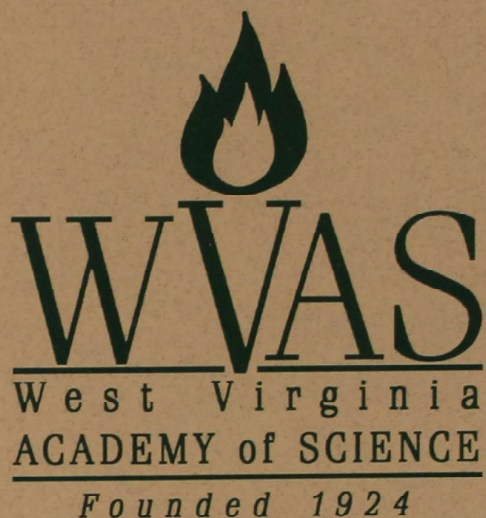


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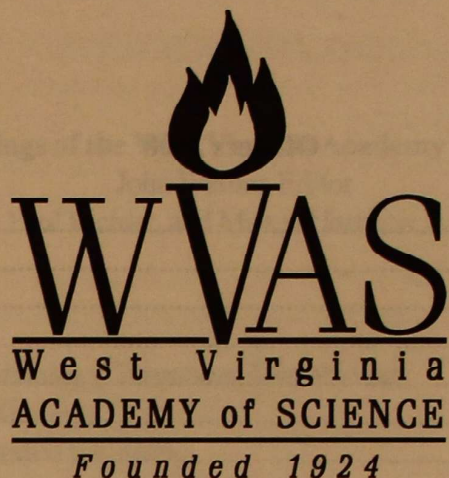


**Proceedings of  
West Virginia  
Academy of Science**

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**Abstracts of the  
Eighty-Third  
Annual Session**





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**EARTH SCIENCES**

- E. RAY GARTON and DAVE PHILLIPS. The first fossil record of *Dunkleosteus (Placodermi)*, an extinct armored fish from the Foreknobs Formation (Devonian) of West Virginia. .... 11
- EGEMEN OGRETIM, GRANT S. BROMHAL, and DONALD D. GRAY. Effects of water table tilt on the near-surface Signature of CO<sub>2</sub> from a geologic sequestration site. .... 12

**POSTER PRESENTATIONS****BOTANY/ZOOLOGY/MICROBIOLOGY**

- BARBARA SHOCK and DONNA FORD-WERNTZ. Analysis of the distribution of the Vascular Plants of West Virginia. .... 12
- TRAVIS FISHER and LISA CASTLE. Do Tree-of-Heaven plants retain their leaves longer than trees of neighboring species do? ..... 12
- FAITH HARPER, J. MCDUGAL, and LISA CASTLE. High-school-friendly genetic techniques to study the invasive Tree-of-Heaven. .... 13
- FREDERICK GARLAND and ROGER SEEBER. Analysis of hyperforin and hypericin and plant regeneration of St. John's wort. 13
- STEPHANIE ZORIO, JOHN PIERSON, and DONALD TRISEL. Mycorrhizae and/or *Rhizobium*? A comparison of the effects on photosynthesis and growth of *Glycine max*. .... 13
- ASHLEIGH LANDIS, EMILY DIMITROFF, CHRISTOPHER SEDLACEK, and DONALD TRISEL. The effects of foliar nutrient spray on photosynthesis and overall growth in crop plants. .... 14
- RODNEY DEVER and DONNA FORD-WERNTZ. The nodding onion: one species or three? ..... 14
- JOHN C. LANDOLT, STEVEN L. STEPHENSON, ADAM W. ROLLINS, and CARLOS ROJAS. Dictyostelid cellular slime molds from northern Thailand. .... 14
- JOHN C. LANDOLT, STEVEN L. STEPHENSON, and ADAM W. ROLLINS. Dictyostelid cellular slime molds of Arkansas. .... 15
- ADAM HAMRICK and JESS CUNNICK. Defining the role of the actin filament-associated protein AFAP-110 in glioblastoma invasiveness. .... 15
- JENNIFER L. ZIMMERMAN and STUART WELSH. PIT tag retention in small American eels, *Anguilla rostrata*. .... 16

**ECOLOGY/ENVIRONMENTAL SCIENCE**

MICHAEL CUNNINGHAM, ANDREW THOMAS, and RICO GAZAL. Understanding the impacts of *Ailanthus* in an Appalachian forest. .... 16

ERIC H. DIEFENBACHER and THOMAS K. PAULEY. Iris-pattern identification (IPID): A technique for identifying amphibians and reptiles during field studies. .... 17

ERIC H. DIEFENBACHER and THOMAS K. PAULEY. An update on the status and life history of the eastern wormsnake (*Carphophis a. amoenus*) in West Virginia. .... 17

**BIOCHEMISTRY/HEALTH SCIENCES**

DAVID WRAY, BONNIE POLLOCK, MARK FLOOD, JEAN CHAPPELL, BOWIE KAHLE, GARY WRIGHT, TODD GREEN, PAULETTE WEHNER, MARK STUDNEY, and ELIZABETH MURRAY. Determining the effect of gene mutations on plasma homocysteine levels. .... 17

ZACH BREWER and SARAH DODSON. Examination of *in vitro* homocysteine exposure to stromal cells. .... 18

DOBIN CHOI. Signal transduction pathway involved in the regulation of glucose-6-phosphate dehydrogenase. .... 18

ALBERT PILKINGTON IV and TONY E. MORRIS. Lung and bronchus cancer mortality and incidence rates of West Virginia compared to the United States and similarly population-sized states. .... 19

CHRISTINA KNOPP and MARK A. AFFELTRANGER. Running speed decreases after immunization in the rat: The role of antibodies. .... 19

**CHEMISTRY/PHYSICS**

SARAH RUTHERFORD and DAVID O'DELL. Extraction and separation of metolachlor and dimethenamid from soil using high-performance liquid chromatography. .... 19

JEREMY J. HAY and DARCEY G. WAYMENT. Development of a microfluidic device for the analysis of perchlorates. .... 20

MATTHEW TALLMAN and DARCEY G. WAYMENT. Development of a microfluidic device for the analysis of nitrates and nitrites. .... 20

JACOB R. LILLY and KEVIN L. EVANS. Synthesis of alkenyl iodides and alkyl diiodides via a surface-mediated reaction using  $PI_3/SiO_2$ . .... 20

- JASON D. POLING and KEVIN L. EVANS. Synthesis of alkyl dibromides via a surface-mediated reaction using silica gel and phosphorus tribromide. .... 21

### **MATHEMATICS/COMPUTER SCIENCE/ENGINEERING**

- WILLIAM KLINGELSMITH, WEIDONG LIAO, and ZHIJUN WANG. Using feature- point extraction and Hopfield networks for the detection and correction of document skew. .... 21

- RAY NAEGLE and XIAOJUN QI. Geometric and removal attack-resistant watermarking in the wavelet domain. .... 21

### **SOCIAL SCIENCES/SCIENCE EDUCATION**

- MINJEE KWON and TONY E. MORRIS. Correlation between gender and results in marathon, half-marathon, 10-Km, and 5-Km races. .... 22

- ADAM COSNER. Effects of caffeine, electrolytes, and water ingestion on the performance of individuals completing a 30-minute cycling test. .... 22

- CHARLSIE ALLEN and TONY E. MORRIS. Correlation between age and time of runners in a marathon to the places the runners finished. .... 22

- ELIZABETH REIDY, KATHLEEN THOMPSON, and JOHN H. HULL. Flower Power: Students' perceptions of characteristics of flowers. .... 23

- MARK A. AFFELTRANGER, TYLER KOWCHECK, and BRENDAN A. CYPHER. Behavior changes three weeks, but not two days, after ovalbumin-immunization in the rat. .... 23

- ANGELA MCKEEN. Seeing science everywhere: Using the arts to teach science in high- poverty areas of Appalachia. .... 23

- SARAH DODSON, MARK FLOOD, JAMES WEEKLEY, STEVEN ROOF, NANCY MCCLURE, LESLIE LOVETT, ROSEMARIE ROMESBURG, and MICHAEL WAIDE. Where is the crime in using a multidisciplinary approach to a forensic science problem? .... 24

### **EARTH SCIENCES**

- ROBERT D. HANNI and JASON S. BEST. Analysis of the large-scale distribution of quasars. .... 24



## Oral Presentations

### Botany/Zoology/Microbiology

ERIC H. DIEFENBACHER and THOMAS K. PAULEY, Department of Biological Sciences, Marshall University, Huntington, WV 25755. Comparison of the digit morphology of an arboreal salamander with potential competitors.

Organisms such as insects, geckos, and frogs exhibit adhesive properties on their digits. However, virtually no studies have been done on possible adhesive structures of North American arboreal salamanders, or how these structures may influence competitive interactions between species for particular habitats. The Cumberland Plateau Salamander, *Plethodon kentucki*, has recently been found to be a major competitor in behavioral experiments involving the green salamander, *Aneides aeneus*. This evidence combined with field data suggests there may be potential for *P. kentucki* to compete for rock crevices with *A. aeneus* where their respective ranges overlap in West Virginia. If *P. kentucki* is competing with *A. aeneus* for arboreal habitats, then *P. kentucki* must have the digit morphology to exploit arboreal habitats. We compared the cellular morphology of digit structures and morphometric data among *A. aeneus*, *P. kentucki*, and the slimy salamander, *Plethodon glutinosus*, another sympatric species. Morphometric data from all three species were analyzed on anatomical features derived as crucial to utilizing arboreal habitats. Analysis shows *P. kentucki* is more similar to *A. aeneus* in front limb length and hind limb length. However, *P. kentucki* was found to have a significantly higher trunk and tail height than *A. aeneus*. Histological preparations show varying amounts in the curvature of the terminal phalanx and amount of dermal cell layers, with *A. aeneus* having the greatest curvature and dermal cell layers followed by *P. kentucki*, then *P. glutinosus*, which had the flattest terminal phalanx and fewest cell layers.

DAVID B. WING, Dept. of Biology, Shepherd University, Shepherdstown, WV 25443. *In vitro* callus induction and shoot regeneration of shale barren rockcress, *Arabis serotina*.

