woodrats being present) being reported. Trapping activities began by trapping at a possible site for one night. Yearly monitoring at a involved trapping for two consecutive nights between mid-September to mid-October. Once survey and monitoring sites were established, trapping has been done on a regular basis since June 1990. Sites are checked in late spring and summer each year, with periodic checks in other months. Results of monitoring since September 1990 show a marked decrease in woodrat populations in Virginia with overall catch per effort dropping from 1.2 per 10 trap nights in 1990 to 0.5 per 10 trap nights in 1993. We present data on woodrat population trends, home range and movements, and habitat analysis.

SOCIAL INFLUENCES ON REPRODUCTIVE MATURATION IN FEMALE WHITE-FOOTED MICE (PEROMYSCUS LEUCOPUS NOVEBORACENSIS). Michelle L. Mabry & C. Richard Terman, Lab. of Endocrinology & Population Ecology, Biology Dept., Col. of William & Mary, PO Box 8795, Williamsburg, VA 23187-8795. Studies on the house mouse (*Mus musculus*) have demonstrated that when juvenile females are housed with other juveniles or adult females, reproductive maturation of the juveniles is delayed compared to juveniles housed alone. This delay has further been shown to be caused by a urinary chemosignal produced by the grouped females. Similar procedures were used in this study using juvenile white-footed mice, but no delay in maturation was seen, as evidenced by age of vaginal introitus, first estrus, or reproductive organ masses. These findings will be discussed.

HEMOCYANIN SUBUNIT COMPOSITION IN SIBLING SPECIES OF THE MARSH CRAB SESARMA FROM THE GULF OF MEXICO AND THE NORTH AMERICAN ATLANTIC COASTS. Amanda L. McKenney and Charlotte P. Mangum, Dept. of Biol., Col. of William and Mary, Williamsburg, Va. 23185. The electrophoretic banding patterns of the hemocyanin in the sibling species, Sesarma sp. (nr. reticulatum)and Sesarma reticulatum, were analyzed. In Sesarma sp. (nr. reticulatum) a total of eleven bands were found, with a minimum of five and a maximum of nine in an individual. Seven bands comprised the major fraction of the material. In S. reticulatum a total of nine bands were found, with a minimum of six and a maximum of seven bands in an individual. Six bands comprised the majority of the material. When the banding patterns were examined in adjacent lanes on the same gel, qualitative differences between the two species were clear. Two bands in Sesarma sp. (nr. reticulatum) and one band in S. reticulatum did not co-migrate with a band in the other species. Each species had five bands which were invariant; however, those five bands in one species did not co-migrate with the five invariant bands in the other. In both species the variation of one band was coupled with that of another, in a way that suggests the possibility of alleles.

CYTOTOXIC ACTIVITY OF STIMULATED LYMPHOCYTES AGAINST ME-180 CELLS. Joseph Moorman and Rosemary Barra, Dept. of Biol. Sci., Mary Washington College, Fredericksburg, VA 22401. Stimulating lymphocytes to become specific activated killer cells against cancer cells hold possibilities for future cancer treatments. The stimulation of lymphocytes by incubation with two cytokines, interleukin-2 and interferon gamma, was investigated in this study. Human lymphocytes were collected from a donor and incubated with human recombinant forms of the cytokines. The activated lymphocytes were assayed against the ME 180 cell line in tissue culture. Evidence of cytotoxicity caused by the activated lymphocytes against the ME 180s existed. The extent and potency of the cytotoxic activity of the lymphocytes varied depending upon the cytokines used, quantity of cytokines used, and the combination of cytokines. The results clearly indicate that lymphocytes stimulated by IL-2 and IF-γ show cytotoxic activity toward the ME- 180 cells.

EFFECTS OF PARITY ON THE DISTRIBUTION OF GRANULATED METRIAL GLAND CELLS IN THE PREGNANT MOUSE UTERUS. Josephine B. Owusu-Sakyi, H. Carl Palmer, Jr.*, and Carolyn M. Conway, Dept. of Biology, Va. Commonwealth Univ., Richmond, VA 23284-2012. Large round cells containing numerous glycoprotein granules, referred to as granulated metrial gland (GMG) cells, accumulate in the pregnant uterus of rodents. The periodic acid Schiff technique was used to stain GMG cells in implantation sites (at 12.5 days of gestation) of 8 month old CD-1 mice of different parity classes (1st, 2nd, and 3rd pregnancies). Although GMG cells were located mainly in the decidua basalis, a small number of GMG cells were occasionally found in the placenta, maternal blood spaces, and the myometrium. The distribution of GMG cells within the decidua basalis was determined using morphometric techniques. Very few GMG cells were located in the region of the decidua basalis adjacent to the placenta. The number of GMG cells increased slightly in the mid-region of the decidua basalis. A significant increase in the number of GMG cells occurred in the region of the decidua basalis adjacent to the myometrium. Neither the total number nor the overall distribution of GMG cells in the decidua basalis was affected by parity. (Supported by the Undergraduate Research Grant Program of Va. Commonwealth Univ.)

MOVEMENT PATTERNS OF COPPERHEAD SNAKES IN SOUTHEASTERN VIRGINIA. Christopher E. Petersen, Dept. of Biol. Sciences, Old Dominion Univ., Norfolk, Va. 23529-0266. Radiotelemetry was used to study the seasonal movement patterns of five copperhead snakes (*Agkistrodon contortrix*) in southeastern Virginia. Movements were summarized by distance, direction, and time elapsed since last location. The data suggest that movements reflect availability of prey. Copperheads spent considerable time moving between cane (*Arundinaria*) patches and river swamps, where densities of potential prey species have been demonstrated to be high. Evidence also suggests that males may engage in long movements more frequently and have larger activity ranges than do females.

BIOLOGICAL ANALYSIS OF WATER QUALITY OF THE OPEQUON CREEK. Anne M. Powers, Christopher Lee, Allen J. Whitehead, Nicole Wilkes, Ronda Howard*, Division of Natural Sciences and Mathematics, Shenandoah University, Winchester, VA 22601. The Opequon Creek, part of the Potomac Watershed, traverses several counties in West Virginia and Virginia including our test sites in Frederick and Clarke Counties, VA. Analysis of preliminary data demonstrated significant levels of fecal coliforms in the Opequon Creek. Mile thirty-seven was chosen from a series of sights surveyed for this study. Multiple monthly samples from December through April were taken and analyzed. Fecal coliform counts ranged from 300 to 1400 cells/100ml using MPN tables. These were levels far above those allowed for recreational use. The Pollution Tolerance Index of Benthic macroinvertebrates showed a prevalence of group one taxa demonstrating good water quality. The dissolved oxygen ranged from 12-14 mg/L supporting the macroinvertebrate growth. Excessive silt deposits were noted and thought to be related to stream bank erosion. The pH of the water was always in the range of 6.8-7.8. Integrating data from these studies indicated a stream of good water quality. However, the erosion, silt, and the fecal coliform counts were indicative of non-point pollution sources. Continued study of the Opequon Creek is needed.

MOVEMENT PATTERNS OF COPPERHEAD SNAKES IN SOUTHEASTERN VIRGINIA. Christopher E. Petersen, Dept. of Biol. Sciences, Old Dominion Univ., Norfolk, Va. 23529-0266. Radiotelemetry was used to study the seasonal movement patterns of five copperhead snakes (*Agkistrodon contortrix*) in southeastern Virginia. Movements were summarized by distance, direction, and time elapsed since last location. The data suggest that movements reflect availability of prey. Copperheads spent considerable time moving between cane (*Arundinaria*) patches and river swamps, where densities of potential prey species have been demonstrated to be high. Evidence also suggests that males may engage in long movements more frequently and have larger activity ranges than do females.

EFFECT OF MATERNAL AGE ON INDUCTION OF RESORPTION BY INTRAPERITONEAL INJECTION OF LIPOPOLYSACCHARIDE IN CD-1 MICE. R. M. Reale, P. S. Nyantakyi, and A. F. Conway, Dept. of Biol., Randolph-Macon Col., and C. M. Conway, Dept. of Biol., Va. Commonwealth U. Three possible mechanisms for increased frequency of pregnancy loss in older female mammals were evaluated by comparing lipopolysaccharide (LPS) stimulated and control females at ages of three, nine to ten, and twelve months. Pregnant CD-1 mice were injected intraperitoneally with 1 ug of LPS on day 9 and sacrificed on day 12 of gestation. Treatment with LPS had no effect on spleen weight or dorsal lymph node weight, indicating that LPS acted primarily through paraimmune rather than specific immune mechanisms. Treatment with LPS significantly reduced maternal weight gain between treatment and sacrifice and reproductive tract weight. Increased maternal age reduced maternal weight gain and significantly reduced reproductive tract weight. Maternal age caused no change in frequency of resorption (pregnancy loss) in control animals. Treatment with LPS significantly increased frequency of resorption and the increase was larger in older females. These results are inconsistent with pregnancy loss mechanisms involving loss of uterine sufficiency or loss of immunotrophism with increased age, but are consistent with mechanisms involving selective loss of immunosuppression with increasing maternal age.

EVALUATION OF THE GROSS ANATOMY AND SEASONAL CHANGES IN A PERINEAL GLAND IN THE HISPID COTTON RAT, SIGMODON HISPIDUS. Robert K. Rose and Julie Winchell, Dept. of Biological Sciences, Old Dominion University, Norfolk, VA 23529-0266. A perineal gland is described for the hispid cotton rat, Sigmodon hispidus. Seasonally cyclical in association with the reproductive organs of males, the gland possesses a strong attachment to the penis, with only loose fascial connections to the rectum and surrounding tissues. Its seasonal growth and regression closely parallel that of the testes and seminal vesicles, indicating that this cyclicity may be under androgen control. Significant differences in the weights of perineal glands, testes and seminal vesicles were noted between the breeding and non-breeding seasons when using a general linear model analysis of variance (ANOVA). The weight of the gland also showed highly significant correlations to the weights of testes and of seminal vesicles. Further evaluations, using ANOVA with stepwise regression, indicate the close association of these three organs, the predictive model for which is: perineal gland weight = -18.67 + 0.443 (testes weight) + 0.398 seminal vesicles weight).

DISTRIBUTION OF LIPOPOLYSACCHARIDE-COATED LATEX MICROSPHERES IN PREGNANT CD-1 MICE FOLLOWING INTRAVENOUS INJECTION. S. S. Soza, J. C. Burnett, and A. F. Conway, Dept. of Biol., Randolph-Macon Col., and C. M. Conway, Dept. of Biol., Va. Commonwealth U. Distribution of lipopolysaccharide (LPS) in pregnant CD-1 mice was studied using LPS-coated fluorescent latex microspheres (1 um diameter). Controls included uncoated and glucose-coated microspheres. Mice were injected in the right lateral tail vein on day 9 of gestation and sacrificed 6, 12, or 24 hours later. Distributions were studied by fluorescent microscopy of frozen sections. Both LPS-coated and control microspheres accumulated in the maternal spleen and liver. Increased (relative to controls) accumulation of LPS-coated microspheres was observed in the maternal dorsal lymph nodes, below the myometrium in uterine decidual tissue, and near the maternal-embryonic interface. These results are consistent with LPS causing loss of implanted embryos either through direct action on the maternal-embryonic exchange surfaces or through triggering inflammatory changes in adjacent maternal tissues.

PLANT CHEMISTRY AND MULTIPLE TROPHIC LEVEL INTERACTIONS: INFLUENCE OF SINIGRIN ON *PIERIS RAPAE* (LEPIDOPTERA: PIERIDAE) AND ITS PARASITOID, *COTESIA RUBECULA* (HYMENOPTERA: BRACONIDAE). Eric Summer & D. Karowe*, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284. All plants contain secondary compounds. Much research has addressed toxic or deterrent chemicals that apparently exist solely in order to defend the plant against herbivores. However, little is known about the effects of plant secondary compounds on higher trophic levels (e.g. parasitoids), though higher trophic levels also are routinely exposed to these chemicals. If secondary compounds adversely affect parasitoids, plants may face an evolutionary dilemma: increasing their intrinsic defense through production of secondary compounds may decrease their extrinsic defense by harming predators and parasitoids. This study examined the effects of sinigrin, a common secondary compound of crucifers, on the fitness of *Cotesia rubecula*, a specialist parasitoid wasp of crucifer herbivores, including *Pieris rapae*. *C. rubecula* were reared in *P. rapae* fed on artificial diet containing 0, 250, 500, 1000, or 1500 mM sinigrin, which spans the range of values reported from crucifer leaves. ANOVA revealed that neither parasitoid pupal weight, development time, nor growth rate was significantly affected by sinigrin concentration. This result suggests that the presence of sinigrin in crucifers does not compromise extrinsic defense afforded by *C. rubecula*. It is possible that specialist parasitoids may in general be less affected than generalist parasitoids by plant secondary compounds.

