Volume 61, Number 1

Proceedings of the West Virginia Academy of Science

1989

Abstracts of papers for the Sixty-Fourth Annual Session

Anatomy of a Micromaster® Microscope

When you select Micromaster microscopes for your classroom, you not only get the finest state-of-the-art optical performance coupled with precision-crafted mechanical components, you also get many features standard on your Micromaster which are extra-cost add-ons with competitive brands (if available at all).

Standard Micromaster features include:

Wide Field Eyepieces. With pointers. Easier to use than old-fashioned Huygenian type because they provide 25-40% greater field of view, plus their higher eye relief means greater viewing comfort. Even for eyeglass wearers.

Three or Four Objectives. Never just two. 4X scanning objective simplifies searching of slide and makes initial focusing on specimen easier due to its great depth of field.

Objectives of maximum numerical aperture. For highest possible resolution of image. DIN or ADO design.

Spring-loaded retractable 40X and 100X objectives. Prevent damage to front lens element and specimen slides in the event of contact.

Stage pre-drilled and threaded. To accept accessory mechanical stage.

Built-in or locked-on illuminator. On nearly all models. All illuminators have heavy-duty 3-wire power cord with 3 prong grounded plug. (Of course mirror models are available too.)

Locked-on student-proof components. Such as eyepieces and stage clips.

360° Rotatable inclined heads. On many models. Handy for students sharing a microscope. Simply swing eye tube from student to student rather than moving entire microscope.

Rugged Cast-metal construction. On bodies, arms and bases.

Heavy-duty rack and pinion focusing mechanism with safety stops.

Slip clutch on many models to prevent stripping of focusing mechanism.

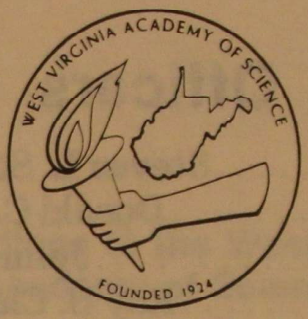
Condensers matched to numerical aperture of highest power objective. In-stage 0.65 N.A. with 5 position disc diaphragm on triple nosepiece models. Substage focusable 1.25 N.A. Abbe design with iris diaphragm on quadruple nosepiece models.

Reagent-resistant baked enamel finish. Keeps your Micromaster looking like new for years to come.

Service. For your Micromaster is as close as your telephone. Just call toll free:
800-242-3772 (in PA)
800-245-2230 (outside PA)
Within Area Code 412 **Call 963-3300**

Complete range of accessories and replacement parts. Genuine Micromaster parts right down to the tiniest set screw are available from Fisher. (Parts lists and parts diagrams are available upon request.)

Insist on Micromaster
Yours exclusively from Fisher Scientific



Proceedings of the West Virginia Academy of Science 1989

Vol. 61—No. 1
ABSTRACTS OF PAPERS FOR THE SIXTY-FOURTH ANNUAL SESSION

West Virginia School of Osteopathic Medicine

Lewisburg, West Virginia

March 31-April 1, 1989

Printed by
McClain Printing Company
Parsons, West Virginia
March 1989

Cover Design
Meredith Pearce
West Virginia University
Office of Publications
Morgantown

West Virginia Academy of Science, Inc.

The West Virginia Academy of Science was founded at Morgantown, November 28, 1924. The Academy was incorporated under the Code of West Virginia on May 9, 1959 as "a nonstock corporation, which is not organized for profit but for the advancement of learning and scientific knowledge."

Officers

President	Steven L. Stephenson, Fairmont
President-Elect	Donald C. Tarter, Huntington
Past President	John A. Chisler, Glenville
Treasurer	Roy B. Clarkson, Morgantown
Assistant Treasurer	John R. Warner, Buckhannon
Archivist	Arthur S. Pavlovic, Morgantown
Secretary	Gary W. Snyder, Glenville
Proceedings Editor	E. C. Keller, Jr., Morgantown
Talent Search Chairman	Joseph Glenco, Buckhannon
Chairman of West Virginia Junior Academy of Science	Joe Evans, Glenville
Chairman of Annual Meeting at Lewisburg	Michael K. Cope

Dues Structure

Student	$ 5.00
Regular	10.00
Contributing	20.00
Sustaining	40.00
Life	100.00
Corporation	200.00 min.
Institutional	200.00 min.
Patron	1,000.00

Institutional Members

Concord State College
Fairmont State College
Marshall University
West Virginia Institute of Technology
West Virginia State College
West Virginia University
West Virginia Wesleyan College

Proceedings of the West Virginia Academy of Science

E. C. Keller, Jr., Editor

Section Editors

Published by the West Virginia Academy of Science, Inc. Manuscripts for publication (which normally must have been read at an annual meeting of the Academy) should be sent to the Editor, E. C. Keller, Jr., Department of Biology, West Virginia University, Morgantown, WV 26506-6057. Proof, edited manuscripts, and all correspondence regarding papers for publication should be directed to the Editor.

Applications for membership in the Academy and dues should be sent to Roy B. Clarkson, Treasurer, same address as editor. Changes of address should be sent to Roy B. Clarkson, at the above address. Correspondence concerning library exchanges should be directed to Director of Libraries, West Virginia University, Morgantown, W. Va. 26506.

Table of Contents

Abstracts of Papers

for the 1989 Meeting

Archeology/Psychology

ANN M. AGUIAR and JOHN H. HULL, Dept. of Psychology, Bethany College, Bethany, West Virginia 26032. Personality Variables Related to Viewing Sports on TV.

Fifteen college students completed items on the aggression, dominance, and succorance scales of the Edwards Personal Preference Schedule (EPPS), then watched the University of Pittsburgh-Pennsylvania State University football game. The students completed the same three EPPS scales ten minutes after the game, and again 24 hours after the game.

Separate repeated measures analyses of variance and Newman-Keuls posttests showed that students' mean aggression and dominance scores were significantly higher ten minutes after the game than they were just before or 24 hours after the game. The mean succorance score was lowest ten minutes after the game, although not significantly so. Taken together, these analyses show an increase in "nastiness" after viewing football on TV. Results are discussed in light of prior studies showing very different results as a consequence of participation in, rather than viewing of, sports.