Tissue culture conditions were determined for the *in vitro* propagation of the rare and endangered shale barren rockcress. Leaf explants were induced by six hormone regimens to form calluses. Each callus line was subsequently treated with six hormone regimens to induce shoots. Calluses and shoots will provide a readily available source of cells and tissues for nutrient studies and a genome preservation project. Should populations reach critically low levels and seeds become unavailable, the shoot regeneration process could also serve as a measure of last resort to repropagate the species. Leaf explants about 4 mm<sup>2</sup> were cultured on auxin/cytokinin (2,4-D/kinetin) regimens to induce and propagate calluses. Of the concentrations tested, 1 mg/L 2,4-D with 0.2 mg/L kinetin yielded the most mass after 10 weeks in culture. Callus from each hormone regimen was transferred to six different shoot-induction hormone regimens. The best hormone regimen sequence to stimulate callus growth suitable for shoot induction was callus induction on 0.5 mg/L 2,4-D and 0.05 mg/L kinetin followed by shoot induction on 5 mg/L 2iP and 0.1 mg/L IAA. The shoots rooted in hormone-free media and the plantlets survived and matured upon transfer to soil. This work was supported by grants from the WV Nongame Wildlife and Natural Heritage Program and WV-EPSCoR.

CLIFFORD STARLIPER, USGS Fish Health Laboratory, Kearneysville, WV 25430. Improved bacteriological medium for primary culture and growth of *Flavobacterium psychrophilum*.

Bacterial coldwater disease, caused by the Gram-negative bacterium *Flavobacterium psychrophilum*, continues to warrant much consideration while rearing and managing important sport and restoration fish species, particularly among salmonids, e.g. trout and salmon species. Fish health specialists continue to be plagued with difficulty in primary culture of *F. psychrophilum*, particularly from low-level infected,

cricket frog, *Acris crepitans blanchardi*, relative to environmental conditions in southern Ohio and western West Virginia.

Amphibian populations have been declining worldwide since 1970. Specifically, *Acris crepitans* has displayed a notable trend towards extinction in the United States. The subspecies, Blanchard's cricket frog (*A. c. blanchardi*), is being monitored by the Ohio Division of Natural Resources to determine a ranking in Ohio and is listed as possibly extirpated in West Virginia. One study on its distribution in the western part of Ohio noted a large-scale decline. *Acris c. blanchardi* is also suffering declines in Wisconsin, Michigan, Illinois, and Indiana. Acidic conditions and habitat degradation are thought to contribute to these major declines. We surveyed 50 sites in both Ohio and West Virginia beginning in May 2007 and ending in September 2007. Dissolved oxygen, water, air and soil temperatures, and pH were recorded at each site. Preliminary results suggest dissolved oxygen and pH may differ significantly between sites with and without frogs. The association with the creeping primrose was tested with a 2x2 contingency and was found not to be significant with a P value of 0.19. However, more research is needed to rule out this association. Frogs began calling prior to May 15<sup>th</sup>, declined through July, and stopped calling on August 1<sup>st</sup>. Vegetative analysis determining percent cover is being conducted at five presence and six absence sites in Ohio and three absence sites in West Virginia. Analyses of pH will be used to test the effect of acidity on populations, and percentages of plant cover will be used to determine vegetation differences between presence and absence sites.

AMY SCHNEIDER and THOMAS K. PAULEY, Dept. of Biological Sciences, Marshall University, Huntington, WV 25755 and MeadWestvaco Corporation. A continued study of the use of man-made ponds for amphibian breeding in fragmented forested areas.

Amphibian populations are declining worldwide due to factors such as habitat degradation, fragmentation, and destruction. We conducted a

study to explore the use of man-made ponds in a forested habitat by breeding amphibians, specifically *Rana sylvatica* and *Ambystoma maculatum*. The objective was to examine the movement of these animals after leaving the ponds and the survival and movement of juveniles. Nine ponds were constructed in December 2002 in the MeadWestvaco Wildlife Ecosystem Research Forest (MWERF) in Randolph County, West Virginia. Three fragmentation treatments (clear-cut to one hectare surrounding a pond, clear-cut to one hectare surrounding a pond with forested corridor, and no treatment) were cut in all compartments in August 2006. Drift fences with funnel traps surrounded each pond to monitor amphibian movements. All amphibians captured were batch-marked with pond-specific tags using visible implant elastomers (VIE). No amphibians bred in the ponds in 2003, therefore the ponds were stocked with *R. sylvatica* and *A. maculatum* egg masses from nearby permanent pools. Thirty *R. sylvatica* juveniles and three *A. maculatum* juveniles emigrated from the ponds in 2005. Only five *R. sylvatica* juveniles and no *A. maculatum* juveniles had emigrated from the ponds in 2006. Five *R. sylvatica* adults were fitted with radio transmitters and tracked for ~35 days to determine movements after leaving the breeding ponds. *R. clamitans melanota*, *Notophthalmus v. viridescens*, *R. catesbeiana*, and adult *R. sylvatica* populated the ponds after the breeding season. Monitoring will be continued in successive seasons and post-cut data will be compared.

THOMAS K. PAULEY, Department of Biological Sciences, Marshall University, Huntington, WV 25755. Life history of the Cheat Mountain Salamander, *Plethodon nettingi*.

The life history of the Cheat Mountain salamander (*Plethodon nettingi*) was studied over a 30-year period throughout its total range. Males display secondary sexual characteristics from mid to late August through mid-June. Females are gravid from September through early June. Field and laboratory data indicate that there may be an

abbreviated breeding period in the fall, but most mating probably takes place in April and May. Oviposition occurs from late April to early June and eggs hatch in September. Eggs in 11 nests found in the field and 30 nests reported in the literature had an average of 9.1 eggs (range 4 - 17). Approximately 50 percent of females observed were on the surface during the nesting period (July and August), indicating that reproduction for females is biennial. Hatchlings emerge in September and range in total length from 1.5 to 1.8 mm. Cheat Mountain salamanders are most active on the forest surface between May and October. Based on these data, I have found that the life history patterns of Cheat Mountain Salamanders are similar to other small plethodontid salamanders in the eastern United States.

JAMES S. RENTCH and JAMES T. ANDERSON, Division of Forestry and Natural Resources, West Virginia University, Morgantown, WV 26506-6125. Vegetation along hydrologic, edaphic, and geochemical gradients in Abe Run wetland, Canaan Valley, West Virginia.

Wetland plant community composition and pattern are regulated by a host of environmental gradients and biotic factors. We used multivariate analyses to classify plant communities and determine the relation of hydrologic, edaphic, and geochemical gradients on composition and structure of 18 vegetation, hydrology, and soil sampling points in Abe Run, a botanically unique poor fen in northeastern West Virginia. Vegetative composition and structure, dominant soil texture, and hydrology lacked the concentric zonation of northern peatlands; instead, all were patchy and varied considerably over short distances. Graminoid-forb meadows with primarily silt-loam mineral horizons, greater depth to groundwater, and fewer days of inundation characterized the lower reaches of the wetland. These plots were more acidic, with absent or shallow O horizons and lower concentrations of soil base cations. In the upper reaches of the wetland, mixed herb-shrub-tree-dominated communities were structurally and compositionally more complex. Here,

organic horizons were much more prominent, concentrations of base cations and peat depth were greater, and the average depth to the water table was 10 cm less than for wells in the lower reaches of the wetland. Much of the variability among plots in the upper and lower reaches of the wetland is consistent with beaver inundation of a large portion of the wetland during the 1980s. Because fens are connected to groundwater, these habitats are particularly vulnerable to disturbances, particularly those that alter existing land use and land cover. Minimization of disturbances in the surrounding watershed, controls on an excessive deer population, removal of exotic, non-native species, and control on foot traffic are all integral to maintaining the integrity of this high-value wetland.

AARON R. YEAGER, DANA A. CINCOTTA, DAVID W. THORNE, Div. of Natural Resources, Elkins, WV 26241, and STUART A. WELSH, U.S. Geological Survey, WVU Fish and Wildlife Cooperative Wildlife Unit, Morgantown, WV 26506. Rebounding fish community of the Upper Gauley River system in West Virginia.

The upstream distributional extent of three native West Virginia fishes is indicative of improving water quality in the upper Gauley River. The impact of acid deposition on the Gauley River and its major tributaries on the Central Appalachian Plateau is well documented. This acid loading remained unmitigated until the WV Division of Natural Resources and others introduced limestone sand into the Middle and South Forks of the Gauley River in 1998. The Kanawha minnow (*Phenacobius teretulus*), mottled sculpin (*Cottus bairdi*), and the least brook lamprey (*Lampetra aepyptera*) were found in a recent survey (May 2007) by the WVDNR on the upper Gauley River. In spite of several historical sampling efforts in this area, no previous data show the subject species inhabiting these waters prior to 2007. Their presence at this location represents upstream distribution records for the Gauley River. A comparison of pre-limestone sand treatment data and this recent survey will be made. This information suggests improving populations of all fish species found in the upper Gauley

River, including uncommon species such as the candy darter (*Etheostoma osburni*) and the Appalachia darter (*Percina gymnocephala*).

STUART A. WELSH, U.S. Geological Survey, West Virginia Cooperative Fish and Wildlife Research Unit, Morgantown, WV 26506, and ROBERT M. WOOD, Department of Biology, Saint Louis University, St. Louis, MO 63103. The diamond darter (*Crystallaria cincotta*), a new species (Teleostei: Percidae) from the Elk River of the Ohio River drainage, West Virginia.

A new species of percid, *Crystallaria cincotta* (diamond darter), was described recently from the Cumberland, Elk, Green, and Muskingum river drainages of the Ohio River basin, USA. It differs from populations of *Crystallaria asprella* (crystal darter) of the Gulf Coast, lower Mississippi River, middle Mississippi River, upper Mississippi River, and Wabash River drainages by having a reduced number of cheek scale rows restricted to the post-orbital region, a falcate margin on the pelvic fins, a preorbital blotch distinctly separate from the anterior orbital rim, and a wide mouth gape. The diamond darter population of the Elk River is also divergent genetically from crystal darters of the Gulf Coast, lower Mississippi River, and upper Mississippi River drainages. Since 1980, sampling efforts have produced a total of 12 diamond darters from the lower 36-km section of the Elk River, West Virginia. The relatively small number of diamond darters collected from the lower Elk River likely indicates species rarity, but may also reflect sampling gear avoidance. Based on museum specimens and sampling efforts, the distribution of the diamond darter has decreased dramatically since the late 1800s with population extirpations in Kentucky, Ohio, and Tennessee.

DAN A. CINCOTTA, DAVID W. THORNE, and AARON R. YEAGER, Div. of Natural Resources, Elkins, WV 26241, and STUART A. WELSH, U.S. Geological Survey, WVU Fish and Wildlife Cooperative Research Unit, Morgantown, WV 26506. The status and distribution of *Notropis*

*ariommus* and *Notropis telescopus* in West Virginia.