REPRODUCTIVE RECOVERY OF WILD WHITE-FOOTED MICE IN THE LABORATORY. C. Richard Terman, Lab. Endo. & Pop. Ecology, Dept. Biol., College of William and Mary, Williamsburg, VA. 23185. Reproduction is consistently curtailed during May, June, and July in a wild population of Peromyscus leucopus noveboracensis which has been studied since 1983 (Terman, 1993, J. Mamm., 74:678-687). Wild mice were captured during the period of reproductive hiatus and at other times of the year and paired for 100 days in the laboratory with each other or with parous or nulliparous laboratory animals. Reproduction following pairing with laboratory mates was significantly more frequent ($P \leq .01$) and of shorter latency for wild males than for wild females no matter when captured. Wild pairs rarely reproduced until re-paired with laboratory mates following which wild males reproduced significantly more frequently than wild females ($P \leq .01$). Reproductive performance did not differ between animals captured during the breeding hiatus and during other times of the year (Supported by a College of William and Mary Faculty Summer Research Grant and by the Thomas F. and Kate Miller Jeffress Memorial Trust).

IS "CARRYING CAPACITY" AN ECOLOGICAL MISNOMER? BEHAVIORAL CONSIDERATIONS. C. Richard Terman, Lab. Endo. & Pop. Ecol., Biol. Dept., College of William and Mary, Williamsburg, VA 23185. The concept of "Carrying Capacity" is of wide usage both in the applied and theoretical population ecology literature. Examination of this literature reveals considerable variability in definition of the concept. Derived from the application of the logistic equation to questions of population control or equilibrium, "K" is often regarded as reflective of the Carrying Capacity of the environment. Experimental studies, both laboratory and field, demonstrate that population numerical levels may be quite variable when asymptote or equilibrium is attained under similar conditions of the physical environment. Theoretically, only the largest population is at carrying capacity while the growth of other populations appears to be curtailed below this carrying capacity. Such differences in equilibrium levels of populations appear to reflect intrinsic differences in populations. Behavioral implications will be discussed.

EFFECT OF PRENATAL EXPOSURE TO LEVONORGESTREL OR TO ETHENYL ESTRADIOL AND NORETHINDRONE ON EXTERNAL GENITAL AND TESTIS DEVELOPMENT IN CD-1 MICE. H. S. Thompson and A. F. Conway, Dept. of Biol., Randolph-Macon Col. Pregnant CD-1 mice were subcutaneously injected with 0.05 ug/day of levonorgestrel (LN) in corn oil or with 0.018 ug/day of ethynyl estradiol plus 0.25 ug/day of norethindrone (EEN) in corn oil to mimic the results of Norplant or oral contraceptive use in humans. Controls were injected with corn oil. Injections began on day 8 of gestation and continued daily until sacrifice on day 18. At sacrifice, all fetuses were measured and sexed. Gonads of male fetuses were embedded, sectioned, and analyzed microscopically for area fractions of each component. Neither treatment affected crown-rump length, but both treatments resulted in shorter anogenital distances in fetuses of both sexes (statistically significant in LN-treated female fetuses). Treatment with LN had no effect on area fraction of any component measured in fetal testes. Treatment with EEN increased area fractions of non-lipid filled Leydig cells with the increase becoming marginally statistically significant in the seminiferous tubule-packed peripheral regions of the testes.

SEX AND AGE CLASS HABITAT DISCRIMINATION BY *Peromyscus* spp. AT DIFFERENT STAGES OF GYPSY MOTH DISTURBANCE. David C. Tomblin and Jack A. Cranford, Biology Department and Museum of Natural History, VPI & SU, Blacksburg, VA, 24061. Demographic structure and microhabitat use among sex and age classes of *Peromyscus* spp. were evaluated at four oak dominated sites impacted by gypsy moths; high tree mortality, disturbance in process, disturbance recovery, and a undisturbed site. *P. leucopus* populations at the disturbed sites exhibited greater demographic stability than reference site populations. There was evidence for density-dependent population regulation at the high mortality and recovery sites. At high densities, *P. leucopus* populations at the high mortality site and the *P. maniculatus* population at the recovery site exhibited intraspecific microhabitat segregation. Female adults segregated from male adults and juveniles and male adults segregated from male juveniles into more optimal microhabitats. The results of this study suggest that gypsy moth at least temporarily improve quality of habitats previously dominated by chestnuts oaks.

COMPARISON OF TUMOR NECROSIS FACTOR-ALPHA CONCENTRATIONS IN PERI-EMBRYONIC TISSUES OF NORMAL AND RESORBING IMPLANTATION SITES IN CD-1 MICE. C. P. Toomey and A. F. Conway, Dept. of Biol., Randolph-Macon Col., and C. M. Conway, Dept. of Biol., Va. Commonwealth U. The hypothesis that resorption (pregnancy loss) results from excessive concentrations of tumor necrosis factor-alpha (TNF-alpha) around implanted embryos was evaluated by comparison of samples from pregnant CD-1 mice in which resorption had been induced by intravenous injection of lipopolysaccharide (LPS) 15 hours before sacrifice with control samples. Organ samples were cut from frozen sections and analyzed by ELISA. Treatment with LPS did not significantly elevate TNF-alpha concentrations in maternal serum, spleen, or liver. Preliminary results indicate that LPS treatment elevated TNF-alpha concentrations near the uterine myometrium and reduced concentrations in the placenta and around the body of the embryo, but none of these differences were statistically significant. These results are inconsistent with hypotheses involving large increases in TNF-alpha concentrations at the maternal-embryonic interface during pregnancy loss.

THE AVAILABILITY OF SMALL MAMMAL PREY FOR FORAGING PIT VIPERS. Victor R. Townsend Jr., Col. of Sciences, Dept. of Biol., Old Dominion Univ., Norfolk, Va 23529-0266. The Canebrake Rattlesnake (*Crotalus horridus atricaudatus*) and the Northern Copperhead (*Agkistrodon contortrix*) are forest-dwelling pit vipers which, as adults, feed predominantly upon small mammals. The frequency of predation by viperid snakes usually reflects the relative abundance of prey species in the environment. From October 1993 through March 1994 I studied the availability of small mammal prey for foraging pit vipers in a variety of microhabitats in southeastern Virginia. In addition, observations of snake activity were used to construct an energy budget for these species of pit vipers, in an attempt to estimate prey requirements and the effect of diet on such variables as reproductive effort and hibernation. Together with the data on prey availability, the energy budget can be used to interpret seasonal foraging activity and microhabitat use by the snakes.

NUMBERS OF FLAGELLATE PROTOZOANS IN RETICULITERMES (ISOPTERA: RHINOTERMITIDAE) HINDGUTS RELATED TO SEASON AND TERMITE SIZE. Deborah A. Waller, Dept. Biol. Sci., Old Dominion Univ., Norfolk, Va. 23529. Termites of the genus Reticulitermes harbor hindgut protozoans that catabolize the cellulosic foods they ingest. Little is known about seasonal patterns in protozoan numbers because the subterranean termite hosts generally overwinter deep underground. However, Reticulitermes colonies spend winter in surface logs in a tidal wetland forest in Brownsville, Virginia. The protozoan populations in worker hindguts were examined monthly for ten termite colonies. Protozoans persisted in low numbers during winter months when termites survived log temperatures as low as 2.1°C. Larger termites harbored greater numbers of protozoans. Protozoan populations increased with warmer temperatures in spring, especially those of the flagellate Trichonympha, which has been previously demonstrated to respond to the nutritional status of the termite host.

Biomedical and General Engineering

THE SOPA SURFACES. William P. Harrison, Jr., Engr. Fundamentals Div., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The principal angles θ_F, θ_H, and θ_P of a plane in space are defined as angles between the plane and the frontal, horizontal, and profile planes of projection. The sum of these angles, $\Sigma\theta$, must be equal to or less than 180° for all positions of the plane in space. This leads to an investigation of those surfaces that represent this sum of the principal angles (SOPA), the so-called SOPA surfaces. The independent variables introduced are the rotational angles θ_V and θ_L, where θ_V measures rotation about a vertical axis and θ_L measures rotation about a horizontal (latitudinal) axis perpendicular to the profile plane of projection. The magnitudes of θ_V and θ_L, as well as the order in which they are performed, both determine $\Sigma\theta$, since they are not commutative in rotation. Thus, two SOPA surfaces emerge as descriptive of $\Sigma\theta$ for all values of the independent variables θ_V and θ_L. In this paper the defining equations are developed, and interesting characteristics of these SOPA surfaces, such as boundaries, minimums, and symmetry, are discussed and shown.

A NEURAL NETWORK BASED ACOUSTIC FETAL HEARTRATE MONITOR. David L. Livingston, Div. Engr. & Ind. Tech., Va. Western Cmnty. Col., Roanoke, Va. 24038, & Stephen A. Zahorian & Roger Zhao*, Dept. of Elec. & Comp. Engr., Old Dominion Univ., Norfolk, Va. 23529. Fetal heartrate has traditionally been measured using the trained ear of a professional with the assistance of an acoustic amplifier or measured automatically using active ultrasonic devices. We report on the development of a system which uses neural networks in conjunction with advanced acoustic sensors and signal processing techniques to extract fetal heartrate from a noisy environment without subjecting the fetus to machine generated energy. The acoustic fetal heartbeat signal is transduced by a belt consisting of an array of acoustic sensors. The resulting signal is electronically amplified and filtered as preprocessing for a neural network. A feedforward neural network trained with back-propagation detects the presence of a fetal heartbeat within the noisy in-vivo environment and produces a signal marking each beat. Autocorrelation techniques are used on the signal produced by the network to extract the heart rate. Provisions are made for detecting loss of signal and automatic sensor selection to acquire the strongest signal. The resulting heartrate information is displayed and stored on a portable computer and may be used in real time or analyzed at a later date. The ultimate goal of the system is the ability to use it as a portable device in non-clinical situations such as home use in high-risk pregnancies. (Supported by NASA Langley Research Center, Hampton, Va.)

Botany

SUCCESSIONAL CHANGES FOLLOWING A MAJOR LANDSLIDE IN ALLEGHANY COUNTY, VIRGINIA. H. S. Adams, D. S. Lancaster Cmnty. Col., Clifton Forge, VA 24422 and E. G. Haverlack*, USDA For. Serv., Covington, VA 24426. On April 17, 1987, following a period of several days of heavy rains, a landslide occurred on a west-facing slope in Rainbow Gap along the Jackson River in Alleghany County, Virginia. The site is clearly visible from U.S. Route 220 between Clifton Forge and Iron Gate. Maximum relief of the slide is around 152 m, extending from the river (305 m) up a very steep slope ($\geq$75% inclination) to 457 m (slightly more than halfway to the ridge). Width is approximately 100 m. Forest composition to either side of the slide is predominantly *Quercus rubra* (red oak), *Q. prinus* (chestnut oak), and *Pinus virginiana* (Virginia pine). In September, 1988 and 1993, we obtained data to describe the general vegetation coverage in the slide region. Since the original slide (which removed all vegetation and topsoil), both number of taxa (59 recorded in 1988 and 103 in 1993) and total coverage (now approximately 50% from original bare substrate) have increased substantially. The greatest increase in number of taxa occurred among non-woody plants (96%). Not surprisingly, plant successsion within the slide area is proceeding from the margin of the adjacent forest with least plant encroachment occurring near the top. Plants having wind-distributed seeds are responsible for the majority of recolonization of the slide. *Paulownia tomentosa* (princess tree) and *Robinia pseudoacacia* (black locust) are two examples of early successional woody species

A NEW ARBORETUM FOR THE STATE OF VIRGINIA. Invited Paper. Norlyn L. Bodkin, Director, JMU Arboretum, JMU, Harrisonburg, VA. 22807. A new arboretum is being developed on the campus of James Madison University. The 125 acre complex is being established on the slopes of an Oak-Hickory Forest Association and provides an ideal combination of developed gardens and a natural forest each complementing the other and serving the purposes of teaching, research and demonstration. Native plant species are being emphasized. One of the more unique gardens is a shale barren with endemic species. The arboretum is on University property but is not state supported. It is funded through contributions to the JMU Foundation.