ALICE ELLISON, Dept. of Geography, Concord College Athens, West Virginia 24712. Snidow Site Excavations (46-Mc-1).

Excavations at the Snidow Site (46-Mc-1) were conducted during the summer of 1988 by Concord College and Marshall University. The Snidow Site proved to be very productive in artifacts of the Late Woodland and Fort Ancient Cultures. The material excavated from the Snidow Site and the palisaded village showed possibly a continuous occupation with a late Woodland-Missippian influence. Finds included portions of five palisade lines, circular housepatterns, and numerous burials, mostly children. This presentation is a review of the first season's work. More extensive archeological work is needed at the Snidow Site to provide better understanding of the area's prehistoric Indian cultures. The Snidow Site could prove to be one of the largest and most important sites in West Virginia to date.

BILL REGER, Bayer Wellness Program, Wellsburg, WV 26070, and JOHN H. HULL and JANICE L. WATSON, Bethany College, Bethany, WV 26032. The Bayer Wellness Program in Wellsburg, West Virginia: An Interim Report.

In May, 1988, 997 residents of Wellsburg, West Virginia, took part in a baseline screening as part of the Bayer Wellness Program. Bayer Aspirin's program is designed to improve cardiovascular health in Wellsburg, and to serve as a model health promotion program for other communities in rural America. Specific components of the Program include: educational seminars on exercise, stress management, and nutrition; behavior modification programs focusing on smoking cessation (Smoke Stoppers), and weight and cholesterol control (Leaner Weigh). Additionally, exercise classes are conducted daily for those at different fitness levels.

Analyses of data collected on 813 of the original 997 participating residents six months after the baseline screening show: statistically significant decreases in weight (5.26 lb, $p < .001$); percent of body weight which is body fat (3.23%, $p < .001$); resting pulse rate (4.80 bpm, $p < .001$); resting systolic blood pressure (5.32 mmHg, $p < .001$); resting diastolic blood pressure (1.91 mmHg, $p < .001$); cholesterol (10.31 mg/dl, $p < .001$); a statistically significant increase in high-density lipoproteins (0.79, $p < .01$); no significant changes in triglycerides. Results from the nine-month screening conducted in February, 1989, also will be discussed.

Biochemistry/Chemistry

P. CARNES, H. HAAS, T. McGREW & R. MARTIN, Chemistry Department, West Virginia State College, Institute, WV 25112.
Malondialdehyde in yogurt: a preliminary survey.

Malondialdehyde ("MDA") is a relatively well-characterized carcinogen that is believed to cause mutations and tumors by crosslinking DNA (1). It causes nuclear abnormalities and elicits DNA repair in cultured rat fibroblasts at concentrations as low as 0.07 parts per million (1,2) and causes skin tumors within 30 weeks in more than 50% of treated mice after one application (3). People who consume foods that are rich in MDA (e.g. cooked animal products) suffer approximately 15% higher mortality rates from both cancer and cardiovascular disease (4). We have begun to investigate the malondialdehyde content of yogurt to facilitate more accurate assessment of average daily MDA intake in the United States and Canada. Initial results obtained with Breyers, Columbo, Dannon, Esprit, Kroger, Lightn' Lively, Weight Watchers, Yoplait and Yubi brands indicate that yogurt frequently contains MDA at potentially dangerous levels. Observed concentrations ranged from 0.08 to 1.10 ppm and averaged 0.32 ppm. One brand of yogurt averaged 0.70 ppm, well above the others ($p < 0.005$, $n = 8$). These concentrations are similar to those found in cooked meat (5) and are approximately four times the level at which nuclear abnormalities and DNA repair are induced in vitro. Neither fat content nor flavor appeared to be related to MDA level in this initial survey. All samples were processed prior to the last permitted date of sale and within several hours of purchase. To measure MDA content, we modified standard procedures for determination of thiobarbituric acid reactive material (2,6). The strongly absorbent MDA-thiobarbituric acid reaction product (molar absorptivity at 532 nm = 156,000 (6)) was identified in representative samples by scanning visible spectrophotometry after purification with Waters C18 Sep-Paks and high performance liquid chromatography.

(1) R.P. Bird, H.H. Draper (1980) J. Toxicol. Environ. Hlth. 6, 811-823.
(2) H.H. Draper, L.G. McGirr, M. Hadley (1986) Lipids 21, 305-307.
(3) R.J. Shamberger, T.L. Andreone, C.E. Willis (1974) J. Natl. Cancer Inst. 53(6), 1771-1773.
(4) R.L. Phillips, J.W. Kuzma, W.L. Beeson, T. Lotz (1980) Amer. J. Epidemiol. 112(2), 296-314.
(5) G.M. Siu, H.H. Draper (1978) J. Food Sci. 43, 1147-1149.
(6) L.W. Yu, L. Latriano, S. Duncan, R.A. Hartwick, G. Witz (1986) Anal. Biochem. 156, 326-333.

H. WAYNE ELMORE and MARK B. WATSON, Dept. of Biology, Marshall University, Huntington, WV 25701 and ALAN R. WHITE, Dept. of Botany, North Dakota State University, Fargo, ND 58105-5517. Glycosyl composition and linkage analysis of polysaccharides released from cell walls of bracken fern cell suspension cultures.

Bracken fern extracellular polysaccharides derived from the culture medium of suspension-cultured cells were analyzed. The extracellular polysaccharides were precipitated with 70% ethanol and charged polysaccharides were removed by QAE Sephadex ion exchange chromatography. Fractions were pooled, dialyzed, lyophylized and subjected to Bio-Gel A-5m and Bio-Gel A-0.5m gel filtration chromatography to separate different sized fractions of polysaccharides. Major polysaccharides groups isolated were large, eluting close to the void volume of a Bio-Gel A-0.5m column. Glycosyl-compositions of pooled column fractions were determined by gas chromatography using the alditol acetates method and glycosyl-linkage compositions were determined by gas chromatography/mass spectrometry using methylation analysis. A major component of the extracellular polysaccharides was a type II arabinogalactan. The arabinoglactan contained 17% terminal arabinosyl and 14% 3,6-linked galactosyl residues. The small amounts of terminal xylose (5%) and 4,6-linked glucose (15%) detected suggests that xyloglucan is a minor component of bracken fern extracellular polysaccharides. The small amounts of charged sugar residues detected indicate that pectins are a minor component of the extracellular polysaccharides. The small amounts of xylosyl residues detected indicate that arabinoxylans, a major hemicellulose of monocots, is only a minor component of bracken fern extracellular polysaccharides.