Two distinctive eastern North American cyprinids, *Notropis ariommus* and *Notropis telescopus*, were described by E. D. Cope in 1866 and 1867, respectively. The former is found in large creeks and small rivers primarily in the Ohio River drainage, while the latter largely inhabits medium-sized upland streams on both sides of the Mississippi River. For no apparent reason, *N. telescopus* was relegated to a subspecies of *ariommus* in 1939, and this conspecific designation remained uncontested for thirty years. In 1969 these forms were elevated to species level and their confusing history was examined. In West Virginia, *N. ariommus* is indigenous to the lower Kanawha and Monongahela river drainages, but only three records have ever been confirmed. *N. telescopus* was introduced into the upper Kanawha River of West Virginia in the early 1970s, and the current literature greatly underestimates its presence in state waters. The history, past records, and the current distribution of both species in West Virginia are discussed.

ZAC LOUGHMAN, Department of Natural Sciences and Mathematics, West Liberty State College, West Liberty, WV 26704, and STUART WELSH, USGS West Virginia Cooperative Fish and Wildlife Research Unit, Morgantown, WV 26506. Distribution and conservation of West Virginia imperiled crayfish species.

West Virginia's crayfishes have received moderate attention since the publication of Jezerinac's et al. (1995) treatment of the state's fauna in 1995. Recently, an increased effort to understand the current distribution, natural history, and conservation standing of West Virginia's crayfishes has led to several new distribution records and insights into the natural history of the state's fauna. Currently, 22 described species occur in the state, of which four species are given S1 status, and three are introduced species. One species, *Orconectes (F.) limosus*, has become extirpated within West Virginia in the past decade. Imperiled species include *Cambarus (P.) veteranus*, *Cambarus (H.) elkensis*, *Cambarus (H.) longulus*,

and *Fallicambarus (C.) fodiens*. Three species, *Orconectes (G.) virilis*, *Orconectes (P.) rusticus*, and *Procambarus (O.) acutus* have introduced populations within the state. Native *P. (O.) acutus* also occur in West Virginia, in bottomland forest along the Ohio River Floodplain. Several undescribed taxa also have been identified, and currently are being investigated. In 2007, a statewide survey was initiated in order to document current distribution and conservation standings of West Virginia crayfishes. Methods and results of this study to date are described, as well as future research endeavors within West Virginia's borders.

BRUCE EDINGER and JEDEDIAH ROBSON, Dept. of Natural Sciences and Mathematics, West Liberty State College, West Liberty, WV 26074, and GREGORY J. POND and MARGARET E. PASSMORE, U.S. Environmental Protection Agency, 1060 Chapline Street Wheeling, WV 26003. Preliminary analysis of leaf decomposition and benthic invertebrate colonization in summer-deployed leaf packs of Japanese knotweed (*Fallopia japonica*), American sycamore (*Platanus occidentalis*), tulip poplar (*Liriodendron tulipifera*), and sugar maple (*Acer saccharum*).

Exotic Japanese knotweed invades riparian zones in North America. Dense stands of knotweed suppress native vegetation, but only recently have studies begun on the effects of knotweed leaf litter on benthic invertebrate communities. To evaluate decomposition and invertebrate colonization of knotweed and three common native species, 96 six-gram leaf packs were placed in a second order stream riffle from July to September 2007. After four regular intervals leaf packs were retrieved, invertebrates identified, and leaves dried. Leaf breakdown rate ( $k$ , negative slope of the linear regression of the  $\log_e$  of percent remaining leaf mass versus days of decay) was second highest for knotweed at 0.0379 per day (0.0134 for sycamore, 0.0268 for sugar maple and 0.0717 for tulip poplar). Average total invertebrate abundance/pack after 15 days varied from 42.3

(tulip poplar) to 55.7 (knotweed), but species comparisons were not statistically significant (paired  $t$ -tests). Thirty-day total abundance averaged 83 individuals/pack overall; species comparisons lacked significance. Average taxa richness/pack ranged from 17 to 20 after 30 days, but knotweed richness didn't differ significantly from the other species. After 15 days *Gammarus* (the dominant shredder) was twice as abundant in knotweed and sycamore than in maple and poplar leaf packs, but these differences moderated after 30 days. Knotweed had the highest or nearly the highest abundances of baetids, ephemereids, leuctrids, hydropterygids, elmids and athericids, but not of empidids (these seven families and chironomids predominated). We acknowledge the financial support of WVEPSCoR (Instrumentation Award) and a WV NASA Space Grant Research Enhancement Award.

### Chemistry/Physics

C. SHANE POLETTI and MARTINA E. BACHLECHNER, Computer Science, Math, and Physics Department, Fairmont State University, Fairmont, WV 26554. Determining the onset of amorphization of crystalline silicon due to hypervelocity impact.

The objective of this study was to determine where the boundary between amorphous and crystalline silicon occurred in a specific part of a silicon solar cell due to a hypervelocity impact. This was done using data acquired from atomistic simulations of a hypervelocity impactor striking a silicon/silicon nitride interface at different velocities. We wrote several computer programs that analyzed the data produced to determine where the boundary between amorphous and crystalline silicon was. The silicon section of the solar cell was separated into sixty layers and for each layer the average  $z$ -displacement was determined. In visualizations of the impact using Paraview, the atoms were color-coded with respect to their displacements. Early results indicate that the boundary between amorphous and crystalline silicon occurs between

layers twenty and twenty-two for an impactor traveling at 5 km/s. This corresponds to a depth of approximately 32 Å into the silicon. Further studies will be conducted using impactors of different mass and having different velocities to determine how these variables affect the level of amorphization. It is thought that as the size and velocity of the impactor increase, the depth of the amorphous region will also increase. We also found that the  $z$ -displacement was noticeably larger for the layers that did not have a silicon atom bonded beneath them compared to the ones that did. Further research will be done to determine if this affects the level of amorphization. Funding for this research project was provided by a WV/NASA Space Grant Scholarship for the Spring of 2008.

#### Mathematics/Computer Science/Engineering

JEREMIAH ALEXANDER, OSMAN GUZIDE, and QING WANG, Department of Computer Science, Mathematics, and Engineering, Shepherdstown, WV 25443. Fibonacci numbers.

The objective of this study is to investigate properties of Fibonacci numbers and their possible application to encryption and decryption in the field of cryptography. Based on computer simulations, we obtained the main result of this work:

$$F_{kn} \text{ MOD } F_n = 0, \text{ for any integers } n \text{ and } k.$$

Simulation results are given for the comparison of running times by using different algorithms. This experimental result has provided conjecture for a theory on Fibonacci numbers and might be used to investigate a possible alternative for the RSA Scheme. A proof for the above conjecture is currently under investigation. The presenting author has been supported by the *NASA Space Grant Fellowship*.

GAVIN HALL, Depts. of Physics, Mathematics, and Mechanical and Aerospace Engineering, ALAN TALBOT, COREY SNIDER, JESSE PHILLIPS, ANDREW HARNER, EILEEN REIFF, EMILY CALANDRELLI, GREGORY

DUCKETT, JOHN H. KUHLMAN, Dept. of Mechanical and Aerospace Engineering, and DONALD D. GRAY, Dept. of Civil and Environmental Engineering, West Virginia University, Morgantown, WV 26506. An investigation in viscous and capillary fingering in microgravity.

The objective of this experiment is to observe flow patterns exhibited by two immiscible fluids as one displaces the other in a two dimensional cavity. This experiment consists of two individual tests for viscous and capillary fingering.

Assuming high injection rate and standard gravity, as the viscosity ratio of the two fluids approaches zero, the flow can be modeled by diffusion-limited aggregation (DLA). The moving interface is unstable to small disturbances that grow into fingers that evolve in patterns dependent on the invading fluid velocity. As the viscosity ratio approaches infinity, the interface remains flat as it moves. This displacement is modeled by anti-DLA. In this test two viscosity ratios will be used, 0.00001 and 200, which are expected to produce flows modeled by DLA and anti-DLA, respectively. Gravitational forces are relatively unimportant in this test, so the results should not change in microgravity.

Capillary fingering occurs for small injection rates. The density difference between fluids produces a slow injection of the more dense fluid in standard gravity. The fluid displacement will be examined in a vacant Hele-Shaw cell and a cell containing a porous medium. Displacement through a medium in standard gravity exhibits a wide, unstable front with trapped clusters of defending fluid ranging from the pore size of the medium to the length of the system. In microgravity there should be no flow.

This project was entirely funded by the WVU MAE department and the NASA WV Space Grant Consortium.

EMILY CALANDRELLI, MEHRAN MOHEBBI, KYLE PHILLIPS, JOHN M. KUHLMAN, Dept. of Mechanical and Aerospace Engineering, and DONALD D. GRAY, Dept. of Civil and Environmental Engineering, West Virginia

University, Morgantown, WV 26506. Investigation of circular hydraulic jump behavior in microgravity.

The objective of the experiment conducted by the 2006-2007 West Virginia University (WVU) Microgravity Research Team (MRT) was to investigate circular hydraulic jump (CHJ) phenomena in a reduced gravity environment, created by a modified C9 NASA research aircraft known as the "Weightless Wonder." The CHJ was produced by impinging a jet of water onto a hydrophilic glass plate, marked with concentric circles identifying different radii. The experiment was equipped with an accelerometer, flowmeter, and video camera to properly monitor the phenomenon throughout various flow rates, in both hyper- and reduced gravity environments.

Upon successful completion of the experiment, data indicated that the radius of the CHJ increased directly with flow rate and varied inversely with gravity, as expected. However, in contrast to previous predictions and equations, the data also suggested that the CHJ formation became increasingly dependent upon surface tension and viscous effects as gravity decreased. Based on the results, the WVU MRT concluded that past theories must be incomplete because they do not account for surface tension effects and viscous forces. This conclusion was supported by the fact that the radius of the CHJ approached a steady state value in microgravity, deviating from previous theories and experiments.

The funding for this research project was provided by the WV NASA Space Grant Consortium Office directed by Dr. Majid Jaraiedi, and the WVU Mechanical and Engineering Department. The WVU MRT would also like to thank the WV High Tech Consortium for their generous financial support.

WAYNE DANIEL, School of Arts and Sciences, Salem International University, WV 26426.  
Teaching math and statistics concepts using a generic mathematical package.

A generic mathematical package (MathPak) was developed by the author over the last four years to assist in teaching mathematical and statistical concepts.

MathPak is written entirely in C++, a modern object-oriented programming language. The objective of the MathPak project is two-fold: 1) to develop an array of useful mathematical objects that can be readily applied to problem-solving activities in the upper-level mathematics and statistics courses, and 2) to provide a programming framework that facilitates the development of new mathematical algorithms or the testing of existing algorithms published in the mathematical literature.