ABIOTIC STRESSORS IN THE DOGWOOD ANTHRACNOSE COMPLEX. I. EFFECTS OF TEMPERATURE ON THE GROWTH AND SURVIVAL OF *DISCULA DESTRUCTIVA*. J. B. Crozier and R. J. Stipes, Dept. of Plant Pathol., Physiol., and Weed Sci., VA Tech, Blacksburg VA 24061 Cardinal growth temperatures and response to thermal stress regimes were determined for isolates of *Discula destructiva*, causal agent of dogwood anthracnose. The optimum temperature was between 20 and 22 C, with 4 of 6 isolates growing best at 20 C. All isolates grew within 7 d at 1 C and 28 C, but no growth was noted after 7 d at 30 C, although regrowth occurred after transfer to a lower temperature. All isolates were killed after 7 d at 35 C. The fungus was alive in 88% of 4-mm mycelium agar discs after 5 min at 45 C in water, while it was alive in 51% after 10 min, and in 0% after 15 min. The fungus was alive in 89% of 4-mm discs from autoclaved dogwood leaves on amended PDA, on which *D. destructiva* was allowed to grow, after 10 min at 45 C. The thermal death point of conidia in free water was 46-47 C, and the thermal death times for 45 and 55 C were 20 min and 30 s, respectively, for conidia from oatmeal agar plates. Conidia from autoclaved dogwood leaves on amended PDA were killed within 5 min at 45 C. This information may lead to an understanding of possible climatic barriers, and the thermal treatment of plant material.

ABIOTIC STRESSORS IN THE DOGWOOD ANTHRACNOSE COMPLEX. II. EFFECTS OF ACIDIC FOG ON LEAF SURFACE ANATOMY OF *CORNUS FLORIDA* AND *CORNUS KOUSA* SEEDLINGS. J. B. Crozier, R. J. Stipes, and K. T. Thornham, Dept. of Plant Pathol., Physiol. and Weed Sci., VA Tech, Blacksburg VA 24061. Acidic precipitation reportedly enhances disease severity of dogwood anthracnose (DA) caused by *Discula destructiva* on *Cornus florida*, the flowering dogwood. Seedlings of *C. florida* and *C. Sousa*, the Chinese dogwood which is moderately resistant to dogwood anthracnose, were subjected to acidic fog episodes at pHs 2.5, 3.5, 4.5, and 5.5, using a simulated acidic rain solution. Leaf discs from these and non-treated plants were examined by scanning electron microscopy (SEM). Damage was noted at all pH levels and was primarily confined to the trichomes and stomata. Trichomes appeared dehydrated on both *C. florida* and *C. kousa* leaves, while the "lips" of *C. florida* stomata were increasingly eroded by decreasing pH; *Cornus kousa* stomata were relatively unharmed. At pH 2.5, trichomes of both species seemed to be brittle and fractured, causing deep holes in the lamina. *Discula destructiva* conidia may germinate at trichome bases where damage may cause the leaching of nutrients. Also, the difference in stomatal damage may account, in part, for differences in disease susceptibility.

PHYTOPLANKTON ABUNDANCE IN THE LOWER CHESAPEAKE BAY: I. METHODOLOGY. Barbara Hiller, D. Seaborn, M. Weinstein, & H.G. Marshall, Dept. Biological Sci., Old Dominion Univ., Norfolk, Va. 23529-0266. This is review to identify the standard activities and methodology associated with Chesapeake Bay Phytoplankton Monitoring Program. The program was initiated in 1985 and is sponsored by the Virginia Department of Environmental Quality. Seven stations in the lower Chesapeake Bay are monitored monthly for the composition and abundance of phytoplankton and autotrophic picoplankton above and below the pycnocline, plus productivity and water quality measurements. Field and laboratory protocols are identified, with quality control/quality assurance standards that are followed also given. In addition to the numerous results and conclusions gained from the study, the data is being used to identify trends related to the health of the Bay and provide information for Bay management.

FOREST COMMUNITIES OF THE CENTRAL APPALACHIANS. David M. Lawrence, Dept. of Environmental Sciences, Univ. of Va., Charlottesville, VA 22903, Harold S. Adams, Div. of Arts & Sciences, Dabney S. Lancaster Cmnty. Col., Clifton Forge, VA 24422, and Steven L. Stephenson, Dept. of Biology, Fairmont State Col., Fairmont, WV 26554. Biogeographic patterns in upland forest community composition in the mid-Appalachians were examined using quantitative data on the composition of the overstory (stems $\geq$10 cm DBH) from 216 stands. Sampled stands occupied a wide range of site conditions and included representatives of all of the major forest types present in the region. Preliminary results obtained using TWINSPAN and DECORANA indicate that there are two major forest types: those with a significant component of red spruce and other species typically associated with spruce, and those without a significant spruce component. Red spruce stands can be further differentiated on the basis of codominant species such as balsam fir, Fraser fir, and eastern hemlock. Forest types without a significant spruce component include pitch pine/black oak, scarlet oak, mixed oak, chestnut oak, chestnut oak/black oak, chestnut oak/red maple, red oak/white oak, chestnut oak/red oak, red oak, red oak/red maple, red oak/white oak/black birch, sugar maple/hickory, sugar maple, and hemlock/yellow poplar. The influences of a variety of environmental factors account for the differences that exist in forest community composition, with those factors related to elevation, topographic position, underlying geological substrate, and disturbance history the most important.

DENDROECOLOGY OF THREE RED SPRUCE POPULATIONS ON SALT POND MOUNTAIN IN GILES COUNTY, VIRGINIA David M. Lawrence, Dept. of Environmental Sciences, Univ. of Va., Charlottesville, VA 22903, Harold S. Adams, Div. of Arts and Sciences, Dabney S. Lancaster Cmnty. Col., Clifton Forge, VA 24422, Steven L. Stephenson, Dept. of Biology, Fairmont State Col., Fairmont, WV 26554, Tarek A. Hijaz, Dept. of Environmental Sciences, Univ. of Va., Charlottesville, VA 22903, Charles W. Lafon, Dept. of Geography, Univ. of Tennessee, Knoxville, TN 37996, Neil A. Pederson, School of Forestry, Auburn Univ., AL 36849, Margot C. Wilkinson, Dept. of Environmental Sciences, Univ. of Virginia, Charlottesville, VA 22903, and P. Joy Young, Savannah River Ecology Lab., Univ. of Georgia, Aiken, SC 29803. The primary objective of the present study was to construct and then to compare tree-ring chronologies for three spruce populations (Little Spruce Bog, War Spur, and Mann's Bog) in the Mountain Lake area of southwestern Virginia. A secondary objective was to collect data on community composition, spruce age structure, and spruce growth characteristics at the three sites. The spruce populations at the three sites represent three distinctive age groupings, ranging from an average of 61 rings (breast height) at Mann's Bog to 195 rings at War Spur. Chronologies for the three sites for the period of 1940 to 1992 were generally similar, but correlation (response function analysis) of growth with climatic factors (monthly mean temperature and total precipitation for June of the prior year through August of the year of ring formation) was unique for each site.

HERBACEOUS PLANTS OF THE DYKE MARSH RIVERINE TIDAL EMERGENT WETLAND. Dean A. Lindholm, 14226 Glenkirk Rd., Nokesville, VA 22123 (w/ George Mason Univ.). June 15 - July 15, 1992 survey sampled 53 quadrats of 1 sq.m. herbaceous marsh, quadrats established by 1991 GMU plant inventory. The Shannon-Wiener diversity index was *H'=1.668* (n=53), and Simpson's diversity index was *C=0.251* (n=53). Species density, cover, and frequency surveys found that 8 of the 20 sp. encountered made up greater than 98% of each category. *Peltandra virginica* was the most common, present in 98% of the quadrats; *Impatiens capensis* exhibited the greatest density, covering 41.2% of the area sampled; *P. virginica* covered 29.9% of the area sampled. Deepwater elevation surveys of 22 sp. discovered elevation minimums for these sp., including *Nuphar luteum* and *Fraxinus pennsylvanica* as the only sp. growing below mean low tide, the latter probably important in Dyke marsh soil stabilization. *Scirpus fluviatilus*, listed "S1" in Virginia, was common in the sampled marsh, present in 13% of the 53 quadrats and constituting just over 1% of the plants sampled.

THE JUDD GARDEN - AN HISTORIC LEGACY IN THE SHENANDOAH NATIONAL PARK. Peter M. Mazzeo, U.S. National Arboretum, Washington, DC 20002. In March of 1926 a group of concerned citizens met on the porch of Sentinel Lodge, the summer residence of the George H. Judd family, which overlooked the Judd garden and Stony Man Mountain. It was their hope that a large section of the Blue Ridge Mountains of northern Virginia might be designated to become a new national park. Although the cabin and most of the original landscape plantings are long gone, some of the original plant materials, rock walls and other physical artifacts still remain at the site. Because of the historical significance of this four-plus acre site, efforts are now underway to preserve, interpret and ultimately restore the George H. Judd garden area at Skyland, the heart of the Shenandoah National Park, Virginia, that was dedicated on 3 July 1936. A review of the garden history and landscape plant materials is presented.

RICE (*Oryza sativa* L) β-GLUCOSIDASE: PARTIAL PURIFICATION, CHARACTERIZATION AND HISTOCHEMICAL LOCALIZATION. C. Muslim and A. Esen, Dept of Biol., Va. Polytechnic Ins. & State University, Blacksburg, VA 24061. We partially purified rice β-glucosidase from the root and shoot of 5-6 day-old seedlings using a combination of differential solubility and ion exchange chromatography. The partially purified enzyme was characterized with respect to its kinetic properties, substrate specificity, pH optimum, pI, and molecular mass at native and denatured stage. In order to localize the enzyme by histochemical procedures, we applied chromogenic substrates for β-glucosidase to tissue sections, isolated protoplasts and plastids of the seedling shoots. We found that the enzymes have three different peaks of activity toward para-nitrophenyl β-D-glucopyranoside (pNPG). However, activity levels observed on the SDS PAGE using 6-bromonaphtyl β-D-glucopyranoside (6BNG) and Fast Blue R dye were different from those expected on the basis of spectrophotometric assays using pNPG. One of the enzyme has the highest enzyme efficiency (Vm/Km) toward paranitrophenyl β-D-fucopyranoside and pNPG, among the substrates tested. The pH optimum was 4.8-5.0, while one of the enzymes has high pI (estimated 9.6). We estimated that the enzyme has a subunit molecular mass of 60 kD. The enzyme is localized histochemically to the plastid.

ESTIMATION OF PRODUCTIVITY AT SEVEN STATIONS LOCATED IN THE LOWER CHESAPEAKE BAY. Kneeland K. Nesius, Harold G. Marshall, Dept. of Biological Sciences, Old Dominion University, Norfolk, VA 23529-0266. Productivity patterns at seven stations located in the lower Chesapeake Bay over a five year period were seasonal consisting of three major peaks - spring, summer, fall. These variations correlated with seasonal changes of neritic phytoplankters. Stations located near the mouth of the Chesapeake Bay had the lower productivity rates. Annual production rates were higher at the western Bay stations. Average annual production rates over the five year period varied from 300 g $C/m^2/yr$ to 180 g $C/m^2/yr$.

IN VITRO GERMINATION OF *BRASSICA RAPA* POLLEN. Mark A. Newsome and Michael H. Renfroe, Dept. of Biol., James Madison Univ., Harrisonburg, VA 22807. To bettter understand pollen growth and development, chemical constituents that initiate pollen tube development were investigated in *Brassica rapa*. The *Brassica* genus is economically and agronomically important. Determination of a successful in vitro pollen germination medium may provide insights to the in vivo requirements for successful pollination. Many successful in vitro germination media have been reported for binucleated pollen species. However, in vitro germination of trinucleated pollen, such as is found in *Brassica*, has been less successful and few germination media have been reported. Various media and in vitro physical and chemical effects were tested for possible influence on pollen germination . A comparison of carbohydrates in the media revealed that sucrose rather than raffinose or glucose was most effective for germination. Specifically, 20% sucrose provided the highest percentage germination. An initial pH value of 7.4 was determined to be optimal. Density of the pollen population appeared to have an effect. Percentage germination was observed over time with the optimized medium. Effective pollen germination occurred within an hour of incubation in the medium.

PHYTOPLANKTON ABUNDANCE IN THE LOWER CHESAPEAKE BAY: II. MEAN CONCENTRATIONS 1985-1991. Sandra Olek, Mollie Weinstein, David Seaborn, H.G. Marshall, Dept. Biological Sci., Old Dominion Univ., Norfolk, VA 23529-0266. Results of a 6 year data set for the phytoplankton populations in the lower Chesapeake Bay indicate the mean monthly averages over this period. Greatest phytoplankton abundance and biomass was associated with the western Bay stations during spring, summer and fall. These populations were dominated by a diatom flora, with the mean number of total phytoplankton taxa recorded per month as 43. Monthly cell abundance maxima at each station were approximately one order of magnitude greater than the mean concentrations. (Supported by the Virginia Dept. of Environmental Quality).