MARCIA HARRISON. Department of Biological Sciences, Marshall University, Huntington, West Virginia 25755. Preliminary isolation of a heat-stress signal in peas.

Many stress conditions are known to stimulate the production of ethylene in plant tissue above the low basal rate. These include mechanical or chemical injury, chilling, heat-shock, drought, and flooding. A pulse of high temperature (>35° C) delays the ethylene response but increases ethylene production after normal temperature is restored. Wound ethylene production in excised pea stem tissue is characterized by a 25-30 min lag and reaches a maximum rate at approximately 60 min. Washing excised stem segments immediately after excision, significantly reduces this wound ethylene response. Exogenous compounds supplied to the cut surfaces of washed-excised pea stems can be assayed for their wound ethylene stimulating ability in this system.

Extracellular fluid (apoplast) of pea stem segments was removed by mild centrifugation and assayed for the presence of ethylene-stimulating factors after heat-shock, chilling or flexure treatment. Notably, apoplast from segments pulsed with 42° C for 2 min induced a 167% increase in ethylene production over segments supplied with control apoplast. Therefore, a putative 'heat-shock factor' in the apoplast was proposed. Preliminary isolation of this factor indicated

that it is not associated with the carbohydrate fraction of the apoplast and is not a known hormone such as auxin, cytokinin or the ethylene precursor, laminocyclopropane-1-carboxylic acid (ACC). Further biochemical analysis and isolation of the heat-shock factor will be presented.

JAMES B. HICKMAN, Department of Chemistry, West Virginia University, Morgantown, WV 26506-6045. The first hundred years of chemistry at West Virginis University: 20 full professors and one more, 1869 - 1969.

Twenty men (no QQ) attained the rank of (full)professor at WVU between September, 1869, when instruction in chemistry began, and May, 1969, when the first century ended. J(ohn) J(ames) Stevenson began the century, teaching in the old Monongalia Academy building, Spruce and Walnut Streets. In 1871, Stevenson returned to his alma mater, NYU, where he had received the Ph. D. in 1867, to rise to national fame (vp AAAS) as a geologist. In 1873, William M. Fontaine, A. M., U. of Va., '59, Captain (Ordnance), CSA, came to WVU. He remained until 1879, when Virginia reclaimed him. He wrote the first publication (Asphaltum deposit in Ritchie Co., Sillimans J., Chem. Centr.) in chemistry for WVU. Woodville Latham, no college degree, 1880-85 was a true character. He fought with Janitor Danser continuously, was exhonorated on charges of public drunkenness, and established lab. instruction in chem. at WVU. Alexander R. Whitehill, A. B., A. M., Princeton, '74,'76, Ph. D. hon. c. 1887, W. & J. Head of Chem. '85 - 1917. Prolific publicist of W. Va., no article(s) ever abstracted by C(Z)entr. or Chem. Abs. Only Morgantower ever full prof. chem. WVU, Bert Holmes Hite, B. S., WVU '90, M. S. (hon. c.) WVU, '96 served through May, '98. Otto Folin, born in Sweden (US 16 y), Ph. D., Chicago, '95, Asst. Prof. WVU 1899-1900. Prof., Harvard, 1907 -, Member National Acad. Sci. Frederick L. Kortright, Sc. D. Cornell, '95, apptd. WVU 1900, full prof. 1907 - death, 1914. Friend E. Clark, B. S., WVU '98, Ph. D. Johns Hopkins '02, instr. WVU 1902-03, prof. '14, head '17 -'47. Five abstracted publications. Samuel Morris, Ph. D. OSU '21, prof. '21 - '47; Hubert Hill, M. S. U. [illegible] C., '11, prof. '28 - '50; Carl A. Jacobson, Ph. D. Hopkins '08, prof., WVU '21 - '46. E. C. H. Davies, Ph. D., Chicago, '17, prof.'32-'50. Remainder still well remembered: Robert B. Dustman, Armand R. Collett, Charles L. Lazzell, John A. Gibson, Jr., James L. Hall, James B. Hickman, Chester W. Muth, George L. Humphrey, Vincent J. Traynelis. All Am. Men of Sci. except Latham, Whitehill, and Morris.

L. T. MASHBURN, Div. Structural Biology and T. A. MASHBURN, JR., Div. Functional Biology, WV School of Osteopathic Medicine, Lewisburg, WV 24901. Protein kinases and their inhibitors in plasmacytoma MOPC-315.

Protein kinases (PKs) are important conveyors of stimuli from ligands bound to cell surface receptors to loci which induce intracellular or intranuclear effects. Our studies have focused on the modulators involved in regulation of lymphoid tumors (plasmacytoma, MOPC-315, in BALB/c mice). Tumor tissue (cultured cells or solid tumor grown *in*