The primary component of MathPak is a generic matrix package that seamlessly handles matrices over any field provided the field is either a built-in data type in C++ or a user-supplied data type (that is, a class). At present MathPak supports matrices over the real field, the complex field, the rational field, and the field of integers modulo  $p$  where  $p$  is a prime number. In addition, MathPak provides facilities for handling Boolean matrices as well as matrices over more general mathematical structures, such as commutative rings. Examples taken from modern algebra, statistics, and discrete mathematics are used to illustrate the utility of MathPak and to exhibit new methods of teaching these classic subjects.

DEEPAK MEHRA, Division of Mathematical and Physical Sciences, Potomac State College, Keyser, WV 26726, DONALD D. GRAY, Department of Civil and Environmental Engineering, and JOHN M. KUHLMAN, Department of Mechanical and Aerospace Engineering, West Virginia University, Morgantown, West Virginia 26506. Computational fluid dynamics study of liquid jet impingement with heat transfer and varying gravity.

Liquid jet cooling is used in several industrial applications where cooling is necessary. These industries may vary from the electronic industry to the glass and metal industries.

CFD-ACE+ is a commercially available computational fluid dynamics (CFD) code primarily utilized to perform multiphysics simulations using multiple modules that can be run in conjunction to simulate complex physical processes. The isothermal, free surface module was previously validated using the results of Labus (1977) by

Mehra et al. (2005). In the present study, Liu and Lienhard's (1989) experimental results for a liquid jet impinging normally to a heated surface were simulated to validate the heat transfer module. This experiment was modeled as a two dimensional axisymmetric flow. The computed local Nusselt numbers were within the estimated experimental error of 13%. Simulations of the flow and heat transfer of a liquid jet of HFE 7000 (an industrial coolant) at an initial velocity of 0.5 m/s impinging normally to a heated surface with several different gravitational force levels will also be presented. The gravitational force was oriented in the direction of the jet motion and was varied from 0 to 1.5 times Earth gravity. Computed average Nusselt numbers were compared with the correlations of experimental data by Womac et al. (1993). It was found that the computed heat transfer in terms of the Nusselt number increased as the magnitude of gravitational force was increased in the direction of the flow. The percentage discrepancy with the correlations of Womac et al. (1993) was highest for the zero gravity case at 7% and decreased to 5.2% as the gravitational force was increased. This work was sponsored by the Air Force Office of Scientific Research under grant number F49620-03-1-0276. The views and conclusions contained herein are those of the authors and not necessarily those of the sponsor.

### **Social Sciences/Science Education**

JENNIFER NEWLAND, Canaan Valley Institute, Davis, WV 26260. Education and research opportunities on Canaan Valley Institute's campus.

Although the colleges of the Mid-Atlantic Highlands offer a variety of programs of study in the natural sciences, most schools lack an outdoor place dedicated to field training and research that complements their classroom work. The Canaan Valley Institute (CVI) campus serves the need for such a science field station. CVI invites teachers and researchers to use its campus. Overlooking the

Canaan Valley and sited near Davis, West Virginia, the property's 3,223 acres feature upland forests and high-elevation wetlands. Wetland areas are already inventoried and detailed information about type, size, and plant communities are available.

Colleges could use the CVI land as a destination for field trips in various courses, including astronomy, meteorology, hydrology, soil science, plant taxonomy, wetland ecology, invertebrate taxonomy, ornithology, environmental restoration technology, wildlife management, forestry, and engineering survey methods.

The CVI campus also lends itself to several kinds of more focused research. Special studies could involve deposition of atmospheric pollutants, environmental impacts of deer populations, experimental enclosures, water-quality monitoring, and population and community ecology of locally abundant plant and animal taxa.

Data are available from monitoring equipment already in place on this property and additional studies could be developed to explore new questions. Information that is available includes continuous-recording stream-volume discharge measurements on Yellow Creek; mercury speciation and wet and dry mercury deposition measurements; trace atmospheric gas species measurements; and acid precipitation records. A 12-meter tower is available for additional instrumentation.

ALAN D. SMITH, Dept. of Management and Marketing, Robert Morris University, Pittsburgh, PA 15219-3099. Implementation of a national identification card and its associated political ramifications.

National identification cards are being dramatically debated in light of the constant increase in technological capabilities and the need for higher national security. Especially due to perceptions in the U.S. about the growing threat of global terrorism, there is ample coverage in the public sector about the costs and benefits associated with governmental tracking programs and pre-screening of citizens and non-citizens. The political dynamics associated with the important tradeoff between



personal freedom and safety, especially within a global economy, cannot be underestimated in the U.S. For this particular research project we developed a 33-item (with subparts) question survey asking participants to provide information regarding their perceptions of a national identity card program and associated technology-enabling experiences (Smith 2006a-f), as well as basic demographic information. A personal interview of 252 professional and semi-professional people was conducted, representative of the service industry located in the metropolitan section of Pittsburgh, PA. A number of factors were positively related in the prediction of the combined invasion of privacy dependent factor construct. Although there are many beneficial reasons why national identity programs should be implemented, such as security, convenience, and enhancing customer relations management (CRM)-related strategies, the vast majority of citizens have many fears and believe there are too many risks involved. These issues regarding national identification cards and CRM were addressed through exploratory data-reduction analyses. After performing the exploratory and specific hypotheses-testing aspects of the present study, it is evident that a majority of people view only the negative aspects and are not fully aware of the benefits and security features that could be successfully offered using a national identity program. They also feel more secure using biometrics technology and smart-card chips.

MAHMOOD HOSSAIN, ERICA HARVEY, and ANDREAS BAUR, Dept of Chemistry, Fairmont State University, Fairmont, WV 26554. A data mining approach for predicting student performance in CHEM 1106 based on mastery of CHEM 1105 learning outcomes.

The present work describes the use of data mining to predict the performance of students in CHEM 1106 (Chemical Principles II) based on mastery levels for learning outcomes in CHEM 1105 (Chemical Principles I). Mastery-based assessment of explicit student learning outcomes underpins teaching and grading in the introductory chemistry course sequence

at Fairmont State University. Student grades in CHEM 1105 and CHEM 1106 are based on outcome mastery status, which is tracked individually for the ~60 outcomes in each course. We analyzed the outcome mastery data to build a classification model and used that model to predict a student's chances of success as "high" or "low". Since it is difficult to select an optimal classification algorithm for a given problem domain, we used several classification algorithms (decision tree, neural network, Bayesian, and instance-based) in our work. We present a comparison of the performances of these algorithms using cross-validation accuracy. We also present the receiver operating characteristics (ROC) analysis for analyzing the classifier performances. In addition to the blind classification, we applied feature-ranking methods to rank the different learning outcomes according to their influence on predicted student performance. Our results indicate that the described work can help instructors enhance student success by identifying at-risk students and pinpointing key learning outcomes. On a larger scale, application of data mining to course assessment data can become a powerful vehicle for supporting programmatic assessment efforts.

### Earth Sciences

E. RAY GARTON, Curator, WV Geological Survey, Morgantown, WV 26508 and DAVE PHILLIPS, Sunset Fossils, Morgantown, WV 26505. The first fossil record of *Dunkleosteus* (Placodermi), an extinct armored fish from the Foreknobs Formation (Devonian) of West Virginia.

A section of skull or jaw plate of *Dunkleosteus*, a large placoderm, armored fish, has been found in the Devonian-age Foreknobs Formation near Elkins, WV. Devonian strata and fossils are abundant in West Virginia, but this represents the first record of this genus from the state. The specimen had fresh breaks on all edge surfaces indicating it came from a much larger specimen that has yet to be found.

EGEMEN OGRETIM and GRANT S. BROMHAL, National Energy Technology Laboratory (NETL), Morgantown, WV 26507, and DONALD D. GRAY, Department of Civil and Environmental Engineering, West Virginia University, Morgantown, WV 26506. Effects of water table tilt on the near-surface signature of CO<sub>2</sub> from a geologic sequestration site.

Coal is a vital energy resource for the United States and the world. However, as global warming becomes more of a concern, the environmental problems caused by burning coal become greater. Geologic sequestration, capturing CO<sub>2</sub> from power plants and injecting in deep geologic formations, is one means of continuing to burn coal without such environmental consequences. Monitoring, mitigation and verification (MMV) are vital components in this process to detect any leak that might occur at a sequestration site before there are any significant consequences. The near-surface migration of a CO<sub>2</sub> plume in case of a leak strongly depends on its interaction with the water present in the saturated and vadose zones. Some examples of such interaction are vertical motion due to buoyancy, blocking due to capillary trapping, and downstream drift due to underground water motion. This presentation reports a parametric study of the effect of water table tilt on the progression of a given CO<sub>2</sub> leak event. The simulations were performed using the TOUGH2 computer program. The results show that, depending on the leak rate and the water table tilt angle, the CO<sub>2</sub> plume can reach several tens of meters away from the breakthrough point. This study will help field researchers design sensor arrays for the detection of a potential leak at lower costs and with higher confidence of detection. This project was supported by the National Energy Technology Laboratory, U.S. Department of Energy. The conclusions are those of the authors.

## Poster Presentations

### Botany/Zoology/Microbiology

BARBARA SHOCK and DONNA FORD-WERNTZ, Dept of Biology, West Virginia University, Morgantown, WV 26506. Analysis of the distribution of the vascular plants of West Virginia.

The Checklist of the West Virginia Vascular Flora ably quantifies the 2689 vascular plants in the state of West Virginia. A project was designed to use this information to begin to establish the distribution of all the vascular plants of West Virginia. The first line of investigation looked at the number of counties the plant species occurs in to classify the plant as rare or common. The next will look at the spatial distribution of the plants in the three distinct geographical regions of West Virginia: the Western Hill Section, which contains central hardwood forests; the Allegheny Mountain and Upland Section, which contains the state's northern forests; and the Eastern Ridge and Valley Section, which is predominately oak and pine forests. The last part of the project tallied the number of plant species per county, and from this counties that are lacking or are abundant in plant life will be evident. Statistical analysis of these data is forthcoming. In addition to this, the project will be able to label which counties contain invasive or rare native plant species. One of the goals of this project is to make this information more accessible by creating visual media. Another goal is to make the information available to organizations so that they can track invasive plant species by date collected, search for species in specific counties, and look for rare plants in specific locales. It is hoped that the information gathered from this project will help those who research West Virginia flora.

TRAVIS FISHER and LISA CASTLE, Glenville State College, Department of Science and Mathematics, Glenville, WV 26351. Do Tree-of-Heaven plants retain their leaves longer than trees of neighboring species do?