FLORAL WHORL ONTOGENY IN *BRASSICA RAPA*. Michael H. Renfroe, Dept. of Biology, James Madison University, Harrisonburg, VA 22807. The sequence and pattern of floral organ initiation and development was examined for the rapid-cycling brassica variety of *Brassica rapa*. The order of floral whorl initiation was calyx, followed by androecium and gynoecium, with the corolla forming last. Organs developed for the most part in paired formations. The two carpels developed as a fused pair. The six stamens of the androecium were formed as a set of four followed by the differentiation of a second set of two. Petals differentiated to either side of the final pair of stamens, resulting in a corolla consisting of four petals. The timing and pattern of organ initiation may be related to spatial constraints of the floral meristem.

ANNUAL PHYTOPLANKTON DYNAMICS IN THE PAGAN RIVER, VIRGINIA. David Seaborn & H.G. Marshall. Dept. Biological Sci., Old Dominion Univ., Norfolk, Va. 23529-0266. The Pagan River is a nutrient enriched river system with annual mean levels of total nitrogen and phosphorus at 1.8 and 0.8 mg/l respectively. Three phytoplankton maxima occurred during the year with the highest in fall, followed by summer and spring peaks. Diatom populations were dominant throughout the year at concentrations of 10^7 to 10^8 cells/l. Other populations exhibited distinct periods of greater abundance, and time of development. An upstream station contained the greatest abundance of flora throughout the sampling period. Turbidity levels were high the entire year with an annual secchi reading mean of 0.4 m. When compared to the James River, the Pagan River had greater cell abundance, higher nutrients, and lower secchi depths.

THE VIRGINIA PITCHER PLANT BOGS, PART TWO: NOTEWORTHY BOGS OF DINWIDDIE COUNTY. Philip M. Sheridan, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284. Dinwiddie County is located along the Appomattox River in southern Virginia west of the town of Petersburg. The fall line divides the piedmont and coastal plain formations in the eastern third of the county and this is where pitcher plant seepage wetlands containing Sarracenia flava L. and S. Purpurea L. occur. Historical stations occurred along Arthur Swamp (Blaha Bog), Hatcher Run (Burgess station), Rohoic (Old Town) Creek and Rowanty Creek. The Arthur Swamp site represented the southern station for the New Jersey Rush, Juncus caesariensis Coville. Over the past ten years new pitcher plant bogs have been discovered on headwaters of Arthur Swamp (Shands Bog), Hatcher Run (Depot Road Bog) and northeast of the town of Addison. All sites are characterized by moderate relief (1-2% slope) and sand-peat saturated soils. There are minor floristic differences between sites. Addison Bog represents the northern most pond pine Pinus serotina Michx. pitcher plant pocosin supporting both Sarracenia species while Shands Bog contains the greatest number of bog rarities.

GENETICS OF ABERRANT SARRACENIA LEAF AND FLOWER COLOR. Philip M. Sheridan, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va, 23284. Sarracenia is a genus of insectivorous plants confined to wetlands of the U.S. and Canada. Eight species are generally recognized with flower and leaf color ranging from yellow to red. Fertile hybrids occur in the wild under disturbed conditions and can be artificially produced in the greenhouse. Thus barriers between species are weak. Normally when crosses occur or are induced between species or between different color types the progeny exhibit a blending of parental phenotypes called incomplete or partial dominance. In most species all-green mutants have been found which lack any red pigment in leaves, flowers or growth point. Self pollinated all-green plants result in all-green offspring and self pollinated wild-type red plants result in red offspring. When all-green plants and wild-type red plants are crossed in these species the offspring are all red plants. These results suggest that red is dominant to the recessive all-green mutant. Since partial dominance is the usual genetic pattern in the genus, dominant/recessive characteristics are an unusual phenomenon.

SYSTEMATICS OF CHAMAESYCE SUBSECTION PLEIADENIAE (EUPHORBIACEAE). Mark P. Simmons and W. John Hayden, Dept. of Biol., Univ. of Richmond, Richmond, Va. 23173. A taxonomic study has been undertaken of the nine nominate species belonging to Chamaesyce subsection Pleiadeniae, which has received no comprehensive study since its proposal by Boissier 125 years ago. This subsection is reputed to be transitional between Euphorbia and Chamaesyce. The species are indigenous to the cerrado of South America. Morphological, anatomical, ultrastructural, and biogeographical studies have been used to assess these species and their position within Chamaesyce. Chamaesyce caecorum is a remarkably variable species with extreme forms that show intergradation. Chamaesyce chamaerrhodos, C. setosa, C. tamanduana, and C. viscoides, which have been variously synonymized, recognized, or ignored in recent studies, are recognized as distinct species. The enigmatic Chamaesyce tamanduana appears to be very rare and is only known from the type collection. Euphorbia Chamaerodos [sic] var. hirsuta has been synonymized with Chamaesyce chamaerrhodos.

STUDIES OF RED SPRUCE/HARDWOOD ECOTONES AT SEVERAL LOCALITIES IN VIRGINIA AND WEST VIRGINIA Steven L. Stephenson, Dept. of Biology, Fairmont State Col., Fairmont, WV 26554, Harold S. Adams, Dabney S. Lancaster Cmnty. Col., Clifton Forge, VA 24422, David M. Lawrence, Dept. of Environmental Science, Univ. of Va., Charlottesville, VA 22903, Mary Beth Adams, USDA Forest Service, Timber and Watershed Lab., Parsons, WV 26287, and John D. Eisenback, Dept. of Plant Pathology, Physiology, and Weed Science, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. We are currently investigating patterns of species composition and distribution, ecologically important population processes, and microenvironmental gradients in permanent transects (each consisting of a series of contiguous 10 x 10 m quadrants) established across the typically abrupt and narrow spruce/hardwood ecotone at five localities in the mountains of central West Virginia and western Virginia. Primary emphasis of our research is directed toward testing three basic hypotheses: (1) red spruce communities in the mid-Appalachians are decreasing in areal extent due to encroachment of surrounding hardwood communities, (2) stress-induced growth decline in red spruce is a factor in this decrease, and (3) the direction and rate of successional change can be predicted from models developed from quantitative data obtained from field studies of spruce/hardwood ecotones. Preliminary data obtained during the 1992 and 1993 field seasons suggest that mid-Appalachian red spruce communities presently exist at least in static equilibrium with respect to surrounding hardwoods and exhibit, at some localities, advance regeneration into the hardwood communities. (Supported in part by funds provided by the USDA Forest Service.)

HIGH ELEVATION BEECH COMMUNITIES IN THE CENTRAL AND SOUTHERN APPALACHIANS. Steven L. Stephenson, Dept. of Biology, Fairmont State College, Fairmont, WV 26554 and Harold S. Adams, Div. of Science and Mathematics, Dabney S. Lancaster Cmnty. Col., Clifton Forge, VA 24422. Forest communities in which American beech (Fagus grandifolia Ehrh) is a major component of the tree stratum occur at elevations up to 1830 m in the southern Appalachians. Such communities are well-documented for the Great Smoky Mountains, where they have been the subject of a number of studies. Beech communities appear to be relatively uncommon in the mid-Appalachians, and only rarely have examples of this forest community type been described for particular localities in western Virginia. In the present study, data on the composition and structure of the vegetation were obtained for forest communities with beech present as a dominant or codominant species at one study site on Mount Rogers in Smyth County and three study sites in the Mountain Lake area of Giles County. Soils data also were obtained for the three Mountain Lake study sites.

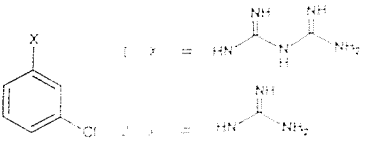
MICROFUNGAL EVIDENCE FOR THE POSSIBLE DYSFUNCTION OF SHIITAKE PRODUCTION LOGS IN VIRGINIA. R. Jay Stipes and Gonzalo Guevara-Guerrero, Dept. Plant Pathol. , Physiol. , and Weed Science, Virginia Tech, Blacksburg, VA 24061. Shiitake growers in Virginia have experienced considerable diminution of the fruiting life of oaks logs (maximum = 5-6 yrs.), and in some cases no fruiting at all has occurred. Growers tend to select on their woodlots the understory, suppressed, slow-growing, and weakened trees (cull stock) rather than vigorously growing, dominant or co-dominant trees. Since the latter prove to be highly functional shiitake log resources, we suspected involvement of competing fungi ("weed fungi") as the precluding factors in shiitake production. We aseptically biopsied sapwood (xylem tissues) cores from typically suppressed oak (Quercus spp. J and those from dominant, healthy, fast-growing ones (controls). A low percentage (23%) of control trees were colonized by fungi, whereas 100% of biopsies from suppressed trees were colonized. We theorize that these opportunists and their metabiotic successors (Hypoxylon, Graphostroma, Eutypa spp.) are precluding factors in shiitake production logs harvested from suppressed trees; research, however, is needed for confirmation.

POTENTIAL ALLEPOPATHIC EFFECTS OF MYRICA CERIFERA ON PINUS TAEDA. Kathryn S. Tolliver and D.R. Young, Dept. of Biol., VA. Commonwealth Univ., Richmond, VA 23284. Myrica cerifera forms persistent thickets on barrier islands. To evaluate potential underlying mechanisms supporting the persistence of the M. cerifera thicket seral stage, a growth chamber study examined potential sources of allelochemicals from Myrica cerifera and the interaction between allelopathy and light intensity on P. taeda seedling growth. Pinus taeda total biomass, root, and shoot biomass were significantly depressed under low light (44 μmol $m^{-2}s^{-1}$). Root biomass was significantly depressed in Myrica soil in high light (300 μmol $m^{-2}s^{-1}$); however, in high light both root and shoot biomass in Myrica soil were significantly higher in the presence of Myrica leaf litter. Thus, litter accumulation may assist replacement species in invading gaps. Low light levels and allelopathic effects may interact and contribute to the persistence of Myrica thicket seral stage by negatively impacting root growth of seedlings, thereby reducing competitive interactions for space and moisture acquisition.

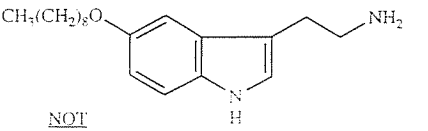
SUMMER VERTICAL DISTRIBUTION OF PHYTOPLANKTON IN CENTRAL CHESAPEAKE BAY. Mollie J. Weinstein & H.G. Marshall. Dept. Biological Sci., Old Dominion Univ., Norfolk, Va. 23529-0266. A vertical series of phytoplankton and autotrophic picoplankton samples were collected at three stations in the lower Chesapeake Bay during the summer of 1993. Results of July 1993 are reported at this time. Diatoms and chlorophytes were evenly distributed over the water column. Phytoflagellates had higher concentrations above the pycnocline. No significant increase in phytoplankton abundance was seen in association with the pycnocline. The picoplankton surface abundance varied among the stations. Overall, there were higher autotrophic picoplankton concentrations in the pycnocline region, and reduced abundance below the pycnocline. (Supported in part by the Virginia Dept. of Environmental Quality).

Chemistry

PHENYLBIGUANIDES AND PHENYLGUANIDINES: A SAFIR ANALYSIS FOR 5-HT_3 BINDING. A. Abdel-Rahman,* M. Dukat,* M. Teitler,* and R.A. Glennon. Department of Medicinal Chemistry, MCV/VCU 23298. 5-HT_3 receptors are ion channel receptors that may be involved in the control of nausea and in various mental disorders. Although a wide variety of 5-HT_3 antagonists have been developed, selective high-affinity 5-HT_3 agonists are virtually unknown. We and others independently identified mCPBG (1; Ki = 17 nM) as a novel 5-HT_3 agonist. In order to determine what structural features are important for affinity/selectivity, we systematically examined the structure of mCPBG in a structure-affinity relationship (SAFIR) study. Guanidine 2, for example, binds with high affinity (Ki = 35 nM), represents a novel class of 5-HT_3 ligands, and suggests that the intact biguanide system is unnecessary for 5-HT_3 binding affinity.

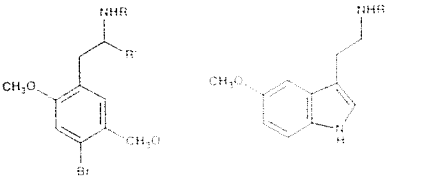


INVESTIGATION OF NOVEL SEROTONIN 5-HT1D RECEPTOR LIGANDS. Bondarev, M.;* Hong, S.;* Dukat, M.;* Teitler, M.;* Glennon, R.A. Dept. of Med. Chem., MCV/VCU; Richmond, VA 23298. Sumatriptan was recently introduced to the American market as a novel agent for the treatment of migraine. Although its exact mechanism of action is unknown, it displays high affinity for two populations of serotonin receptors (5-HT1A and 5-HT1D), and acts as a 5-HT1D agonist. In addition to difficulty in penetrating the blood-brain barrier, it has been suggested that its 5-HT1A component may detract from its therapeutic efficacy. To overcome these problems, we have developed a series of agents that binds at 5-HT1D receptors with higher affinity and selectivity than sumatriptan. For example, ALX-1323 or 5-(nonyloxy)tryptamine (NOT), binds with several-fold higher affinity and > 250-fold selectivity for 5-HT1D versus 5-HT1A receptors. Preliminary functional studies reveal NOT to be a 5-HT1D agonist. Investigation of structure-affinity relationships is currently underway.