vivo) was extracted with 20 mM Tris-HCl, pH 7.5, containing 1 mM $CaCl_2$, 50 mM mercaptoethanol, and 2 mM PMSF using a polytron (2 X 15 sec) to yield a mixture of kinase activities and, at least, one associated PK inhibitor. Protein phosphorylation (^{32}P-ATP, kinase assay) was measured in the presence of NaF to inhibit phosphatase activity. When crude homogenates were fractionated by differential centrifugation, most of the kinase activity was found in the microsomal or cytosolic fractions (pellet or supernatant of 100,000 x g). In contrast, the mitochondrial (40,000 x g) fraction, inhibited the kinase activities of the preparations. DEAE-cellulose chromatography of the cytosolic fraction yielded at least 2 peaks of kinase activity which eluted at 0.17 and 0.24 M NaCl. Autoradiography of PAGE electrophoretograms of the assay mixture showed that these enzymes could phosphorylate various putative endogenous substrates. Added protamine or histone (II-S or III-S) was strongly phosphorylated and, surprisingly, increased the phosphorylation of endogenous substrates. Partially purified inhibitor almost totally abolished phosphorylation of exogenous, and some endogenous, substrates but caused only moderate inhibition of the phosphorylation of other endogenous substrates. The inhibitor was stable at -20°, at 37° for >16 h, at 45° for 1 h, and was destroyed in 5 min at 56°. Moreover, the inhibitor is very high molecular weight as it appeared in the void volume on gel exclusion chromatography (AcA-34, > 400,000 d) and was retained by Amicon YM-100 on ultrafiltration. Interactions of the inhibitor(s) with the various kinases may alter the mechanism of controls within the tumor cell.

Biology

DAVID E. BROWN & PAUL C. HARRISON
WVSOM and Univ. of Illinois

Local regulation of blood flow to the gravid uterus during hyperthermia

Two experiments were performed to determine if H^+ and/or CO_2 changes during acute heat challenge of the pregnant ewe are responsible for reduction of uterine blood flow UBF. In Expt 1, five ewes were instrumented with an electromagnetic flow probe. Ewes were subjected on alternate days to heat episodes in a metabolic chamber which reached 40 C in 1.5 hr. beginning 5 days post surgery. At the time of maximum depression of UBF, chamber CO_2 was elevated to 3% with addition of pure CO_2 gas. Heart rate, RR, MAP and UBF were recorded every 5 min. Ewes were in respiratory alkalosis (pHa 7.85, $PaCO_2$ 10.2 mmHg) and UBF had decreased ($P<.05$) from 467 to 234 ml/min at the start of CO_2 gas. Fifteen min of elevated atmospheric CO_2 resulted in pHa 7.60, $PaCO_2$ 24.2 mmHg and UBF increased ($P<.05$) 320 ml/min, 75% of the thermoneutral flow rate. UVR decreased during CO_2 to 0.47 $mmHg \cdot ml^{-1} \cdot min$.

In the second experiment nine ewes were instrumented and subjected to acute heat stress episodes as in Expt 1. Ewes were infused with either 0.9% NaCl (S), n=9, or 0.5 M MOPS buffer pH 6.8 in 0.9% NaCl (MOPS), n=7 at the time of maximum UBF depression. Infusions were given at the rate of 16.7 ml/min for 45 min. Ewes were in respiratory alkalosis at the time of infusions; pH 7.76-7.84, $PaCO_2$ 13.7-14.0 mmHg for S and MOPS respectively. UBF was depressed ($P<.05$) from 429 to 251 and from 458 to 305 ml/min for S and MOPS treatments, respectively. After infusions S ewes had continued respiratory alkalosis. UBF remained at 260 ml/min. MOPS resulted in pH decreasing from 7.84 to 7.62 ($P<.05$) while hyppocapnia persisted (14.0 VS. 16.4 mmHg $PaCO_2$). UBF increased ($P<.05$) from 66% to 73% of thermoneutral flow rates. Uterine vascular resistance increased by the start of MOPS ($P<.05$) and decreased to thermoneutral levels with 45 min of MOPS infusion.

One half of the reduction in UBF during acute heat exposure is a result of resistance changes associated with vascular pH and/or $PaCO_2$. This suggests local metabolic control of uterine blood flow by H^+ and or CO_2 occurs in the gravid ewe.

BETH CHOBY and E.C. KELLER, JR. Department of Biology, West Virginia University, Morgantown, WV 26506. Major Relationships Among Types of Human Mortality in West Virginia.

Correlations among 38 classes of human mortality in the 55 counties of West Virginia were examined. The data were compiled from mortality records on computer tapes obtained from the WV Health Department and covered a 24 year period between 1959 and 1982. The 38 classes of mortality were those used by the WV Health Department in their annual reports. The 38 mortality variables examined were averages for each county over the 24 year period.

Correlations among the variables were grouped at the r=0.90, r=0.80, r=0.70, and r=0.60 levels. Three distinct subgroups emerged. Group I included those neonatal related mortality classes; mortality group II included death due to pneumonia and influenza; and group III represented major cardiovascular and cancer mortalities. Groups II and III were related at the r=0.70 level, but group I variables remained separate at all correlation levels examined.

In addition, the six highest and six lowest counties for each of the 18 mortality variables in groups I through III were determined. For these mortality classes, Mason, Marshall, Ohio, Webster, Ritchie, Doddridge, Lewis, and Taylor counties showed high group I through group III mortality rates. Conversly, Putnam, McDowell, Logan, Wyoming, Boone, Wayne, Grant, and Hardy counties showed low mortality levels. Overall, Southern West Virginia was low in the major cardiovascular and pneumonia/influenza categories but high in neonatal mortalities. A band of counties which runs through Central West Virginia was high in all three categories.

ELIAS COSTIANES and E.C. KELLER, JR. Morgantown, WV and Biology Department, West Virginia University, respectively. Methodology and Treatment of TMJ Symptoms.

Since Costen related a dysfunctional syndrome of the temporomandibular joint (TMJ) to the teeth (in the 1950's), clinicians and scientists have discussed various concepts of pathology, diagnosis, and treatment of the disorder. A considerable number of research articles, clinical observations, and personal testimonials offer insight into the complex nature of this condition. The diagnosis of TMJ joint syndrome has traditionally been made on the presence of a group of clinical symptoms that produce pain and limit movement. At the present time, advanced bioelectronic technology makes an accurate diagnosis possible, based not merely on clinical symptoms, but on reproducible scientific data. Using these methods, a specific cause of TMJ syndrome is discern-

able and thereby makes reliable treatment possible. These data, and subsequent treatment, make long-lasting resolution of symptoms objectively monitorable with the Mandibular Kinesiograph (MKG 5-R). The Myo-monitor, a transcutaneous electrical neural stimulation device, (TENS), is a therapeutic device that painlessly induces relaxation of hyperactive or spastic muscles. TENS is not a pain suppresant. Electrical stimulation is applied over the area bilaterally between the condyle and coronoid processes of the mandible. It stimulates the mandibular division of the fifth cranial nerve, as well as the seventh cranial nerve, located superficially. The amplitude of stimulus is adjusted by the operator to provide the minimal stimulus that produces a palpable rise of the mandible. This is considered a clinical threshold of muscle contraction.