Tree-of-Heaven (*Ailanthus altissima*) is an invasive species that is encroaching on the territory of our native deciduous forest species. Tree-of-Heaven spreads quickly and grows extremely quickly. Various projects are being conducted to determine what exactly makes this species so successful. In order to assess if phenological differences might give Tree-of-Heaven a competitive advantage, a sample of ten Trees-of-Heaven was compared with a sample of 15 other trees neighboring the Trees-of-Heaven. For seven weeks, leaf color change and leaf-drop were observed and recorded. An application of a *t*-test showed that this study strongly supported the alternative hypothesis that Tree-of-Heaven plants retain their leaves longer than neighboring trees of other species do.

FAITH HARPER, J. MCDUGAL, and LISA CASTLE, Glenville State College, Department of Science and Mathematics, Glenville, WV 26351. High-school-friendly genetic techniques to study the invasive Tree-of-Heaven.

Many genetic research procedures exist, which makes matching the proper procedure to meet the exact research requirements difficult. In this project, we set out to determine a student-friendly protocol for acquiring genetic material from trees as well as an easily repeated method for analyzing the resulting sequences. Recently, Glenville State College received a NASA grant to expand research opportunities for high school and undergraduate students. The applied research initiative centers on the invasive species, Tree-of-Heaven (*Ailanthus altissima*). The initiative allows students to perform campus-based summer research. The initiative also allows students to participate in a hands-on experience by collecting genetic material and sending it to Glenville State College for analysis. Our research included developing a method in which students could successfully obtain samples that were not easily contaminated or in need of refrigeration. We also developed a method to extract, amplify, and analyze the DNA once it was obtained. These clear protocols are the first step towards answering larger ecological questions about the population genetics of invasion and are absolutely essential for an initiative

that includes student researchers dispersed in space and time.

FREDERICK GARLAND and ROGER SEEBER, Dept. of Natural Sciences and Mathematics, West Liberty State College, West Liberty, WV 26074. Analysis of hyperforin and hypericin and plant regeneration of St. John's wort.

*Hypericum perforatum* (St. John's wort) is a medicinal herb that was first used for wound healing and is being studied today for anti-tumor and anti-viral properties. Presently, the major use worldwide is as an antidepressant [4]. The accepted secondary metabolites in the plant that give it medicinal value are hypericin and hyperforin. The intent of this research is to develop a genetic variant of St. John's wort that would produce higher concentrations of hypericin and hyperforin and to develop a procedure to regenerate the St. John's wort plant from callus. Through the process of somaclonal variation, it is possible for a genetic variation to be found within callus cultures that would produce higher concentrations of these compounds. For determining if concentrations of hypericin and hyperforin in callus differ, high-performance liquid chromatography (HPLC) was used [3, 5, 6]. A procedure for St. John's wort plant regeneration was developed by placing callus from stem explants onto a shoot-induction medium. Once shoots formed, this plant will then be placed onto a rooting medium and subsequently placed into a growth chamber to be acclimated to less humidity [2]. If a variant line of callus is found to have higher concentrations of secondary metabolites, the callus could then be regenerated into a plant for further production within an agricultural setting.

STEPHANIE ZORIO, JOHN PIERSON, and DONALD TRISEL, Dept. of Biology, Chemistry, & Geoscience, Fairmont State University, Fairmont, WV 26554. Mycorrhizae and/or *Rhizobium*? A comparison of the effects on photosynthesis and growth of *Glycine max*.

*Glycine max* (soybean) is an important agricultural crop. Nitrogen fixing symbiotic organisms can drastically improve the overall health and productivity of their hosts. *Rhizobium* encompasses many bacterial strains while mycorrhizae refer to a number of species of symbiotic fungi. Almost all higher plants have some sort of mutualistic relationship with mycorrhizal fungi in the root system. *Rhizobium* is more specialized, only fixing nitrogen in the roots of legumes. *Glycine max* seeds were planted in 12 pots with three replicates per treatment. One group consisted of *Rhizobium*, another with mycorrhizae, a group with both mycorrhizae and *Rhizobium*, and a control group with no inoculant. Height measurements were taken daily. After three weeks the *Rhizobium* and the mycorrhizae passed the control group in height and general plant health. LiCOR-6400 measurements showed varying results between treatments. Photosynthetic rates were highest in a *Rhizobium* treatment, with the mycorrhizae treatment having the next highest rate. We had hypothesized that our treatment of both mycorrhizae and rhizobium would yield the highest photosynthetic rates; our initial data do not support our hypothesis.

ASHLEIGH LANDIS, EMILY DIMITROFF, CHRISTOPHER SEDLACEK, and DONALD TRISEL, Department of Biology, Chemistry, & Geoscience, Fairmont State University, Fairmont, WV 26554. The effects of foliar nutrient spray on photosynthesis and overall growth in crop plants.

This study compared some of the effects of two different commercially available foliar sprays on the overall photosynthetic activity and growth of tomato (*Lycopersicon esculentum*) and pumpkin (*Cucurbita maxima*). Plants were grown in the greenhouse at Fairmont State University and watered and cared for daily. Each foliar spray was applied to two sets of tomato plants and two pumpkin plants once a week for the duration of the experiment. After the plants had large enough leaves, we did experiments to measure the photosynthetic responses of the plants with the LICOR-6400. Our preliminary results show

that the tomato plants sprayed with Spray and Grow<sup>®</sup> have higher rates of photosynthesis than the Liquid Kelp<sup>®</sup>-sprayed plants, while the control plants (tap water spray) had the lowest rate. Pumpkins with the two nutrient sprays had higher rates of photosynthesis than the control plants.

RODNEY DEVER and DONNA FORD-WERTZ, Department of Biology, West Virginia University, Morgantown, WV 26506. The nodding onion: one species or three?

This research investigates a botanical controversy that has gone unresolved for about a century. The *Allium cernuum* complex in Appalachia potentially consists of three taxa: *A. cernuum* Roth (nodding onion), *A. allegheniense* Small (Allegheny onion) and *A. oxyphilum* Wherry (acid-loving onion). Currently there is no consensus as to their taxonomic status, nor has this question been fully addressed.

Some botanists conceive of these taxa as three distinct species, whereas others recognize only *A. cernuum* as a species and regard the other taxa as subspecies. This study will investigate the issue by assessing variation in the morphology, anatomy, cytology, and ecology of the Appalachian *A. cernuum* complex. These measurements will be analyzed using a multivariate statistical analysis so that classification options may be quantitatively assessed.

In the summer of 2008, a common garden will establish whether this variation is genotypic or phenotypic in nature. Also, a comprehensive herbarium search is anticipated to reveal the whereabouts of disparate populations potentially ranging from the Appalachians of Pennsylvania to Georgia. Field research will entail documentation of populations and collection of samples.

Ultimately this matter is a conservation concern, as *A. oxyphilum* and *A. allegheniense* are considered rare and possibly threatened in West Virginia and Virginia.

JOHN C. LANDOLT, Dept. of Biology, Shepherd University, Shepherdstown, WV 25443, STEVEN L. STEPHENSON, ADAM W. ROLLINS, and CARLOS ROJAS, Dept. of Biological Sciences,

University of Arkansas, Fayetteville, AR 72701.  
Dictyostelid cellular slime molds from northern Thailand.

Samples of soil/humus for isolation of dictyostelid cellular slime molds were collected at four localities in northern Thailand during January 2008. These samples yielded 15 different taxa, including such common and widespread species as *Dictyostelium giganteum*, *D. mucoroides*, *D. purpureum*, *Polysphondylium pallidum* and *P. violaceum*. However, a number of isolates could not be referred to any described species when first examined and require additional study. Several of these are likely to be new records for Thailand and it is possible that one or two may represent species new to science. The average number of clones/gram ranged from 68 to 363, with the highest total recorded for a moist montane tropical forest at the Mushroom Research Centre north of the city of Chiang Mai. Numbers of taxa recorded for a particular sampling locality varied from five to 10, with the highest total for an upland tropical forest on Doi Inthanon, the highest mountain in Thailand. Interestingly, more than half of all samples also yielded the plasmodia of myxomycetes. This research was supported in part by a grant from the National Science Foundation.

JOHN C. LANDOLT, Dept. of Biology, Shepherd University, Shepherdstown, WV 25443, STEVEN L. STEPHENSON, and ADAM W. ROLLINS, Dept. of Biological Sciences, University of Arkansas, Fayetteville, AR 72701. Dictyostelid cellular slime molds of Arkansas.

During the period of 2003 to 2007, samples for isolation of dictyostelid cellular slime molds (dictyostelids) were collected from 16 localities throughout the state of Arkansas. The localities sampled included at least two examples in each of the six natural regions (Arkansas River Valley, Ozark Plateau, Ouachita Mountains, Gulf Coastal Plain, Crowley's Ridge, and Mississippi Alluvial Plain) recognized for the state. The 157 samples collected from the 16 localities yielded a total of 1973 individual

clones representing 13 different species plus one form that could not be assigned to any described species. *Polysphondylium pallidum* was by far the most abundant species, comprising almost 50% of all isolates. Three other species (*Dictyostelium minutum*, *P. violaceum* and *D. purpureum*) made up approximately 30% of all remaining isolates, and the nine other species recovered were uncommon to rare. Two isolates of what appears to be *Dictyostelium rhizopodium*, a species in which the sorocarps have crampon bases, apparently represent the northernmost known occurrence of a dictyostelid with this feature, which is associated only with forms characteristic of tropical and subtropical regions. Support was provided by a grant from the Shepherd University Alumni Association.

ADAM HAMRICK, Dept of Biology, Fairmont State University, Fairmont, WV 26554, and JESS CUNNICK, Mary Babb Randolph Cancer Center, West Virginia University, Morgantown, WV 26506. Defining the role of the actin filament-associated protein AFAP-110 in glioblastoma invasiveness.

The invasiveness of glioblastoma cells presents a significant obstacle for the treatment of this type of brain cancer. Although surgical removal of the primary tumor is possible, migration of these cells into the surrounding parenchyma of the brain prevents complete removal, resulting in a low cure rate.

The actin filament-associated protein, AFAP-110, is a multi-domain adaptor protein that binds to actin stress fibers and is a binding partner for Src kinase. In response to protein kinase C (PKC) activation by phorbol ester, a general reorganization of the actin cytoskeleton occurs. Actin stress fibers are lost and ruffles, lamellipodia, and invasive structures referred to as invadopodia form. Invadopodia are ventral protrusions formed by cancer cells that contain actin-rich cores and extracellular, matrix-degrading proteases. AFAP-110 relocates from actin stress fibers to invadopodia upon stimulation with phorbol ester and is thought to play a role in the formation of these invasive structures.