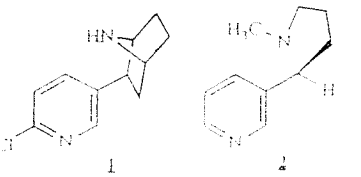


NOT

INFLUENCE OF AMINE SUBSTITUENTS ON 5-HT2A VERSUS 5-HT2C SEROTONIN RECEPTOR BINDING. M. Dukat,* H. Law,* M. El-Bermawy,* J. De Los Angeles, M. Teitler,* R.A. Glennon, Dept. Med. Chem. MCV/VCU, Richmond, VA 23298. Many ligands previously shown to bind at 5-HT2A receptors have now been found to bind with nearly comparable affinity at 5-HT2C receptors. For example, DOB (1 R = Me, R = H) binds with nearly equal affinity at both populations (Ki = 41 and 70 nM, respectively). We under took an examination of two series of N-substituted compounds (i.e. phenylalkylamines and indolylalkylamines 1 and 2) in order to identify compounds with greater selectivity. In general, amine substitution decreases receptor affinity; however certain substitution (e.g. 1, R = 4-Br benzyl, R´ = H; 2, R = 4-Br benzyl) results in compounds that bind at 5-HT2A receptors with high affinity (Ki < 1 nM) and with > 100 fold selectivity relative to 5-HT2C binding.

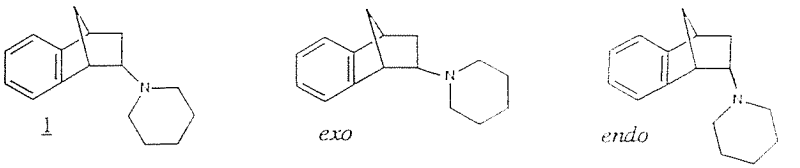


EPIBATIDINE: A NEW NICOTINE RECEPTOR LIGAND. Dumas, D.;* Dukat, M.;* May, E;* Glassco, W.;* Martin, B.; Glennon, R.A. Dept. Med. Chem., MCV/VCU; Richmond, VA 23298. It is speculated that nicotine receptor ligands might be of therapeutic benefit for the treatment of obesity, anxiety, and memory loss. With the exception of nicotine, few selective high-affinity agents exist. (-)Epibatidine (1), isolated from Ecuadoran frogs, shows structural resemblence to (-)nicotine (2). Molecular modeling studies reveal that the N to N distance in 1 (5.5 Å) is greater than that found in 2 (4.9 Å). This distance exceeds that previously considered optimal for the nicotine receptor pharmacophore (4.8 ± 0.3 Å) by about half a bond length. Nevertheless 1 binds (Ki = 0.025 nM) at [^{3}H]nicotine-labeled receptors with nearly 100-fold higher affinity than 2. Although our studies are still in progress, molecular superimposition and preliminary results with various structurally modified analogs suggest that it is the conformationally constrained nature of 1 that accounts for its high affinity, and that the nicotine receptor pharmacophore may require re-formulation.



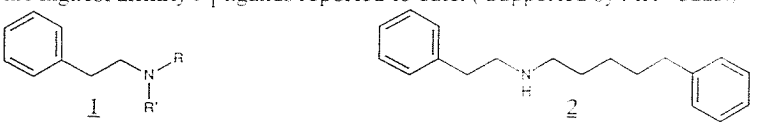
1 2

SYNTHESIS AND RE-EVALUATION OF A SPURIOUS σ RECEPTOR LIGAND. M.B. El-Ashmawy*, S.Ablordeppey*, J.Fischer* and R.A.Glennon. Dept. of Med. Chem., MCV/VCU, Richmond, VA 23298. Sigma (σ) receptor ligands have been proposed to be a new class of neuroleptic/neuroprotective agents. Recently, we identified phenylethylamines as a common pharmacophore of various σ agents and developed a number of high affinity σ-selective compounds. Meanwhile, a conformationally-restricted analogue of our phenylethylamines, 1, was reported by others to be a superpotent σ ligand (Ki = 0.075 nM). Because structure-activity relationships (SAR) developed in our laboratory would have forecast this agent to be of much poorer affinity, we resynthesized 1 as well as its individual *endo* and *exo* isomers. The low affinity determined for 1 (Ki = 66 nM) is consistent with our SAR and further suggests that the *exo* form is the higher affinity isomer.



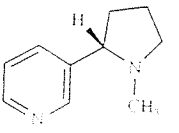
1 *exo* *endo*

DESIGN AND SYNTHESIS OF SUPERPOTENT σ-1 RECEPTOR LIGANDS. M.B. El-Ashmawy*, S.Ablordeppey*, A.Ismaiel*, J.Fischer* and R.A.Glennon. Dept of Med. Chem., MCV/VCU, Richmond, VA 23298. Current interest in sigma (σ) receptors relates to possible involvement in psychiatric disorders and regulation of motor behavior. Problems hampering σ research are the lack of high-affinity agents and identification of multiple populations of receptors (σ_1 and σ_2). We have previously identified phenylethylamine 1 as the binding pharmacophore of benzomorphans and other σ agents. In the present investigation, different phenylalkylamines were designed and evaluated for σ_1 binding, using [^{3}H]pentazocine as radioligand. Most showed higher affinity at σ_1 than at "overall σ" receptors, e.g. phenylpentylamine 2, Ki = 0.17 nM. Common structural features important for σ_1 binding were identified, a possible ligand pharmacophore model has been proposed, and a novel class of superpotent σ_1 agents (Ki < 1 nM) was developed. In fact, the phenylpentylamines represent the highest affinity σ_1 ligands reported to date. (Supported by MH-45225.)

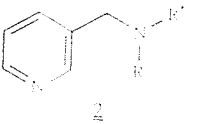


1 2

STRUCTURE-AFFINITY RELATIONSHIPS OF SIMPLE NICOTINE ANALOGS AT CENTRAL NICOTINE RECEPTORS. W.J. Fiedler*, M. Dukat*, B. Martin*, R.A. Glennon. Dept. of Med. Chem., MCV/VCU, Richmond, VA 23298. Central nicotine receptors are involved in memory, learning and neurodegenerative disorders such as Alzheimers disease. The development of structure-affinity relationships (SAFIR) for [^{3}H]-nicotine receptor binding should aid the development of novel nicotine agents. Ring opening of the pyrrolidine ring of (-)nicotine (1; Ki 2 nM) results in retention of, but a reduction in, affinity. For example, optimal substitution in 2 is R = Et, R' = Me (Ki = 30 nM) Lengthening one R chain beyond propyl abolished affinity. Secondary amines were also inactive; aromatic substituted analogs of 2 were of lower affinity than 2. Further study is necessary to complete the formulation of SAFIR. Development of conformationally restricted analogs are of particular interest to further delineate the bioactive conformation of 1. (Supported in part by funds from CIT/TDC.)



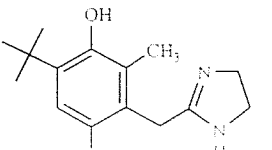
1



2

WHAT DO SEROTONIN RECEPTORS LOOK LIKE: A COMPARISON OF MOLECULAR DYNAMICS SIMULATIONS OF MEMBRANE BOUND RECEPTOR MODELS. J. L. Herndon,* R. B. Westkaemper,* R. A. Glennon. Dept. of Medicinal Chemistry, Medical College of Virginia, Virginia Commonwealth University, Richmond, VA 23298-0540. Serotonin 5-HT$_{2A}$ receptors are members of the guanine nucleotide regulatory protein-coupled family of receptors (GPCR) and have been implicated in a variety of central and peripheral functions, making them attractive targets for structural modeling studies. Sequence alignments based on hydrophobicity patterns and helical turn potentials were used to construct 3-dimensional models of the human 5-HT$_{2A}$ receptor using the experimental structure of bacteriorhodopsin as a template. Molecular mechanics minimizations followed by molecular dynamics simulations gave qualitatively different results that depended on the force-field used [Tripos' Maximin2, Tripos' Kollman united atom (Amber3.1), Insight/Discover's cvff]. The best model obtained using this approach is compared to similarly treated models constructed using sequence homology and/or the low resolution experimental structure of bovine rhodopsin as a template.

A STRUCTURE-AFFINITY RELATIONSHIP INVESTIGATION OF BENZYLIMIDAZOLINES AS 5-HT1D RECEPTOR LIGANDS. H. Law,* M. Dukat,* M. Teitler,* and R.A. Glennon, Dept. of Med. Chem., MCV/VCU, Richmond, VA 23298. 5-HT1D receptors are one of the most recently discovered serotonergic receptors and agents that bind selectively at 5-HT1D receptors may be potential drugs for the treatment of migraine. Unfortunately, there have been few reports of high-affinity selective ligands. Oxymetazoline (1, Ki = 1.1 nM), although non-selective, is a very high affinity 5-HT1D ligand. In the present investigation, we prepared a series of oxymetazoline analogs where 1 was systematically abbreviated or modified in such a way that we might determine the contribution to 5-HT1D binding of each of the various substituents. In this manner, it might eventually be possible to design agents with greater selectivity. Results suggest that the entire intact molecule is necessary for high affinity.



1

Computer Science

EFFICIENCY ISSUES IN DETERMINING DATA EQUIVALENCE OF BINARY SEARCH TREES. Juanita Avila and Rita M. D'Arcangelis, Department of Computer Science, Mary Washington College, Fredericksburg, VA 22401. Binary trees are called equivalent if they have the same topology and the information in corresponding nodes is identical. A recursive algorithm is known to exist which will determine whether two binary trees are equivalent. Binary trees are called 'data-equivalent' if they have possibly different topologies and yet contain the same data. Research was undertaken to develop iterative, linear time and bounded space algorithms for determining data equivalence of ordinary binary search trees as well as threaded binary search trees. The algorithms developed are presented, and the rationale for the strategy used is discussed.

ILLUSTRATING ABSTRACT DATA TYPES USING MICROSOFT VISUAL C++. Tiffany Bond and Rita M. D'Arcangelis, Department of Computer Science, Mary Washington College, Fredericksburg, VA 22401. Microsoft Visual C++ is an object-oriented programming language which contains necessary abstraction, encapsulation, modularity, and inheritance features, plus a Windows-based application development and execution environment. Experiments in combining the built-in classes and object instances with programmer-defined classes and objects have produced a useful tutorial program: an interactive, menu-driven program which illustrates how several important data structures, such as stacks and queues, can be implemented in this language. The program will serve as a practical guide for instructors on implementing abstract data types in an object-oriented environment. The program will also benefit beginning Computer Science students because they will be able to select data types and then observe and affect the behavior of the structures containing those types during program execution.

ERROR FREE EDITING USING STED (SYNTAX TEXT EDITOR). Shawn Chambliss, Samone Jones, and Larry Morell, Dept. of Computer Science, Hampton University, Hampton, Va. 23668. STED is a syntax-directed editor that ensures the user will produce syntactically correct programs by allowing only valid constructs to be entered. STED is novel in that it is language-independent: it can be instructed to check the structure for any programming language. Valid constructs are defined by a BNF-like grammar, augmented to include format rules to describe how the constructs are to be displayed. STED is implemented in Turbo Pascal, using object-oriented programming and runs on a PC.

INTELLIGENT LOGIC TUTOR. Ying Gu & Rhonda Eller, Department of Computer Science, Randolph-Macon College, Ashland, VA 23005. This framework for a tutoring system is designed to help student users with formal logic proofs by incorporating techniques from theoretical works of planning, plan recognition, and plan repair. It adapts a formal AI framework for use in a learning tool with an intelligent user interface. The student may ask the system to do a complete proof, to provide guidance only when needed, or to judge and optimize an established proof. Two types of plans are used by the system: rule plans and strategy plans. Each rule plan sets specifications and grammar for an individual logic rule. Any attempt by the user to apply a logic rule in a syntactically incorrect manner results in temporary suspension of proof construction until the error is corrected by the user with help from the system. Strategy plans encode relationships between sets of formal logic rules, developed from analyzing the strategy used by humans in construction of correct, optimal proofs. Each line in the user's proof will be assigned a weight. Weights reflect the similarities in the user's proof and the system's view of the optimal proof, the system's recognition of the correctness of the user's partially constructed proof, and the system's confidence in the rules applied to create the user's proof. In cases when proof repair becomes necessary, the line with the lowest weight is first considered for removal. Next, all descendent-lines derived from it are removed. Unlike the traditional AI resolution theorem proving approach where dependency backtracking is widely used, our system builds proofs with the forward-chaining technique which starts from the premises and attempts to reach the desired goal state. By this method, we can effectively model the direction of the human student's thought processes and thus provide advice to the student about what went wrong or could be optimized in his/her particular proof.