In our study, all patients were checked for spastic pterygoid muscles by a TENS device to assure a relaxation of these muscles prior to evaluation with a Kinesiograph. The Kinesiograph enables the three-dimensional positioning of the Mandible in space. From the Kinesiograph information on positioning, physiological occulusal splints were constructed.

A list of 187 symptoms that were monitored for possible relief by proper TMJ treatment are quite varied. This has been shown by a variety of studies mainly in the U.S. and in Japan. The results of these earlier studies will be discussed in relation to our findings.

J. LAURENCE DAVIS and JOHN BURNHAM,
Division of Functional Biology, West Virginia School of Osteopathic Medicine, Lewisburg, West Virginia, 24901. Effects of oxygen tension on the binding of glucose to hemoglobin of human erythrocytes.

Formation of the glycosylated hemoglobin, HbA1c, occurs via two sequential, nonenzymatic reactions in erythrocytes. Glucose binds reversibly to the N-terminal amino group of a beta chain to produce the aldimine intermediate, pre-HbA1c, which slowly rearranges to the stable ketoamine product, HbA1c. The rate of formation of HbA1c in human erythrocytes incubated under anaerobic conditions has been reported to be twice the rate under aerobic conditions. In order to determine the effect of oxygen tension on the steady state concentration of pre-HbA1c, we incubated erythrocytes with glucose at high and low oxygen tensions. Erythrocytes isolated from human blood samples were suspended in a medium containing 1000 mg/dl glucose, 144 mM Na^+, 5.4 mM K^+, 1.8 mM Ca^{2+}, 0.8 mM Mg^{2+}, 125 mM Cl^-, 26 mM HCO_3^-, 1.0 mM phosphate, and 0.8 mM sulfate. Using a shaker bath, incubations were carried out for 6 hours in flat culture bottles with a gas mixture flowing over the agitated surface of the cell suspension. The aerobic gas mixture contained 20% O_2, 5% CO_2, and 75% N_2, and the anaerobic gas mixture contained 5% CO_2, and 95% N_2. A portion of each sample of erythrocytes was also incubated in a glucose-free medium to remove pre-HbA1c. At the end of the incubations, pO_2, pCO_2, and pH of the suspensions were measured, and glycosylated hemoglobin was assayed by column chromatography which measures both pre-HbA1c and HbA1c together. Pre-HbA1c concentration was calculated for the cells incubated with glucose by subtracting the value for the cells incubated

in the glucose-free medium. The mean pO_2 for the aerobic incubations was 143 mmHg versus 8.2 mmHg for the anaerobic incubations. At low oxygen tension the steady state pre-HbA1c concentration was only 1.28 times greater than at high oxygen tension. Thus, the rate of conversion of pre-HbA1c to HbA1c must also be increased at low oxygen tension.

E.C. KELLER, JR. and ELIAS COSTIANES, Biology Department, West Virginia University and Morgantown, WV, respectively. TMJ Syndrome Symptom Removal by Oculusal Splint Treatment of 99 Patients.

Ninety-nine patients (72 females and 27 males) were treated for TMJ Syndrome. Data were obtained on 187 symptoms before and after treatment.

The findings indicated that there was a declining profile of the frequency of occurrence of symptoms. This frequency profile ranged from 0 to 71%. However, most of the symptoms occurred less than 60% of the time. In regard to the distribution of symptom removal, three general groups were observed viz., 1) those symptoms for which TMJ treatment had little effect, (about 40% of the symptoms), 2) those symptoms with a moderate amount of removal (about 5% of the symptoms), and 3) those symptoms with significant to complete removal (about 55% of the symptoms). Different frequency of occurrance profiles of symptoms and different distributions of symptom removal were found between males and females as a result of TMJ treatment.

John A. Schriefer, Ph.D., Department of Pharmacology, West Virginia School of Osteopathic Medicine, Lewisburg, WV 24901. Effect of Opioids on Oxytocin-induced uterine contractions.

The posterior pituitary hormone, oxytocin, contributes to the production of contractions in the term pregnant uterus during labor. Endogenous opioid peptide systems become active during pregnancy and labor, but little information is available regarding the effects of endogenous opioids on uterine contractility. This study was designed to examine possible interactions of oxytocin and opioids in the production of contractions in the term pregnant rat uterus, in vitro. Pregnant rats were decapitated on the 22nd day of pregnancy, and the uterus rapidly excised. Fetuses were removed from the uterus, and 1 1/2 cm segments of uterus from the center of each uterine horn isolated and suspended in a tissue bath containing oxygenated Munsick's solution at 37°C. After 30-60 min equilibration, the tissues were exposed to oxytocin and isometric contractions recorded. A dose of oxytocin producing a 50% maximal contraction was selected and the effects of various opioid drugs on the OT-induced contraction determined. Morphine (10^{-6} M) was found to enhance

OT-induced contraction. Naloxone (10^{-6} M) blocked the morphine enhancement of contraction. DAGO (a mu agonist) and U50,488H (a kappa agonist) inhibited OT-induced contractility, while D-penicillamine 2,5-enkephalin (a delta agonist) was without effect. These findings suggest that endogenous opioid systems could have a functional role in the production of uterine contractions during labor. (Supported by WVSOM Intramural Research Funds and USPHS Grant HD 22362.)