High levels of expression of AFAP-110 have been found in glioblastoma tumors. To define the contribution of AFAP-110 to the invasive behavior of these cells, we have determined the levels of AFAP-110 in several glioblastoma cell lines. High expression of AFAP-110 correlated with an enhanced reorganization of the actin cytoskeleton in response to phorbol ester stimulation and the ability to form invadopodia. Future studies will define the contribution of AFAP-110 to actin cytoskeleton reorganization, invadopodia formation, and invasiveness by knocking down AFAP-110 in these cell lines.

JENNIFER ZIMMERMAN, Division of Forestry, West Virginia University, and STUART WELSH, USGS Cooperative Fish and Wildlife Research Unit, West Virginia University, WV 26506. PIT tag retention in small American eels, *Anguilla rostrata*.

Passive integrated transponders (PIT tags) are commonly used in ecological studies of aquatic and terrestrial animals. Researchers have used PIT tags in American eels (*Anguilla rostrata*) to study growth rates, home range size, and migration. The placement of PIT tags within the body of American eels differs among studies, including insertion in the dorsal musculature behind the head, the dorsal musculature near the dorsal fin origin, and the abdominal cavity. Retention rates of PIT tags for American eels are reported in the literature, but researchers have not previously compared and reported tag retention rates among different tagging locations. The objective of this study was to compare retention rates of PIT tags placed in the dorsal musculature behind the head, the dorsal musculature near the dorsal fin origin, and the abdominal cavity of American eels. Eighteen American eels were collected during fall 2006 from the Millville dam eel ladder on the lower Shenandoah River, West Virginia. Each eel was PIT-tagged in three locations and tag retention was monitored for nine weeks. Tag retention in the dorsal musculature near the dorsal fin origin (100%) and the abdominal cavity (100%) were higher than the retention rate of tags placed behind the head (88%). Our results, consistent with previous

literature, support an overall high retention rate of PIT tags in American eels. Previous studies have primarily focused on large eels and our results document high tag retention rates in small eels (205-370 mm) total length.

### Ecology/Environmental Science

MICHAEL CUNNINGHAM, Dept. of Biology, Glenville State College, Glenville, WV and ANDREW THOMAS, and DR. RICO GAZAL, Dept. of Land Resources, Glenville State College, Glenville, WV. Understanding the impacts of *Ailanthus* in an Appalachian forest.

*Ailanthus altissima*, Tree-of-Heaven, is an invasive species that grows across a wide area of West Virginia. Understanding the invasive character of *Ailanthus* and the environment where it exists is necessary to determine its impact on the ecology and functions of Appalachian forests. Soil and microclimate were monitored in a mixed hardwood forest in Glenville, WV in summer 2007. Three forest sites selected differed in the size and number of *Ailanthus* trees; site 1 possessed large, mature trees (mean±SE: 10.91±1.75 cm diameter, N=55), site 2 with small young trees (4.72±0.36 cm, N=225), and a control site with no *Ailanthus*. Soil pH differed significantly among sites. Site 2 had the greatest pH (6.03±0.07), followed by the control site (5.80±0.07). Air and soil temperature, relative humidity, and total rainfall (168-188 mm) did not differ among sites. However, soil moisture (within 20 cm of the surface) was greatest at the control site (21.33±0.48 %) and lowest at site 1 (13.90±0.62 %). Mean maximum photosynthetically active radiation (PAR) also differed significantly, with the control site receiving the greatest quantity of PAR (655.47±46.54  $\mu\text{mol m}^{-2}\text{s}^{-1}$ ). Sites with *Ailanthus* did not differ in maximum PAR observed with only 200.29±16.54 and 252.88±29.85  $\mu\text{mol m}^{-2}\text{s}^{-1}$  for sites 1 and 2, respectively. The water use and light interception by *Ailanthus* likely contribute to its competitive ability. Continuous encroachment of *Ailanthus* and its accompanied modification of the

site conditions pose a great threat to the existence of native plants and to the overall productivity and stability of central Appalachian forests.

ERIC H. DIEFENBACHER and THOMAS K. PAULEY, Department of Biological Sciences, Marshall University, Huntington, WV 25755. Iris-pattern identification (IPID): A technique for identifying amphibians and reptiles during field studies.

Numerous techniques have been published regarding the marking of individual amphibians and reptiles for capture/recapture studies. Two popular marking techniques, toe clipping and passive integrative transponder (PIT) tags, are not without pitfalls. Toe clipping severs tendons crucial for mobility in some species; affects survivorship where multiple digits are clipped; causes inflammation and the potential risk for infection; plus digit loss and regeneration has been noted to be natural events in many species. PIT tags are expensive and often get lost, destroyed, malfunction, or cannot be used on small individuals. Here we suggest a technique that takes high resolution images of iris patterns that are unique to each individual. This technique can be done easily with any single-lens reflex (SLR) camera and a set of diopters. This technique meets the criteria set forth by Ferner (1979): (1) the technique should not affect the survivorship or behavior of the organism; (2) allows the animal to be as free from stress or pain as possible; (3) identify the animal as a particular individual; (4) should last indefinitely; (5) be easily read and/or observable; (6) be adaptable to organisms of different sizes; (7) be easy to use in the laboratory, in the field, and easily obtained material at minimal cost.

ERIC H. DIEFENBACHER and THOMAS K. PAULEY, Department of Biological Sciences, Marshall University, Huntington, WV 25755. An update on the status and life history of the eastern wormsnake (*Carphophis a. amoenus*) in West Virginia.

Small fossorial snakes such as the eastern wormsnake, *Carphophis a. amoenus*, are often

neglected in studies because they lead a subterranean life and are therefore hard to find. Here we present an update on the distribution, habitat preferences, and dietary habits of *Carphophis a. amoenus* in West Virginia since it was last studied nearly 30 years ago. Field studies indicate this species occurs in only three of 27 historical sites due to habitat destruction by industry, residential areas, and agriculture. Habitat data from this study suggests this species can tolerate a range of soil temperatures (15°C-24°C), air temperatures (23.1°C-34.3°C), relative humidity (24.5%-80%), soil moistures (0%-43.8%), and can be found on nearly all slope directions. Dietary analysis shows *Carphophis a. amoenus* eat a small amount of arthropod prey; however, annelids make up the majority of their diet. Morphometric data indicate that females have a significantly larger snout-vent length, fewer sub-caudal scales, and shorter tails than males, all of which are useful in determining sex in the field.

A population of midwest wormsnaes, *Carphophis a. helenae*, was also found in southwestern West Virginia. Habitat, dietary, and morphometric data indicate no significant difference in the life histories of these two subspecies.

### Biochemistry/Health Sciences

DAVID WRAY, BONNIE POLLOCK, MARK FLOOD, Dept of Biology, Chemistry and Geoscience, Fairmont State University, Fairmont, WV 26554, and JEAN CHAPPELL, BOWIE KAHLE, GARY WRIGHT, TODD GREEN, PAULETTE WEHNER, MARK STUDNEY, and ELIZABETH MURRAY, Marshall University, Huntington, WV. Determining the effect of gene mutations on plasma homocysteine levels.

Homocysteine (Hcy) is a biologically important amino acid occupying a pivotal position in the metabolism of the essential amino acid, methionine. High blood levels of Hcy are known to be a risk factor for coronary artery disease (CAD), which is one of the leading causes of death in the U.S. Elevations of plasma Hcy have various causes, including low levels

of folic acid, vitamins B<sub>6</sub>, and B<sub>12</sub>, and genetically controlled variations in Hcy metabolic enzymes. Several single nucleotide polymorphisms (SNPs) were identified for genes involved in the metabolic pathway of Hcy and evaluated in an effort to assess the effect of genotype on plasma Hcy levels within an obese population. DNA was extracted from the patient population using a QIAamp DNA Blood Mini Kit, and plasma Hcy levels were quantified using an Abbott Diagnostics IMX autoanalyzer. Several gene SNPs were determined by amplification (PCR) followed by pyrosequencing of the polymorphic region. The polymorphic rate for each SNP will be compared to the various population data available, and statistical correlations with plasma Hcy will be conducted. Further studies are expected for additional SNPs in Hcy metabolism candidate genes to assess whether elevated Hcy levels are caused by mutations and lead to increased risk for CAD. Once SNP mutations that correlate with plasma Hcy levels are found, then specific treatment regimes can be recommended. This research was supported by a NIH grant #RR16477 (WV IDeA Network for Biomedical Research Excellence) and Fairmont State University NASA Space Scholars grant.

ZACH BREWER and SARAH DODSON, Department of Biology, Chemistry, & Geoscience, Fairmont State University, Fairmont, WV 26554. Examination of *in vitro* homocysteine exposure to stromal cells.

Homocysteine (Hcy) is an amino acid produced through methionine metabolism. Hyperhomocysteinemia, a condition of high Hcy levels, has been associated with cardiovascular disease. Because the effect of circulating Hcy on bone marrow stromal cells has not been studied extensively, the objective of this study was to examine the direct effects of hyperhomocysteinemia. Stromal cells (S10) were cultured and exposed to 0.05, 0.1, 0.5, and 1.0 mM of D, L-homocysteine in tissue-culture medium. Controls were cultured in medium alone. Cells were collected after time intervals of exposure. Since Hcy has been reported to induce

apoptosis in several cell types, DNA integrity was examined. DNA laddering, indicative of apoptosis, was not observed following Hcy exposure. Results indicate S10 stromal cells do not undergo apoptosis due to homocysteine. Production of insulin-like growth factor-1, a cytokine produced by stromal cells, and cell proliferation following Hcy exposure were assayed to determine Hcy impairment of stromal cell function. This project was supported by Fairmont State University SURE Grant, Fairmont State University/ WV NASA Space Grant, and NIH grant RR16477 of the West Virginia IDeA Network for Biomedical Research Excellence.

DOBIN CHOI, Department of Biology, Wheeling Jesuit University, Wheeling, WV 26003. Signal transduction pathway involved in the regulation of glucose-6-phosphate dehydrogenase.

As the number of incidents of diabetes and obesity increases, the need to understand the role of nutrition in regulating metabolic genes becomes especially important. One important factor involved in fatty acid synthesis is glucose-6-phosphate dehydrogenase (G6PD), the rate-limiting enzyme in the pentose phosphate pathway. It was previously found that G6PD mRNA is regulated by a posttranscriptional mechanism. If polyunsaturated fatty acid is added to a diet or a cell treatment, the amount of G6PD mRNA decreases. However, insulin or a diet rich in carbohydrate results in an increase of G6PD mRNA. Our laboratory has demonstrated a role for the mitogen-activated protein kinases in this mechanism, specifically p38. The addition of polyunsaturated fatty acid to hepatocytes results in phosphorylated p38, which leads to a decreased amount of phosphorylated AKT. This signaling pathway results in a decreased amount of G6PD mRNA.