IDENTIFICATION AND REMOVAL OF HIDDEN SURFACES FROM THREE DIMENSIONAL OBJECTS. Laura A. Keiner and Marsha Zaidman, Department of Computer Science, Mary Washington College, Fredericksburg, VA 22401. Hidden surface removal is an essential process to render realistic images on a graphics system. Many algorithms exist to remove surfaces, which vary depending upon the particular application. HP Starbase is the graphics package available at MWC, which contains procedures to implement the Z-buffer algorithm to solve this problem. While the Z-buffer effectively handles most graphical situations, the amount of memory used to set up the buffer is immense. Each element of the buffer represents the depth of a particular pixel. The system at MWC does not support the Z-buffer. Therefore, hidden surface removal must be accomplished without the help of HP Starbase's predefined procedures. An alternative solution is using a depth sorting method such as the painter's algorithm. Backface surfaces are first removed by examining the direction of the polygon's normal vector. Then,the remaining polygons are sorted and drawn according to their depth on the screen.

Education

PROJECT SCIENCE AT DSLCC--PHASE II. H. S. Adams and J. S. Barnes*, D. S. Lancaster Cmnty. Col., Clifton Forge, VA 24422. During its second year, full and part-time faculty at Dabney S. Lancaster Community College continued to develop and incorporate modules into their courses to help students in the areas of: (1) overcoming deficiencies in science knowledge; (2) increasing positive attitudes toward science; and (3) developing critical thinking skills. In all, over thirty percent of the DSLCC faculty (including some part-time faculty who teach dual enrollment courses) have participated in developing modules during the two years of our program. Modules were developed in anatomy and physiology, nutrition, economics, business law, history, and general biology this past year. Additionally, three films were shown and nine speakers from various disciplines presented public programs for students and general public alike with attendance averaging around 100 persons (primarily students). These speakers also conducted classroom presentations for specific disciplines generally outside their area of expertise. Post-test assessment results are not yet complete, but general response to the program by both students and faculty has been very positive. (Supported in part by funds provided by the State Council on Higher Education in Virginia.)

PARTNERSHIP FOR EXCELLENCE: A MODEL FOR AUTHOR VISITATION PROGRAM. Krishan M. Agrawal, Virginia State University, Petersburg, VA 23806 and Wallace O. Pendleton, Jr., Chesterfield County Schools, Chesterfield, VA 23832. A description of how a school system, local book store, and a publisher of science books work together to foster student interest in science. An author of a current popular science book is invited to visit school classrooms to present topics covered in his or her book to the students. The author later participates in a panel discussion attended by a larger audience, which includes students who have read the book, educators, and scientists. The panel discussion covers a broader range of topics, including the current status of research in the related field.

CHANGING ASSESSMENT METHODS IN MATHEMATICS AND SCIENCE (V-QUEST). Eurice J. Dawley, Norview M.S., 6325 Sewells Point Road, Norfolk, VA 23513, & Emily Pugh, Norview M.S., 6325 Sewells Point Road, Norfolk, VA 23513. Some conventional assessment methods are not the best measurement tools to test for mastery of objectives taught or skills learned. For too many years, the only assessment instruments used by many teachers on a regular basis have been multiple choice tests, matching, completion, or tests structured to give a single "right" answer. Too often effort is unrewarded. Science laboratory activities are difficult to assess. Grading is perceived as one of the most painful components of the educational act for teachers and students. It does not have to be that way. Many teachers of science and mathematics want to identify alternative assessment procedures to use. There are several initial changes that can be made to existing measurement instruments with relative ease. These changes will afford us opportunities to identify behaviors and skills used to formulate and execute a plan to organize data and describe the solution set.

PERCEPTIONS AND ATTITUDES OF UNDERGRADUATE SCIENCE FACULTY TOWARD SCIENCE TEACHING: ESTABLISHING A BASELINE FOR THE INTERDISCIPLINARY SCIENCE AND MATHEMATICS EDUCATION PROJECT (V-QUEST). Susan C. Eriksson , Dept. Geological Sciences and Virginia Tech Museum of Natural History, and George E. Glasson, College of Education; Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061. Faculty teaching introductory science courses were interviewed in order to assess attitudes and perceptions about their own teaching, the students and how their courses should be changed. Although several positive attitudes were voiced (satisfaction in teaching, 'getting through' to a few students, and some changing techniques in teaching over the years), faculty mainly expressed feelings of frustration in teaching large sections, little pedagogical training in their careers, and pressure to compromise standards. They felt students are not conscientious, expect teachers to be entertainers, are disruptive and don't get intellectually involved in their courses. Faculty also expressed interest in teaching in smaller sections, relating laboratory experiences more closely to lectures, and improving the pedagogical skills of teaching assistants.

PERCEPTIONS AND ATTITUDES OF UNDERGRADUATE SCIENCE STUDENTS TOWARD SCIENCE: ESTABLISHING A BASELINE FOR THE INTERDISCIPLINARY SCIENCE AND MATHEMATICS EDUCATION PROJECT (V-QUEST). George E. Glasson, College of Education, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061-0313, & Susan Eriksson, Dept. of Geol. Sciences, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061-0420. In an effort to assess the perceptions and attitudes of pre-service teachers toward undergraduate science courses, fourteen students were interviewed. Of these students, three were pre-service elementary teachers, seven were pre-service middle school science teachers, and four were pre-service high school science teachers. The following themes emerged from the interviews: (1) lecture classes are too large and impersonal; (2) lecture and lab classes are disjointed; (3) lab classes are "cookbook" rather than investigative; (4) students learn more in upper level lab classes with investigative approach; (5) information presented is unrelated to real world problems; (6) more interdisciplinary approach needed for science programs; (7) too much emphasis on multiple-choice tests; (8) women should be encouraged in science; (9) many graduate teaching assistants not qualified to teach; and (10) teaching is not a priority for professors.

ENCOURAGING QUESTION ASKING AND WRITING IN THE SCIENCE CLASSROOM. Kenneth Lawwill, Chantilly High School, Fairfax Co. Public schools; Thomas Teates, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0313. Student apathy towards science may be reduced by allowing more ownership of the topics. Permitting students to ask their questions and seek their answer should contribute more to long term than just emphasising the questions the teacher or text believe are important. Literacy requires asking. Several techniques to encourage questioning, including student writing schemes, will be discussed. Allowing students more opportunities to individualize their learning and expression can contibute to more meaningful construction of knowledge.

INVESTIGATING HIGH SCHOOL STUDENTS' PERCEPTIONS OF THEIR SCIENCE EDUCATION-INITIAL VQUEST STUDY. Woody McKenzie, Southwest Va. Governor's Sch., Dublin, Va. and Dr. George Glasson, Div. of Curriculum and Instruction, Va. Poly- technic Inst. & State Univ., Blacksburg, VA . Students from two high schools were interviewed in an open-ended format both singly and in small groups to gain insight into their perceptions of their science education. Seven topics were addressed including important memories/experiences, science literacy, goals, and the relevance of their education to their world outside school. Interviews were transcribed and the data was systematically explored. Ability to self-evaluate was noted as a factor limiting the richness of students' responses in some cases; however, some students were capable of in-depth critical evaluation of their educational experiences. From this data, it was concluded that these particular students view their science education as not related to their outside school world, but as important preparation for their future. They perceive motivated, competent teachers as more important to learning than the specific course material. They have little conscious memory of science courses before freshman year. Most believe their earth science course was not worthwhile. Evidence of reform was noted in students' experiences with an open-ended physics laboratory.

A BLINDING REFORM: A HISTORICAL LOOK AT LABORATORY AND INTERDISCIPLINARY SCIENCE INSTRUCTIONAL METHODS IN LATE 19TH CENTURY AMERICA. Pamela C. Turpin, Dept. of Chem., Roanoke College, Salem, Va. 24153-3794. One hundred years ago, a reform agenda of science educators in the United States was the institution of the laboratory method of science instruction into public schools. Seen as the ideal instructional method for science teaching, this reform initiative seemed to impact adversely on considerations and implementation of other alternatives to reform science teaching in secondary schools during the late-nineteenth century. It seems that this new and different instructional method appeared so bright and right to late-nineteenth century science educators that its aura overpowered, overshadowed, stifled and blinded reformers to other creative suggestions and recommendations that were not at the forefront of the reform movement. The overwhelming support of science educators for the laboratory method acted to inhibit implementation of other alternative means of instruction at the secondary level. One victim of this blinding reform was interdisciplinary methods and courses in secondary school science. I refer to this type of reform as a *blinding reform.*.

PERSPECTIVES ON COLLABORATION IN AN STS LANDFILL RESTORATION PROJECT: SCIENTIST, CLASSROOM TEACHER, AND RESEARCHER. Beatrice Taylor & Mara Sabre, Depts. of Educ. and Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061-0313. & John Kowalski, Roanoke Valley Gov. Sch., Roanoke, Va. 24015. Being a part of a community involves the identification of community problems and negotiating solutions that contribute to the public good. The closing of the Roanoke Regional Landfill and the building of a spur across it to Virginia's Explore Park constitutes such a community problem. Students at the Roanoke Valley Governor's School participated in a study in which they studied the problems of opening, maintaining and closing landfills. They took field trips to the old landfill, the new one under construction, and Explore Park. Guest lecturers also visited the school. Using this information, students generated experiments using seeds that are being considered for use on the closed landfill. This was a year long study in which the classroom teacher, the scientist, and the researcher planned and taught collaboratively. They share insights on how the scientist and researcher become a team with the teacher and students. The students culminated this unit by sharing results with representatives from the landfill authority, the board of supervisors, and Explore Park. (Supported by DuPont and Mobil Education Programs and the Roanoke Solid Waste Mgt. Brd.)

THE BREADTH OF SCIENTIFIC LITERACY - SOME EXPERIENCES AND ACTIVITIES THAT ILLUSTRATE THE NEED FOR SCIENCE CURRICULUM REFORM Thomas G. Teates, Div. of Curriculum and Instruction, Va. Polytechnic Institute and State Univ., Blacksburg, VA 24061; Kenneth S. Lawwill, Chantilly High School, Chantilly, VA 22021. Science teachers, science educators, and scientists do not recognize their groups' lack of "literacy." Expertise in one endeavor among the many in science does not constitute "literacy." Rather than mastery of a superficial body of facts, "literacy" need s to be encouraged as the goal that requires both being capable of understanding and the desire to try to keep on learning about our environment. To restrict one's learning to a field of specialty is to ensure one's loss of literacy. Education, including that in science, needs to prepare and challenge students at all levels to continue their informal, general learning about the environment.

Environmental Science

METHANE EMISSIONS ASSOCIATED WITH *SAGITTARIA GRAMINEA*, MICHX., ARROWHEAD, UNDER ENRICHED ATMOSPHERIC CO_2. Kelly M. Alexander, K.E. Brunke* and G.J. Whiting*, Dept. of Biol., Chem., and Envir. Sci., Christopher Newport Univ., Newport News, VA 23606. Atmospheric CO_2 levels are expected to double by the mid-21st century. Elevated atmospheric CO_2 is known to significantly affect plant physiological functioning, which may impact the soil microbes that metabolically produce methane. To date, best estimates suggest that wetland plants and agricultural rice contribute 40-50% of the total methane emitted to the atmosphere each year. We tested the hypothesis that increasing atmospheric CO_2 would translate into higher methane production and emission by measuring below ground concentrations and above ground emissions associated with *Sagittaria graminea* under ambient and two times ambient CO_2. Results suggest a positive correlation between increased atmospheric CO_2 and increased methane production and emission. These results imply greater contributions of methane to the atmosphere from these sources under future projected atmospheric CO_2 levels.

ISOLATION OF KEROSENE-DEGRADING BACTERIA FROM KEROSENE-CONTAMINATED SOIL. Keitha M. Dattilo and Lynn O. Lewis, Dept. of Biological Sciences, Mary Washington Col., Fredericksburg, VA 22401-5358.

In 1989, a rupture in a kerosene pipeline caused contamination of 17,000 yd^3 of soil near the Rappahannock River above Fredericksburg. The soil has been stored in a large, covered mound since that time. Core samples were collected from several locations within the mound, and all soil samples were mixed for inoculation into a minimal medium with 0.05% yeast extract and kerosene as the carbon sources. On the first attempt to isolate organisms, many motile rods and a possible cyanobacterial species were found. When plated on T-soy agar (TSA) or minimal salts agar (MSA), five characteristic colonies, ranging from filamentous to typical bacterial-type, were evident. A second isolation trial is underway using kerosene as the sole carbon source. Preliminary plating on TSA has revealed four distinct colonies of rod-shaped bacteria. Currently, identification of all isolated microbes is being pursued.