JAMES P. WELLS, PH.D., West Virginia School of Osteopathic Medicine, 400 North Lee Street, Lewisburg, WV 24901, Neural Control of Locomotion: Kinematic and Kinetic Evidence

Locomotion requires the complex interaction of both muscles and external forces which act upon the link system. Kinematic studies may provide evidence of underlying principles relative to the neural control of locomotion. Thus, in addition to forces arising from muscle contraction, both gravitational and interactive forces may also influence limb trajectory. Muscle contributes primarily to the following: 1) stabilization of body segments so that the muscles in more distal segments may work against a stable bases of support; 2) counteraction of torques which arise as a result of the mechanical interaction of one segment moving about another segment already in motion; 3) deceleration of limb segments by eccentric contraction of muscles; 4) control of trajectory of the body segment in space; and 5) initiation of movement and development of body segment acceleration.

Studies of non human primate leaping demonstrate a commonality of pattern in joint role. For instance, similar sequences of stability verses active contribution by muscles occur in both Lemur fulvus and Cercopithecus atheiops leaping in similar preparatory, transition and lifting phases.

This study demonstrated that the key element to understanding recruitment patterns of muscle and other parameters of neural control may lie in a detailed understanding of these patterns of change in role of body segment joints during movement.

Funded by a grant from the Bureau of Research of the American Osteopathic Associaton and a grant from the West Virginia School of Osteopathic Medicine.

Botany

WM. HOMER DUPPSTADT, Department of Biology, West Virginia University, PO Box 6057, Morgantown, WV 26506-6057. Updates on the Vascular Flora of West Virginia. V.

During the past year, the following species of vascular plants have been recorded at the West virginia University Herbarium as additions to the flora of West Virginia: Peltandra virginica (L.) Schott & Endl., Scleria pauciflora Muhl., Carex tetanica Schkuhr, Silene cserei Baumg., Lonicera maackii (Rupr.) Maxim. and Eupatorium godfreyanum Cronq.

VERNON W. KERNS, Route 1, Box 131, Shock, West Virginia 26638. An Investigation of Stalk Strength and Prolificacy in West Virginia Bloody Butcher Corn.

Many corn breeders are concerned about the narrowing of the United States corn germplasm used in the production of hybrid corn. This concern has led to many attempts to cross Iowa Stiff Stalk materials and Lancaster Surecrop materials with exotic germplasm. Some of these exotic germplasms are Tuxpeno, Tuson, Cuban Flint, ETO, Coastal Tropical Flint and others from South America, Africa, and Europe. The majority of these attempts have failed (Holley R. N. and Goodman, 1988).

However, corn breeders at Iowa State University have selected (by mass selection) an early version of ETO, a tropical composite. The resulting variety has been named BS 16 (Hallauer A.R.,1982).

Dr. M. M. Goodman of North Carolina State University selected inbred lines from pure tropical hybrids. These inbreds combined well with B73HTXA632 (Iowa Stiff Stalk Synthetic material, Holley and Goodman, 1988).

West Virginia has a variety of field corn that up until now has played only a minor role in the development of hybrid corn in this country. After having grown Bloody Butcher corn for several years, I decided this variety could add favorable genes, controlling yield and stalk strength, to hybrid corn.

Since 1985, I have been developing a foundation synthetic of Bloody Butcher corn. I have collected seed of four strains of this variety, which I named A, B, C, and D for the sake of record keeping. These varieties were planted separately. Prolific plants were selfed and two eared plants were selected in each variety. This S_1 seed of each variety was bulked forming four seed samples. These samples were then combined in a four way cross (A X B) (C X D). Selection for the two eared trait was practiced in each generation. The F_1 of the four way cross was planted in 1988. This F_1 generation of the synthetic had 37% root lodging and 38% of the standing stalks produced two ears of varying size. The bottom ear of prolific plants

was selfed and the top ear was fullsibbed. Forty-two selfed ears were bulked and used to produce the F_2 generation. Sixty-two ears which were fullsibbed and open pollinated were bulked to be detasseled and pollinated by the selected selfed ears.

Selection for strong stalks, prolificacy and low ears will be continued.

ROBERT K. RILEY, WILLIAM J. VAIL, AND DAVID L. BRANT, Biology Department, Frostburg State University, Frostburg, Md. 21532. Hymenoscyphus monotropae identified on the roots of Monotropa hypopithys.

The Ascomycete fungus, Hymenoscyphus monotropae was found growing on the underground roots of Monotropa hypopithys in mid-January in a Monotropa-oak association. Apothecia were found only on M. hypopithys roots. To our knowledge this is the first report of an association of H. monotropae with M. hypopithys. In the laboratory, apothecia were removed from the M. hypopithys roots and placed at a 45° angle on 4% w/v water agar. The violent ejection of ascospores from the asci carried the spores several millimeters beyond the apothecium, where they were easily seen under a microscope at 100X. Spore germination began within 8 hours and 75% germination occurred after 24 hours. previously, our laboratory had reported identical results for sporocarp development and laboratory spore germination for H. monotropae removed from Monotropa uniflora roots. We believe that H. monotropae is the mycorrhizal fungus for both M. hypopithys and M. uniflora.

Ecology

WM. JAMES ARNOLD, Four-Pole Research Associates, 409 Grand Boulevard, Huntington, WV 25705. A Notable Occurrence of the Bronze Copper, *Hyllolycaena hyllus* (Cramer), at Greenbottom Swamp, Cabell County, West Virginia (Lepidoptera, Lycaenidae).

The Bronze Copper butterfly, Hyllolycaena hyllus (Cramer), 1775, was found to occur in Cabell County, West Virginia, at Greenbottom Swamp (38°35'35"N, 82°14'55"W, elevation 550 feet). This is the first known record of the species in southwestern West Virginia. H. hyllus is a northern species ranging from the Northwest Territories south to Colorado, east then northeast from western Kentucky across Ohio to Newfoundland and then down the coast to Maryland. Heretofore, it had been documented in West Virginia only from the northern panhandle until reported by T. J. Allen (WV-DNR) in 1985-87 from Randolph County in the Allegheny/Central Highlands, from Marion and Monongalia counties in the northern hills, and from Brooke County in the northern panhandle. The Greenbottom site lies more than 100 miles from the nearest previously recorded West Virginia site. No records are known from localities in nearby Kentucky and Ohio counties.