In order to understand these molecular events in a physiologically relevant context, primary rat hepatocytes are isolated for these experiments. These primary hepatocytes retain the metabolic profile of intact liver, and are therefore ideal for studying the regulation of G6PD. To further address the role of



AKT in this signaling mechanism and the regulation of G6PD mRNA, the primary hepatocytes were infected with adenovirus expressing constitutively active AKT; the cells were then treated with insulin or polyunsaturated fatty acid accordingly. We learned that overexpression of constitutively active AKT can overcome the effect of polyunsaturated fatty acid on G6PD mRNA accumulation. The signaling pathway was further examined by western blotting.

ALBERT PILKINGTON IV and TONY E. MORRIS, Dept. of Biology, Chemistry, and Geoscience, Fairmont State University, Fairmont, WV 26554. Lung and bronchus cancer mortality and incidence rates of West Virginia compared to the United States and similarly population-sized states.

In the United States lung cancer is the leader in cancer-related deaths, accounting for 30% of all known cancer-related mortalities. West Virginia, when compared to similar states in population size, appeared to have a high number of lung cancer mortalities per year. The objective of the experiment was to determine if West Virginia's lung and bronchus cancer rates were high for a state of its population size. Using an Excel spreadsheet and data from the U.S. census and the American Cancer Society, the average death and incidence rates for all 50 states were calculated from 2000 to 2007. Among all 50 states, West Virginia was the leader in lung and bronchus cancer mortality (0.0854%) and incidence (0.0965%) rates, computed to 95% confidence. West Virginia was also compared among the five closest states both above and below West Virginia's population. Mortality and incidence rates for West Virginia were found to be on average twice as high for a state of its population size. Since the intervention of the C.D.C. in 2004 due to West Virginia's high cardiac problems, lung and bronchus cancer rates have started on a downward trend from 1,640 deaths in 2004 to 1,450 deaths in 2007. West Virginia still has 2/3rds greater mortality and incidence rates of lung and bronchus cancer than that of the national average.

CHRISTINA KNOPP and MARK A. AFFELTRANGER, Psychology Dept., Bethany College, Bethany, WV 26032. Running speed decreases after immunization in the rat: The role of antibodies.

Previously, our lab demonstrated decreased running speeds in the rat three weeks after immunization. We suggested that antibody levels could be a mechanism behind this phenomenon since antibodies are typically elevated three weeks after immunization. In this current study, we investigated this possible mechanism by giving rats two immunizations since the second immunization would produce a primarily antibody-based immune response. Thirty female, Sprague-Dawley rats were injected intraperitoneally (i.p.) with a low dose (200 ng) of ovalbumin. Three weeks later, subjects were randomly assigned to receive an i.p. injection of either a second low dose of ovalbumin (200 ng) or saline control. Two days later, all rats ran in a wheel that recorded the number of rotations per hour. We also measured food and water intake on this day to see if other forms of motivation were altered. The subjects given two injections of ovalbumin demonstrated less running but showed no difference compared to the other group in terms of eating or drinking. Although the antibody response appears to play some role in our phenomenon, we discuss some future studies examining other mechanisms including cytokines.

#### Chemistry/Physics

SARAH RUTHERFORD and DAVID O'DELL, Glenville State College, Department of Science and Mathematics, Glenville, WV 26351. Extraction and separation of metolachlor and dimethenamid from soil using high-performance liquid chromatography.

Varying methods of soil extraction with different solvents and procedures were used to derive percent recoveries for chloroacetamide herbicides including metolachlor and dimethenamid. Soil was

spiked with the herbicides metolachlor and dimethenamid. It was then shaken, centrifuged, decanted, and filtered using various solutions and ratios of water, water and methanol, methanol, isopropyl alcohol, and methanol and calcium acetate. High-performance liquid chromatography (HPLC) was used to separate and quantify the herbicides. The mobile phase consisted of 65% methanol and 35% water at a flow rate of 1 mL/min. Standard curves were graphed and method detection limits were calculated for metolachlor and dimethenamid at 99% confidence to be 0.00266 and 0.000492  $\mu\text{g/mL}$ , respectively.

JEREMY J. HAY and DARCEY G. WAYMENT, Department of Chemistry, West Virginia Wesleyan College, Buckhannon, WV 26201. Development of a microfluidic device for the analysis of perchlorates.

An important area of forensic and environmental field analysis is determination of perchlorate,  $\text{ClO}_4^-$ . Perchlorates are used in rocket fuels and other incendiary devices, and their detection and quantitation are important in forensic investigations of bombings and environmental chemistry. The goal of this research is to develop a quantitative method to rapidly detect perchlorates using microfluidic devices. Microfluidic devices offer many advantages over traditional instrumental methods due to their compact size. Consequently, only microliters of analyte and reagents are consumed in the analysis. This results in faster analysis times and compact size.

This work will present the results of investigations into developing a microfluidic device that can be used for perchlorate determinations. The perchlorate in solution is allowed to react with a colorimetric reagent, forming an intensely colored ion pair that is then extracted into a cuvet and analyzed spectrophotometrically using fiber optics and a spectrometer. We will present results of the investigations that optimize the instrument design and the colorimetric reaction.

Support for this work has been provided by West Virginia NASA EPSCoR, West Virginia University, and West Virginia Wesleyan College.

MATTHEW TALLMAN and DARCEY G. WAYMENT, Department of Chemistry, West Virginia Wesleyan College, Buckhannon, WV 26201. Development of a microfluidic device for the analysis of nitrates and nitrites.

An important area of forensic and environmental field analysis is determination of nitrate and nitrite ions. Currently there are several different types of field spot tests that are used to detect nitrates and nitrites, but no quantitative methods usable outside of the laboratory. The goal of this research is to develop a quantitative method to rapidly detect both nitrates and nitrites using microfluidic devices. Microfluidic devices offer many advantages over traditional instrumental methods such as use of only microliters of analyte and reagents, faster analysis times, and compact size.

This work will present the results of investigations into developing a microfluidic device that can be used for nitrate and nitrite.

JACOB R. LILLY and KEVIN L. EVANS, Glenville State College, Department of Science and Mathematics, Glenville, WV 26351. Synthesis of alkenyl iodides and alkyl diiodides via a surface-mediated reactions using  $\text{PI}_3/\text{SiO}_2$ .

Previous research in our group has shown that the *in situ* generation of hydrobromic acid via surface-mediated hydrolysis of phosphorus tribromide ( $\text{PBr}_3$ ) on silica gel ( $\text{SiO}_2$ ) can be used to efficiently convert alkynes to either alkenyl bromides or alkyl dibromides. This research has been modified by exchanging the  $\text{PBr}_3$  with phosphorus triiodide ( $\text{PI}_3$ ). Instead of creating hydrobromic acid we are able to create hydroiodic acid via surface-mediated hydrolysis of  $\text{PI}_3/\text{SiO}_2$ . Conditions for synthesizing either the alkenyl iodide or alkyl diiodide were developed. These reactions were controlled by changing the ratio of alkyne to  $\text{PI}_3$  (alkyne: $\text{PI}_3$ ), while the amount of  $\text{SiO}_2$  remained constant. To produce the alkenyl iodides, a 1:0.33 ratio was used. In order to produce the alkyl diiodides, a 1:1 ratio was needed. Comparisons of the relative amounts of starting material (alkyne), alkenyl iodide, and alkyl diiodide were determined

by using the integral values of the proton ( $^1\text{H}$ ) NMR scan.

JASON D. POLING and KEVIN L. EVANS, Glenville State College, Department of Science and Mathematics, Glenville, WV 26351. Synthesis of alkyl dibromides via a surface-mediated reaction using silica gel and phosphorus tribromide.

Alkyl and alkenyl halides are frequently needed as key intermediates in a variety of multi-step organic syntheses. Recent examples in which these intermediate compounds were needed include the production of a fluorinated medicine and flame retardant fibers. Thus, an effective and efficient method to synthesize these intermediate compounds is needed.

The synthesis of alkyl and alkenyl halides can be accomplished with the addition of anhydrous hydrohalic acid to alkenes or alkynes, respectively. The required hydrohalic acid can be generated *in situ* from a variety of inorganic and organic acid halides using surface-mediated reactions. Previous research in our group has shown that hydrobromic acid generated from phosphorus tribromide on silica gel will react with alkynes. This research has expanded our prior investigation. Five alkynes (two terminal alkynes and three internal alkynes) were studied. Appropriate conditions to convert three of these alkynes to alkyl dibromides were developed. A mixture of products was formed from the other two alkynes. Additional research is planned to overcome this problem.

### Mathematics/Computer Science/Engineering

WILLIAM KLINGELSMITH, WEIDONG LIAO, and ZHIJUN WANG, Dept. of CME, Shepherd Univ., PO Box 3210, Shepherdstown, WV 25543. Using feature-point extraction and Hopfield networks for the detection and correction of document skew.

Automation plays an increasing role in the retrieval and distribution of information in the business world. In this area, flatbed scanners are vital machines for

quickly digitizing spreadsheets and other documents that exist on paper. Problems arise when the document being scanned is incorrectly aligned and can lead to inaccuracy or even failure of the OCR techniques. The discovery of a better algorithm is essential to maintaining the flow and pace necessary in business applications.

This algorithm's purpose is to correct document skew using a technique that is non-geometric in execution. The algorithm utilizes elements of typography and artificial intelligence to isolate, analyze, and correct document skew in scanned images. Individual characters are isolated using feature-point extraction. After a single character is extracted, it is checked against a Hopfield network containing the set of glyphs from a specific font. Once the amount of rotation necessary to correct the character is achieved, the entire document is rotated the same amount. Because this approach does not use lines to determine the angle of skew correction, it may be a higher precision technique that will be able to increase the accuracy of OCR. The overall objective is to exceed the accuracy of current techniques in skew normalization. The research presented here is supported by NASA WV Space Grant Consortium.

RAY NAEGLE, Shepherd University, P.O. Box 3210, Shepherdstown WV 25443, and XIAOJUN QI, Computer Science Department, Utah State University, Logan, UT. Geometric and removal attack-resistant watermarking in the wavelet domain.

As access to broadband Internet connections becomes more ubiquitous, it becomes continually easier to share information. Unfortunately, this presents a problem—some individuals share copyrighted information in digital form with many people over the Internet. Image watermarking provides a way for copyright holders to identify who distributed their content; however, watermarking remains fragile to various removal attacks.