A GREENHOUSE STUDY TO DEVELOP SEEDING RATES ON DISTURBED SOILS: A CASE STUDY OF A LANDFILL AND TWO MINE SITES. Ken Hyer, Mara Sabre, and John Cairns, Jr. Univ. Ctr. for Environmental and Hazardous Materials Studies, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24060. Topsoil from three disturbed sites and a control soil was used to conduct greenhouse germination tests on monocots and dicots that were either native to Virginia, or common in revegetation projects. The data generated were to be used to recalculate seeding rates on revegetation projects, helping to assure adequate coverage. Variability in percent germination of species between the four soil types was large. Also, the species often deviated from the distributors' published germination rates. Results from soil analyses established no relationship between the soil and the observed germination rate. Germination studies using appropriate soil provides a more acceptable method of determining a seeds expected percent germination than either the distributor's reported percent germination or a soil analysis. A short-term greenhouse germination study is an inexpensive yet informative method of developing appropriate in-field seeding rates on restoration projects.

MACROINVERTEBRATES OF ACCIDENTAL WETLANDS ON SURFACE MINED AREAS OF SOUTHWESTERN VIRGINIA--PRELIMINARY RESULTS. David H. Jones, R.B. Atkinson, J. Cairns, Jr., Univ. Ctr for Environmental and Hazardous Materials Studies, VA Tech, Blacksburg, VA 24061. Surface mining in Southwest Virginia prior to the passage of the Surface Mining Control and Reclamation Act of 1977 (SMCRA, P.L. 95-87) has resulted in the formation of accidental wetlands. Macroinvertebrate inventories of nine accidental wetlands were made in July and September 1993 using three replicate sweeps of a D-frame net. Species richness was compared to water chemical parameters, physical parameters, water depth and fluctuation, and macrophyte richness and biomass. Results indicate that drawdown variations, conductivity, and maximum depth influence macroinvertebrate species richness. All orders of aquatic insects were present except Plecoptera. A total of 53 taxa was identified. These findings are being used in the development of design specifications for wetlands to be constructed in surface mine reclamation.

ADSORPTION BEHAVIOR ON IRON OXIDE AND ALUMINA., ESHETE MATTHEWOS & W.H.LEUNG Dept. of Chemistry, Hampton Univ., Hampton, VA 23668. Adsorption phenomena play an important role in the aquatic system. It has been shown that metallic oxides show various degree of adsorption to different trace constituents like Humic acid, metals, and phosphate at different pH. Extended experimental investigation of these metallic oxides to systems containing more than one potential adsorbate can give understanding unattainable from single adsorbate laboratory model. We have been investigating Humic acid adsorption on iron oxide and aluminum oxide in the presence and absence of phenol or Cu at different pH. Results suggest that the presence of phenol does not have significant effect on the adsorption of Humic acid on alumina while the presence of Cu found to facilitate the adsorption of Humic acid. The results of these adsorption experiments carried out at both pH 6 & 8 could be fitted to Langmuir adsorption isotherm.

EFFECTS OF WATERSHED URBANIZATION ON STREAM FISH COMMUNITIES IN PRINCE WILLIAM COUNTY, VIRGINIA. Donald R. Morgan, Dept. of Biol., George Mason Univ., Fairfax Va. 22030, D.P. Kelso, Dept. of Biol., George Mason Univ., Fairfax Va. 22030, & R.C. Jones, Dept. of Biol., George Mason Univ., Fairfax Va. 22030. Prince William County Va. possesses three watersheds, Neabsco, Powells and Quantico each affected by vastly different levels of development. These watersheds offer a unique opportunity to assess the negative impacts on streams, associated with increased urbanization. To evaluate the impact of such urbanization, this study incorporates an index of biological integrity (IBI) as the principal component of the analysis. The IBI integrates twelve metrics of stream fish assemblages for assessing stream quality. Relationships among sites were also explored using principal component analyses (Correlation matrix) on fish abundance and presence-absence data. The results indicate major differences in IBI scores among sampling stations were related to watershed area. Sites in smaller watersheds show great biotic similarity, while substantial differences were observed among sites in larger watersheds. Sites in Large watersheds showed little difference in IBI scores between the suburbanized Neabsco and the forested reference watershed Quantico Creek. Stream passage through riparian parkland resulted in increased IBI scores. Sites located below BMP's had IBI scores that ranged from high to low. High IBI values were associated with favorable habitat conditions found below many wet ponds, while a low score was associated with a degraded stream reach below several dry ponds.

REMOVAL OF WATERBORNE RADON BY REVERSE OSMOSIS AND ACTIVATED CHARCOAL Douglas Mose and George Mushrush, Department of Chemistry, George Mason University, Fairfax, VA 22030. Reverse osmosis is a process by which water is forced under a pressure sufficient to overcome osmotic pressure through a semipermeable membrane, leaving behind imputities. Removal effectivess for dissolved ionic ans suspended impurities is typically above 90%. A two year study in a home with waterborne (well water) radon of @4000 pCi/l shows that the reverse osmosis unit removes almost all of the radon (90%+). In contrast, experiments using activated charcoal in the same home can with some types of charcoal initially show a 90%+ radon reduction, but the removal effectiveness decreases monthly, to @50% after two years. Also, the gamma radiation levels quickly increase outside of the activated charcoal tank, and could pose health problems. Although the cost of a reverse osmosis unit (@$2000) greatly exceeds similar capacity activated charcoal units (@$500), the advantages of lower waterborne radon, more easily replaced components and no gamma-ray health problem suggest that the reverse osmosis method of radon removal has a lower cost/benefit ratio that the activated charcoal method.

THE EFFECTS OF DIMILIN® APPLICATIONS ON FOREST FLOOR LITTER ARTHROPOD POPULATIONS IN PRINCE WILLIAM COUNTY,VA. Larry L. Rockwood and Kim Largen, Dept. of Biol., George Mason Univ., Fairfax, VA. 22030. Diflubenzuron (Dimilin®) has been used to suppress gypsy moth (Lymantria dispar) populations in Prince William County since 1986. A chitin inhibitor, Dimilin, has no effect on plants or vertebrates, but may pose a threat to non-target arthropods. To determine if leaf-litter arthropods are affected, ten plots were established in each of three forested areas (30 total plots) in western Prince William and eastern Fauquier Counties in 1992. Including 1992, the Prince William sites had been sprayed for 3 and 5 consecutive years. The Fauquier (control) site has never been sprayed. Leaf litter was collected on 1 pre-spray and 5 post-spray dates. Arthropods were extracted using Berlese funnels and sorted to order. Mean absolute abundance and mean relative abundance were analyzed with ANOVA after appropriate transformations. Results show no consistent trends. Mean absolute abundance of total arthropods for control versus spray sites was not significantly different except for one post-spray date, in which the 5-year spray site had a significantly larger mean than the control site. Although some taxonomic groups have significantly lower mean absolute abundances on spray plots for occasional pre- and post-spray dates, other taxonomic groups actually have higher means on sprayed plots. At present, spraying with Dimilin shows no detectable effects on litter arthropods.

EFFECTS OF WATERSHED URBANIZATION ON STREAM MACROBENTHOS IN PRINCE WILLIAM COUNTY, VA. Steve Winesett, Donald Morgan, R. Christian Jones, Biology Department, George Mason Univ., Fairfax, Va. 22030. Macroinvertebrate stream communities were used to asses the impacts of stormwater runoff and suburban nonpoint pollution in three watersheds of varying development in Prince William County Va. Samples were collected using kick nets at predetermined sites during May and June. Macroinvertebrate ratings were calculated using the EPA bioassessment protocol II and site relationships were compared using Principal Component analysis (PCA).

Results showed that macroinvertebrate communities were influenced by both watershed area and level of disturbance from suburban activities. PCA using abundance data for insect families occurring at more than 5 stations showed that the most impacted watersheds were of small size and occupied a tight cluster indicating similarity with one another. Larger watersheds exhibited clear differences associated with degree of suburban development with the most degraded sites being located in the highly developed Neabsco creek basin.

Geography

SPATIAL DISTRIBUTION OF HISPANICS IN THE CITY OF HARRISONBURG, VA. Amy B. Cohen and Dominic Pisciotta, Dept. of Geography, James Madison Univ., Harrisonburg, Va. 22807. While extensive studies have been made into the location of minorities in large cities, the distribution of Hispanics in non-metropolitan cities has been largely ignored. This study uses U.S. Bureau of Census population data for Harrisonburg to locate groups of Hispanics within the city. The income statistics from the census were used to identify spatial distribution of Hispanics according to their incomes. Substantial numbers of Hispanics were found in approximately ten of the twenty-four block groups comprising Harrisonburg. The per capita income for these block groups is generally lower than that of the city as a whole, and the income of Hispanics is significantly lower than that of the general population. Because little information is currently available and because of the disparity in income levels between Hispanics and the general population, more extensive studies must be made in non-metropolitan cities.

THREE TECHNIQUES OF IMAGE MERGING: LANDSAT THEMATIC MAPPER AND SPOT PANCHROMATIC DATA. Warren Crowder and William Kane*. Dept. of Geography, James Madison Univ., Harrisonburg, VA 22807. The High Frequency Merge, IHS2RGB, and a composite of the two methods are discussed. Our goal was to maintain the spectral characteristics of the TM data (30 x 30 meter pixel size) while adding the spatial characteristics of the SPOT Panchromatic data (10 x 10 meter pixel size). In our study the High Frequency method provides the best images for interpretation. Our training site, Winchester, Virginia, provided a balanced sample in agriculture, forest and urban settings to make good comparison between each of the methods. Overheads and handouts will be used in the presentation.

TECHNOLOGY TRAINING METHODS: AN UPDATE. Glen C. Gustafson, Dept. of Geography, James Madison Univ., Harrisonburg, Va. 22807. Some of the basic methods of computer technology training for undergraduate college students are discussed and evaluated. The training methods are appropriate for such tasks as: video digitizing hard-copy aerial photography, using tablet digitizers on maps and airphotos, digital photogrammetric plotting, digital mapping from satellite imagery, and digital image enhancement. The most useful training methods in this environment have been found to be: demonstrating the software with an LCD projection panel, providing flow diagrams for the processing steps, and using an example session listing to get the student through his or her first run of the program.

ENVIRONMENTAL ASSESSMENT OF THE RIPARIAN ZONE OF THE SOUTH FORK OF THE SHENANDOAH RIVER, VA. Matthew J. Humke and Dr. Jack Gentile. Dept. of Geography, James Madison Univ., Harrisonburg, VA 22807. Various methods have been used to measure the environmental quality of riparian zones, but the most effective has been the Environmental Impact Assessment Inventory, which selects certain environmental variables (i.e. slope, vegetation type, water quality) and assess each individually. The objective of this study was to develop an inventory unique to the riparian zone of the South Fork of the Shenandoah River located near Elkton, VA. Eleven environmental variables were selected, placed into one of four classes, and assigned a impact value with larger values indicating high environmental impact and lesser values indicating little or no environmental impact. Once completed, the eleven variable values were added, with the final value indicating the environmental "quality" of the area. The developed inventory was then applied to two homogenous branches of the river.

TOWARDS THE PREDICTION OF BURGLARIES IN HARRISONBURG, VIRGINIA
Stephen E. Wright, Dept. of Geol. & Geog., James Madison Univ., Harrisonburg, Va. 22807. The purpose and problem of this paper was to examine whether variables used to predict burglaries in large and medium size cities were adequate predictors of burglaries in small town Harrisonburg, Virginia. Burglary data for 1990 were provided by the Harrisonburg city police. Social-economic data were acquired from the United States 1990 Census of Population and Housing. The population consisted of 225 reported burglaries for the year 1990. In order to measure the concurrent effects of the nine selected independent variables on one dependent variable (Burglaries), the regression analysis technique was chosen. The results indicated that, individually, the most significant predictor of Harrisonburg burglaries were *residence in 1985*, *median year structure was built* and *median family income* (their beta coefficient were 0.0124, 0.0185, and 0.0207 respectively, significant at $p.\leq 0.05$).