Five individuals were observed during a visit in July 1987, patrolling or perching along a shady fence row and at the edge of a creek-side woodlot. Two, a male and a female, were taken as voucher specimens on July 18, 1987. H. hyllus appears near marshes, streams, ponds and wet meadows over neutral to alkaline soils. Its caterpillars are reported to feed mostly on dock plants, Rumex, particularly curly dock, R. crispus, observed at the swamp; and R. verticillatus, swamp or water dock, reported from Cabell County and possibly present at Greenbottom. The species appears in two broods across the warmer parts of its range, June-July and August-October, but none was seen in three visits at the swamp during September 1987, (a very dry year).

The locality is on the floodplain and within one-half mile of the Ohio River, situated at a shrub marsh and snag swamp along a small stream running through what remains of an 18th century historical land grant plantation. Despite pressures from long term adjacent cultivation and marginal inroads from railroad and highway construction, the site remains one of startling biological diversity and interest. It was recently acquired by the Army Corps of Engineers in mitigation for wetlands habitat destruction at a project. The Bronze Copper has been described by Klots as, "Not uncommon, but quite local." It has been described by West Virginia authorities as "rare" in abundance and "of scientific interest" and "habitat restricted". Its present disjunct distribution probably reflects a growing trend throughout its range, the effects of development, habitat destruction and encroachment upon wetlands.

The Cabell population occupies the lowest elevation of any in the state and appears to rival the one of Randolph for the distinction of being the southernmost in West Virginia, and if that is true, the most southerly Appalachian population of Hyllolycaena hyllus.

BRIAN HAGENBUCH, Plant Protection Programs, West Virginia Department of Agriculture, Charleston, WV, 25305, JAMES AMRINE, and TERRY STASNY, Division of Plant and Soil Science, West Virginia University, Morgantown, WV 26506. Distribution of rose rosette disease of multiflora rose and its eriophyid mite vectors in the United States.

Multiflora rose is regarded as the most serious weed pest of agricultural land in West Virginia. A 1981 census indicated that approximately 26,013 ha (at least 25%) of ground surface were infested with multiflora rose. Thus far, chemical and cultural practices have not been effective in controlling the noxious weed. Rose rosette, a disease of poorly known etiology, has been found killing multiflora rose in the midwestern United States and has gradually been spreading eastward. The disease, transmitted by the eriophyid mite Phyllocoptes fructiphilus, has shown considerable promise as a natural biological control agent. In 1986, the West Virginia Department of Agriculture and West Virginia University initiated a cooperative research program on rose rosette, the eriophyid mite vectors, and other arthropods associated with multiflora rose. In 1987 and 1988, rose rosette surveys were conducted in 11 other states as part of the National Cooperative Agricultural Pest Survey Program. To date, rose rosette has been found in 13 states and Canada, and P. fructiphilus from 11 states. Although surveys have not revealed the presence of rose rosette in West Virginia, P. fructiphilus was found in 31 counties throughout the state, and another potential vector, Phyllocoptes rosarum, was found in 30 counties. The presence of these mites indicates that rose rosette should be able to become established in West Virginia, whether by natural spread or artificial introduction. Because little is known about the disease and mites, current efforts are focusing on alternate hosts of rose rosette, isolation of the disease organism, and host-mite-pathogen interactions.

BRIAN HAGENBUCH, MICHAEL THOMAS, Plant Protection Programs, West Virginia Department of Agriculture, Charleston, WV, 25305, TOM McCUTCHEON, and JOSEPH WEAVER, Division of Plant and Soil Sciences, West Virginia University, Morgantown, WV, 26506. Species composition, distribution, and flight periodicity of adult Phyllophaga (Coleoptera: Scarabaeidae) in West Virginia.

Approximately 152 species of Phyllophaga, commonly known as May or June beetles, exist in North America, primarily in the northeastern United States. The larvae, or white grubs, feed on the roots of grasses and cause considerable damage to pastureland, golf courses and home lawns. Some adults are considered pests of shade and forest trees, ornamentals and fruit trees. Blacklight traps were monitored at various locations across the state

during 1987 and 1988 to determine the species composition, distribution and flight periodicity of adult beetles. Records from these surveys and from the Reference Collections of West Virginia University and West Virginia Department of Agriculture indicate that 25 species of Phyllophaga presently occur in the state. Six species were reported from only single counties. The most widely distributed species were P. fusca (15 counties), P. futilis and P. hirticula (13 counties), and P. anxia (12 counties). Flights for most species were in May and early June, with collection dates ranging from mid-April through the end of June. Information based on species trapped and flight periods should be useful to turf managers in predicting timing of spray applications for control of white grubs.

JEFFREY W. HIVELY, Dept. of Biological Sciences, Marshall University, Huntington, West Virginia 25701. Population dynamics of adult *Unionicola formosa* (Acari: Hydracarina); a parasite of *Anodonta imbecillis* (Mollusca: Bivalvia) in West Virginia.

Population dynamics of a parasitic aquatic mite, *Unionicola formosa* (Dana and Whelpley), were studied in two McClintic Wildlife Station (Mason County) ponds that supported different densities of the host mussel, *Anodonta imbecillis* (Say). Pond 27 with 26.0 host individuals/m^2 was categorized as a high density pond, while Pond 14 with 8.6 host individuals/m^2 was considered a moderate density pond. Collections were made monthly from May through November 1986. All hosts in both ponds were infected by female mites, but only 57 of 90 and 60 of 79 hosts, from ponds 14 and 27, respectively, were infected by males. Intensity of infection, as mean adult mites/host, was lowest in May (5.4 for Pond 14; 19.7 for Pond 27) and highest in August (12.9 and 31.3) for those ponds. While number of mites per host was positively correlated with host shell length for hosts in Pond 27, there was little or no correlation in Pond 14. Mite sex ratios were heavily female biased at 10.7:1 in Pond 14, and 18.5:1 in Pond 27.

JAMES E. JOY, HOWARD L. MILLS, Dept. of Biological Sciences, and STUART W. THOMAS, Office of Institutional Research, Marshall University, Huntington, W. Va. 25701. Spatial pattern of freshwater mussels, *Anodonta imbecillis* Say, 1829, in a West Virginia pond.