We present an autocorrelation-function-based watermarking scheme, based on work by Lee *et al.* [1, 2], that is resistant to both filtering and geometric attacks. A cover image is processed to give itself high periodic autocorrelation. A periodic watermark is then additively blended into the Discrete Wavelet Transform (DWT) sub-bands of the image, which gives resistance to removal attacks such as compression and mean filtering. Exploiting properties of the DWT allows the watermark to be embedded with higher weight without compromising image quality. The periodic signal is later detected using Fast Fourier Transform (FFT), and any geometric attack is estimated and removed. The watermark signal is extracted and compared to a reference pattern, which determines whether the image is marked or not. The research presented here is supported in part by NASA WV Space Grant Consortium and by National Science Foundation under its REU program.

#### References

- [1] *Int. J. of Image and Graphics*, World Scientific, Vol. 5, No. 1 (January 2005), pp. 37-65.
- [2] *Optical Society of America, Optics Express*, Vol. 13, No. 4 (February 2005), pp. 1307-1321.

#### Social Sciences/Science Education

MINJEE KWON and TONY E. MORRIS, Department of Biology, Chemistry, and Geoscience, Fairmont State University, Fairmont, WV 26554. Correlation between gender and results in marathon, half-marathon, 10-km, and 5-km races.

Physical characteristics may affect individuals' results in sports. Gender is one of the factors that can differentiate the outcome. We gathered and statistically analyzed marathon, half-marathon, 10-km, and 5-km race results. The top 100 male times were compared to the top 100 female times for each race. Conclusions made from this research include that males placed higher on average than females, as expected. However, when finishing times were adjusted to the

average time for each gender and race, females placed higher on shorter races relative to males.

ADAM COSNER, Department of Health and Human Performance, Fairmont State University, Fairmont, WV 26554. Effects of caffeine, electrolytes and water ingestion on the performance of individuals completing a 30-minute cycling test.

The purpose of this study was to determine how caffeine, water, or electrolyte solutions aided the participant in completing a bout of cycling. Eight individuals performed a total of five cycling bouts each. Subjects initially participated in a maximal exercise test to anchor the Borg RPE scale and to obtain maximum volume of oxygen consumed ( $\text{Max VO}_2$ ) so work rate could be established for remaining exercise tests. The second trial subjects cycled for 30 min at 75% of their  $\text{Max VO}_2$  with no hydration solution ingested 1 hour prior to or during exercise. Heart rate (HR), rating perceived exertion (RPE), and volume of oxygen consumed ( $\text{VO}_2$ ) were measured every minute throughout the 30-min test. The final three test participants repeated this procedure; however, twenty-five minutes preceding the exercise participants ingested either 12 oz. of water, electrolyte solution, or a solution containing approximately 637 mg of caffeine. HR, RPE, and  $\text{VO}_2$  were measured at the 1-, 5-, 10-, 15-, 20-, 25-, 30-min marks via a repeated measures ANOVA. A follow-up test was performed as needed. A SD ( $p < 0.05$ ) was found for RPE at the 15- and 25-min marks between no solution ingested and the three other methods of hydration. The 30-min mark also produced an SD ( $p < 0.05$ ) for HR and  $\text{VO}_2$  between the ingestion of caffeine and the three other tests, resulting in a higher heart rate when caffeine was ingested. These results suggest that during the later stages of cycling caffeine creates a greater HR and  $\text{VO}_2$ . Findings also suggest that RPE was increased at the 15- and 30-min marks when an individual did not consume some type of solution prior to exercise.

CHARLSIE ALLEN and TONY E. MORRIS, Department of Biology, Chemistry, and Geoscience, Fairmont State University, Fairmont, WV 26554.

Correlation between age and time of runners in a marathon to the places the runners finished.

Physical characteristics may affect individuals' results in a sport. Time is one of the dynamics that can distinguish the outcome of the results. Together we statistically analyzed the results of the marathon of the top 100 runners by age. A conclusion made from this research is that runners more advanced in age will finish the marathon in a greater amount of time.

ELIZABETH REIDY, KATHLEEN THOMPSON, and JOHN H. HULL, Dept. of Psychology, Bethany College, Bethany, WV 26032. Flower Power: Students' perceptions of characteristics of flowers.

Thirty-eight undergraduate student research participants viewed slides of 30 different flowers, and evaluated them on the following dimensions: masculine-feminine, peaceful-aggressive, beautiful-ugly, interesting-uninteresting, and simple-complex. Subsequent analyses indicated statistically significant correlations between: femininity and peacefulness ( $r(28)=0.764$ ,  $p<0.001$ ), femininity and beauty ( $r(28)=0.820$ ,  $p<0.001$ ), peacefulness and beauty ( $r(28)=0.644$ ,  $p<0.001$ ), peacefulness and simplicity ( $r(28)=0.694$ ,  $p<0.001$ ), and interestingness and complexity ( $r(28)=0.609$ ,  $p<0.001$ ). Independent-groups *t*-tests showed very few statistically significant differences between females' and males' evaluations; only seven of the 150 comparisons were statistically significant, about what ought to have occurred by chance at a 0.05 significance level. Finally, comparing results from this study to previously reported research (e.g., Conrad, Shaw, Hull, & Hull: Color my world – but only with “boy” colors, please, WVAS, 2000) showed that strong peacefulness, beauty, and femininity evaluations generally occurred to flowers of “feminine” colors.

Our study indicates that when people – women or men – view flowers, their perceptions of flowers' beauty, peacefulness, and femininity are strongly interrelated, and may reflect the perceived masculinity-femininity of the flowers' colors. Future research should address whether these findings are peculiar to

people's evaluations of flowers, or apply more generally to a variety of situations.

MARK A. AFFELTRANGER, TYLER KOWCHECK, and BRENDAN A. CYPHER, Psychology Dept., Bethany College, Bethany, WV 26032. Behavior changes three weeks, but not two days, after ovalbumin-immunization in the rat.

Last year, we presented evidence that rat-running behavior could be decreased by an immunization with ovalbumin three weeks earlier. In this study, we used a repeated-measures paradigm to observe how the behavior change may evolve over time. Fifty Sprague-Dawley rats (25 male and 25 female) were randomly assigned to receive an intraperitoneal injection of either a low dose of ovalbumin (200 nanograms) or saline. Two days later and again three weeks later, all rats ran in a wheel that recorded the number of revolutions per hour. We found no evidence of ovalbumin-induced running change two days later for either gender. We did find that running was decreased significantly for the ovalbumin-injected females, but not the males, three weeks after immunization. The more potent immune response typical in female rodents could explain the gender difference. The roles of cytokines and antibodies as physiological mechanisms behind these effects will be discussed.

ANGELA MCKEEN, Dept. of Biology, Chemistry, and Geoscience, Fairmont State University, Fairmont, WV 26554. Seeing science everywhere: Using the arts to teach science in high-poverty areas of Appalachia.

This poster presentation explores the impact of using the arts in teaching science with three fifth-grade science teachers in rural Appalachia. This study examined the perceptions of incorporating more aesthetic methods of science instruction (i.e. student artwork, creative writing, music, creative dramatics, etc.) through the experiences of three fifth-grade science teachers who have taught for a minimum of fifteen years in high poverty areas of rural Appalachia. The teachers had varied levels of previous implementation of such approaches in the science

classroom, ranging from one who had been utilizing this method of instruction for at least nine years to one who had no prior experience with these methods in the science classroom. All teachers in the study agreed to incorporate more of the arts in their science classes for a minimum of six months. Teachers who had never incorporated the arts with science were given broad and general options to incorporate, were provided with brainstorming sessions as they needed, and had the support of their school administration in their efforts to include such methods in their science classes. The inclusion of the arts in the science classes in no way affected the inquiry instruction or the amount of hands-on activities currently used by the teachers in this study.

SARAH DODSON, MARK FLOOD, JAMES WEEKLEY, STEVEN ROOF, NANCY MCCLURE, Fairmont State University, Fairmont, WV 26554, and LESLIE LOVETT, ROSEMARIE ROMESBURG, and MICHAEL WAIDE, Pierpont Community & Technical College, Fairmont, WV 26554. Where is the crime in using a multidisciplinary approach to a forensic science problem?

The Problem-Based Faculty Learning (PBL) Community, a small professorial group that arose on the Fairmont State campus in January 2006, utilized a case-study approach to encourage more independent, active-learning in our courses. The problem-based student learning teams were comprised of undergraduate students enrolled in two different laboratory science courses: Molecular Biotechnology and Medical Laboratory Technology Clinical Case Studies. As faculty members gained knowledge about problem-based learning, we prepared the complex forensic case that was presented to the students. There was significant learning that occurred by both students and faculty as the crime unfolded. The faculty established the crime scene in the Crime House near the Fairmont State University campus. Student teams were responsible for analyzing the evidence from the crime scene based on their background coursework, giving an oral report to the entire group, and then submitting a formal written report

of the complete case. Teams were assigned different rooms in the Crime House so that one team would not be able to "solve" the case without the results shared by other teams. The PBL Faculty Community found that incorporating more complex PBL cases into the classroom was challenging at times but does encourage critical thinking on the part of the students as they put the pieces of the case together. This is the second time that the PBL Faculty Community has incorporated a large-scale case into the classes. Changes in the approach and presentation of the PBL between Spring 2007 and Spring 2008 semesters will be discussed. The Problem-Based Faculty Learning Community is supported by the Center for Teaching Excellence at Fairmont State University.

### Earth Sciences

ROBERT D. HANNI and JASON S. BEST, Shepherd University Observatory, Shepherd University, Shepherdstown, WV 25443. Analysis of the large-scale distribution of quasars.

Quasars, which were discovered in the early 1960s, have presented astronomers with countless new and exciting questions about the universe. We now know that they are some of the most luminous objects in the sky and can be used to probe the universe at its earliest stages of development due to their enormous redshifts. This paper investigates the large- and small-scale distribution of quasars in our universe. Focusing on a variety of scaling ranges, we examine quasar clustering with respect to both magnitude and redshift. By exploring these aspects, we hope to form insights into the formation of galaxies, and into the structure and development of our entire universe. To study these objects, we employ the Fifth Data Release of the Sloan Digital Sky Survey (SDSS) Quasar Catalog, which contains detailed physical properties on over 77,000 quasars. We use the pointwise dimension technique (a mathematical technique, based on fractal geometry, that quantifies the scaling of objects around a specified position) to explore

environmental relationships between quasars. A preliminary analysis of our data shows that the evolutionary structure of quasars varies over scales as large as 100 megaparsecs. We also find that luminosity is a significant factor in quasar clustering. Additional examination will provide information on how this evolution varies as a function of redshift and magnitude ranges.