Geology

NIOBIUM AND TANTALUM DISTRIBUTION IN COLUMBITE - TANTALITE FROM THE MOREFIELD PEGMATITE, AMELIA, VIRGINIA. J. M. Ayers, Dept. of Geol./Geog., James Madison University, Harrisonburg, Va. 22807. Samples of columbite - tantalite from the Morefield Pegmatite in Amelia county, Virginia were analyzed for Ta, Nb, Mn, Ti, Fe and Sn. One hundred and twenty samples were examined for elemental zoning and compositional variation. The samples were collected from 49 sites along the 65.9 meters of pegmatite exposed at the 60 foot mine level. The analyses shows a relationship of Ta to Mn, Ti and Sn. Niobium also shows a correlation with Fe. Greater chemical variation occurs in the NE section of the pegmatite; the SW section is typified by less variation. The samples tend to be more chemically homogenous. Tin occurs only in the NE section which coincides with a marked increase in Ti. The samples tend to be more Ta rich near the quartz core and more Nb rich away from the core.

POTENTIOMETRIC INVESTIGATIONS ON A TRAVERSE NEAR THE NORTH RIVER. Rachel L. Callahan, Michael L. Maloy, Dept. of Geology and Geography, James Madison University, Harrisonburg, VA 22807. A preliminary study examined selected marginal wetland soils for their relationships between a fluctuating water table, soil type, and geomorphology. Eleven piezometers were installed and monitored on ancient floodplains and terraces of the North River in Rockingham County, Virginia. Examination of soil classifications, gradation analyses slug tests and recorded rainfall data have yielded the following theories: 1) Sandy soils have a greater value of hydraulic conductivity than soils with a high clay content. 2) The water table responds more quickly to moisture in a sandy soil than a clayey soil. 3) Location of mottling and manganese concretions in clayey soils corresponds to the existence of a water table. 4) Cumulative rainfall for the rainy season directly influences values of hydraulic head.

CREATIVE WRITING: A TEACHING AND LEARNING TOOL IN INTRODUCTORY GEOLOGY. Roseann J. Carlson, Debra F. Duffy and Samuel L. McKay, Geophysical Sciences Department, Tidewater Community College, 1700 College Cres. Va. Beach, Va. 23456. Recently TCC faculty members from several disciplines participated in a State funded project known as "Writing to Learn" (WTL). The participants integrated writing as a learning tool into traditionally taught lectures. Writing assignments were evaluated on content alone and took the form of letters to classmates or instructors, poems, journals, summaries and test questions. Creative writings such as these when incorporated into introductory geology lectures have proven useful in helping students discover and articulate difficult geologic concepts. A study conducted in Fall of '93 compared a traditionally taught physical geology lecture class to a lecture class using WTL assignments. Results indicated the WTL lecture class increased in the number of C to B grades over the traditionally taught lecture class. Student evaluations and comments concerning these assignments tend to be positive. This suggests that creative writing can have an impact when used in the introductory lecture class.

HYDRAULIC CONDUCTIVITY AND RETENTION OF A HYDROCARBON FUEL IN SOILS. Roger E. Decker & Dr. W. Cullen Sherwood, Dept. of Geology, James Madison Univ., Harrisonburg, VA 22807. The potential exists for many groundwater sources to become contaminated by liquid hydrocarbon products. The movement of these fluids through unsaturated soil is a complex process and many aspects are poorly understood. An experimental model is presented which analyzes mobility of diesel fuel in two common western Virginia soils. A sandy soil (Millrock Series) and a clay soil (Frederick series) were tested for gravitational saturation and hydraulic conductivity under varying soil moisture conditions. An increase in both saturation rates and hydraulic conductivity of the soils tested was found to be directly related to an increase in moisture content. It is concluded that the increased velocity of fuel movement is related to the lack of adsorption of the hydrocarbon to soil mineral surfaces when water is present. Water, due to its substantially higher dipole moment apparently adheres to the mineral surfaces and acts to facilitate the movement of hydrocarbon liquids through the system.

ANTHROPOGENIC EFFECTS ON STREAM PIRACY IN A SMALL WATERSHED IN SOUTHERN ILLINOIS, L. Scott Eaton, Dept. of Geology and Geography, James Madison University, Harrisonburg, VA 22807. Wolf Creek river basin, located in northeastern Alexander County, Illinois, has undergone a series of rapid geomorphic changes related to anthropogenic activities such as stream channelization, logging, and intense farming practices. Studies of aerial photographs indicate that a tributary of Wolf Creek was lengthened by 25% (350 m) between the years of 1938 and 1956 by a combination of headward erosion and stream piracy. A 2.0 m knickpoint in the tributary channel, migrating upstream at a rate of 7.9 m/yr, marks a geomorphic transition between the upper and lower reaches of the tributary. Above the knickpoint, channel widths (5.3 m) and depths (1.1 m) are small, whereas below the knickpoint, the channel is substantially wider (7.4 m) and deeper (1.8 m). The current incision of the tributary probably reflects headward erosion initiated where the mouth of the incipient channel spilled off the floodplain surface at the confluence of the deeper main channel of Wolf Creek.

LAND CLASSIFICATION OF THE JAMES RIVER FACE REVEALS THE EFFECTS OF PAST CLIMATES ON THE BLUE RIDGE. Quinn T. Kiley and David J. Harbor, Dept. of Geology, Washington and Lee Univ., Lexington, Va. 24450. The surficial deposits and geomorphic processes in the James River Face Wilderness Area (JRFW) in the Jefferson National Forest, Va. form the basis of a successful land classification. The occurrence of coarse colluvium is strongly controlled by outcrops of resistant quartzite and granodiorite within the folded Blue Ridge complex. The morphology of the deposits, especially talus, varies in the degree of soil and vegetation cover, and the degree and process of erosion. Mapped units of open talus occur primarily on south and southwest facing slopes where soil and vegetation are less easily developed. These conditions, plus incision of debris flow fans, indicate the response to change of climate and climate-controlled erosional processes from periglacial to fluvially dominated. (Funded jointly by Washington & Lee University and the USFS.)

THE USE OF HYDRIC SOIL FOR WETLAND IDENTIFICATION. T.S. McDonald, Geol. and Geog. Dept., James Madison Univ., Harrisonburg, VA 22807. The concept of hydric soil is a relatively recent development, but in the past hydromorphic terms were used to describe saturated soils. Hydric soils are seen as saturated for sufficient periods during the growing season to develop anaerobic conditions in the upper horizons. Reducing or anaerobic conditions are necessary for a soil to be considered hydric and usually take about two weeks to develop. Reducing conditions are necessary for soil modifiers or indicators to develop, the most important being mottling and gleization. However, there are some problems using indicators to identify hydric soils. Hydric soil criteria are changing with time and recent additions have increased the necessary saturation time for a soil to be considered hydric. Consequently, even though it is recognized that soils are important aspects of wetland areas they are still largely overlooked in wetland identification. Priority needs at this time are clearly defined criteria for the identification of hydric soils and more data on the time factor required for hydric soils and their indicators to form. When these needs are met better classifications systems can be developed for wetland identification.

SOILS AND SEDIMENTS IN HIGH-LEVEL TERTIARY ALLUVIUM, GHOLSONVILLE, VIRGINIA. G. Richard Whittecar, Nancy K. Pontier, P.B. Corrigan*, S.W. Herman*, P.N. Henderson*, J.V. Gravette*, and P.A. Luchetti*, Dept. of Geol. Sci., Old Dominion Univ., Norfolk, Virginia 23529. The uplands along the divide between the Meherrin and the Roanoke Rivers in Brunswick County, Virginia contain irregular, broad remnants of a low-relief, deeply weathered landscape. Along that divide on VA Rt. 611 4.0 km west of Gholsonville, a 4 meter deep roadcut exposes two sedimentary units and a saprolite. Both sediment bodies are interpreted as alluvium based upon the presence of subrounded quartz pebbles and subangular quartz sand throughout. The entire profile contains abundant amounts of illuviated clay (up to 45%) that obliterate sedimentary structures. The silty saprolite and the lower alluvial unit (2.1 m thick) contain strongly developed reticulate mottling and in-situ plinthite with soil colors ranging from 10R to 5YR. The upper alluvium (1.75 m thick) contains rounded ironstone (reworked plinthite) gravel and soil colors from 5YR to 10YR. Rounding of quartz sand in the 1 and 3 phi size ranges increases somewhat upwards throughout the entire profile. A concentration of gravel (mostly ironstone) in the uppermost 30 cm may be a surficial lag recently mixed by plowing. All observations are consistant with a late Tertiary age (Miocene?) for the lower fluvial deposit that was deeply weathered and subsequently reworked by a younger (Plio-Pleistocene?) stream.

USE OF FRACTALS IN GEOLOGY. John E. Sander, Dept. of Geol. and Geog., James Madison Univ., Harrisonburg, Va. 22807. Mathematician Benoit Mandelbrot developed the fractal concept from the ideas of earlier mathematicians such as Peano and von Koch. Fractals have found application in many disciplines, including recently those of the geological sciences. For purposes of application in geology, a fractal may be defined as an object that scales in such a manner that a part of it, when magnified, is indistinguishable from the whole. Some specific applications in geology include analysis of the shape of river meanders, analysis of the trace of large faults such as the San Andreas, and measurement of the distribution of sinkholes in karst regions. The ruler method and the box-counting method are the techniques most widely used in the geological sciences to determine fractal dimension. Although the fractal dimension of a geologic object can usually be readily determined, a challenge lies in correlating this dimension with a specific geologic cause.

SAND FRACTION STUDIES OF AN UPLAND ALLUVIAL CAPPING IN APPOMATTOX COUNTY, VA. Matthew Scott & W. C. Sherwood, Dept. of Geol. and Geog., James Madison Univ., Harrisonburg, Va. 22807. Recent soils mapping in Appomattox and nearby counties has identified an extensive upland alluvial capping ranging from 0 to over 2 meters in thickness. In an attempt to determine the origin of this deposit, a total of 15 samples were taken from the alluvium and underlying residuum at three test sites. Wet sieving of the samples was carried out using a phi scale of #5, #10, #18, #35, #60, #120, and #230 sieves. All samples were found to contain high percentages of fine sand and -230 material. However, samples from the A soil horizon of the capping contained high percentages of coarse material in the phi -2 and -1 range. This coarse fraction appears to armor the capping and retard erosion. From the lab data sample mean, sorting, and skewness values were calculated. These were compared to modern beach and fluvial sands. This comparison yielded inconclusive results. Additional research involving grain rounding and heavy minerals is recommended.

ORANGEBURG SOILS AND PLIOCENE SEA LEVELS, DINWIDDIE COUNTY, VIRGINIA. G. Richard Whittecar, D.L. Rasmussen*, M.D. Zamkotowicz*, S.Y. Boyd*, A.T. Hoffmeister*, and B.C. Comstock*, Dept. of Geol. Sci., Old Dominion Univ., Norfolk, Vir. 23529. In Dinwiddie, Hanover, and Brunswick counties in southeastern Virginia, the Orangeburg soil series occurs on high level Coastal Plain terraces between the Chippenham and Broad Rock scarps, a belt mapped as the near-shore equivalent of the Pliocene Yorktown formation. The Orangeburg soil, a Typic Paleudult, contains a thick argillic subsoil that commonly has two color zones. At one 180 cm deep excavation examined in detail in Dinwiddie County, the upper "orange" (7.5YR) argillic zone contains numerous rounded pebble-size rip-up clasts of the lower "red" (2.5YR) argillic horizon, thus indicating the color break marks a disconformity that truncates a significant weathering profile. The sand fraction throughout the profile is a very uniform coarse-to-medium sand (0.25-0.28 phi, average) comprised of quartz with as much as 14% heavy minerals. Grain roundness in both the 1 and 3 phi samples decreases upwards through the profile with no discernable changes at the erosional boundary. These data suggest that a significant period of subaerial weathering occurred at this site prior to a transgression that reworked the upper portion of the soil profile. Geomorphic and pedologic features suggest that this relatively brief(?) event occurred during the Late Pliocene.

SEDIMENTS OF GUNSTON COVE, POTOMAC RIVER, VIRGINIA. Anita A. Williams, Dept. of Geography and Earth Systems Science, George Mason Univ., Fairfax, VA 22030. Gunston Cove is a tidal embayment on the Virginia side of the Potomac River. It is approximately 5 km long, 1-2 km wide, and up to 2 m deep; mean tidal range is 60 cm. The cove is underlain by Cretaceous strata of the Coastal Plain. Its two upstream drainage basins, Accotink and Pohick Creeks, have their headwaters in the Piedmont. Sediment cores of 25 to 50 cm in length have been taken in the cove. After initial description in the field, cores were sampled and analyzed for grain size, organic content, and general mineralogy; some clay minerals identified by X-Ray diffraction. Preliminary results indicate that surface sediments predominantly are mud except along the cove's southern shoreline where they are sand and at its northern shore where they are clay. Generally, the sediments coarsen with depth. These initial findings suggest that Gunston Cove contains an ancient microtidal meander zone facies that has been overlain by the present-day estuary funnel facies. This change implies a relative rise in sea level.