A sampling methodology developed and refined by plant ecologists is employed, with some modification, to evaluate population structure of the freshwater mussel, *Anodonta imbecillis* Say, 1829 in a West Virginia (Mason County) pond. It is proposed that certain population characteristics of mussels can be reliably predicted with a sample size of $\geq$ 20 individuals mapped within a circular area whose diameter is based upon population density. This is so because as N reaches 20, variations in the calculated value of area-per-point (or area-per-mussel) stabilize, and the $\sqrt{A/P}$ becomes a useful tool to estimate mean nearest neighbor distances

and evaluate spatial pattern. Departure of observed nearest neighbor distances from the random situation is tested with a percentile distribution Chi-Square analysis.

JOHN C. LANDOLT, Div. of Science and Mathematics, Shepherd College, Shepherdstown, West Virginia 25443 and STEVEN L. STEPHENSON, Dept. of Biology, Fairmont State College, Fairmont, West Virginia 26554. Distribution patterns of cellular slime molds in forest soils of West Virginia.

A study of the occurrence and distribution of cellular slime molds (CSM) in forest soils of West Virginia was carried out during the 1985-88 field seasons. Samples for CSM isolation were collected from 21 different study sites. The latter included examples of all of the major forest types that occur in the state and ranged in elevation from 146 to 1210 m. Twelve different species of CSM were isolated. The average number of species isolated at a given study site was 6.6, and the mean number of clones/gram of wet soil was 140. Based on importance values calculated from pooled data for all study sites within each of three different elevation ranges, several of the more widely distributed and abundant species have distribution patterns that show a response to elevation. For example, Polysphondylium violaceum, Dictyostelium minutum, and D. purpureum become less important with increasing elevation, whereas D. mucoroides and D. discoideum become more important. In general, absolute densities of CSM are highest in soils at lower elevations and tend to decrease with increasing elevation.

MICHAEL LITTLE, THOMAS PAULEY and M. DALE ADKINS. Dept. of Biological Sciences. Marshall University, Huntington, West Virginia 25701. The extent of acidification of vernal pools in the Appalachian Highlands of West Virginia.

During June of 1985 and 1986 we located 22 vernal and overflow pools in the northern half of the Monongahela National Forest, measured the pH of these pools, and surveyed their populations of larval amphibians. These pools contained larvae of Bufo americanus, Hyla crucifer, Rana sylvatica, Ambystoma maculatum, and Notophtalmus viridescens, and had pH's which ranged from 3.8 to 8.2 with a mean of 4.8. We located nine vernal and overflow pools in the Cranberry Wilderness Area of the Monongahela National Forest, sampled their larval amphibian populations, and measured: dissolved oxygen, air and water temperature, carbon dioxide, pH, and total alkalinity. These pools had mean pH's of 6.1, 6.0, and 6.2 and mean alkalinities of 1.7, 2.5, and 3.5 on June 4, June 17, and July 15 of 1985, respectively. Precipitation in this area had pH's of 4.78 and 4.51 in June and July of 1985 (West Virginia Department of Natural Resources). These pools with little alkalinity had relatively high pH's in an area of high acid deposition. Larvae of R. sylvatica, B. americanus, H. crucifer, A. maculatum and N. viridescens were identified from these pools. Although H. crucifer and B. americanus are normally abundant in the eastern mountains of West Virginia, these species constituted

only two percent of larvae samples in the Cranberry Wilderness Area. Ninety-six percent of larvae sampled were R. sylvatica.

ROBERT NORMAN and DONALD TARTER. Dept. of Biological Sciences, Marshall University, Huntington, West Virginia. Effects of artificial lake destratification on the benthic macroinvertebrate populations in Beech Fork Lake, West Virginia.

The benthic macroinvertebrate populations at Beech Fork Lake, Wayne County, West Virginia, were studied in 1987 to determine the effects of first year operation of artificial destratification fans upon the populations compared to pre-destratification samples taken in 1985. The samples were taken from two stations at 5 and 15 feet and 15 feet at two additional stations during all sampling seasons. Water quality profiles were also taken weekly from each study period.

The analyses of the benthic macroinvertebrate populations and water chemistry show significant changes occurring during both seasons in first year operation based on MANOVA ($p < 0.05$), t-tests ($p < 0.05$) and step-wise discriminate analysis ($p < 0.01$). Significant increases have occurred in number of individuals, diversity values, number of taxa, and temperature. Depending upon the location, significant increases and decreases have occurred in the dissolved oxygen values. Significant decreases occurred in the pH values. The resident benthic macroinvertebrate populations migrated into the profundal zone. The overall trophic structure shows a slight trend towards the resident detritovores and away from the predators. Based on Wilks' Criterion, significant ($p < 0.05$) overall increases have occurred in the benthic populations during both seasons. The benthic macroinvertebrate populations at Beech Fork Lake are limited by the water quality. The changes in the water quality that have occurred in 1987 due to operation of the destratification fans are favorable for the benthic macroinvertebrate populations.

THOMAS PAULEY and MICHAEL LITTLE, Dept. of Biological Sciences, Marshall University, Huntington, WV 25701. The assessment of salamander populations in an Appalachian forest.

Salamander species in two watersheds in the Fernow Experimental Forest (Parsons, West Virginia) were studied monthly from May through September to determine population sizes, niche overlaps, fluctuations of surface densities, selection of natural vs artificial cover objects (boards), and the influence of aspect and elevation on species composition and density. One watershed had slopes facing north and south, and the other watershed had southwest and northeast aspects. Elevation ranged from 2,000 ft (609.6m) to 2,200 ft (670.6m) in one watershed and 2,400 ft (731.5m) to 2,520 ft (768.1m) in the other. Both stream and terrestrial species of salamanders were considered.

Three species, Plethodon cinereus, Plethodon g. glutinosus, and Desmognathus ochrophaeus, were found to be the dominant terrestrial forms. One species, Desmognathus m. monticola, was the most common in the streams. There was broad niche overlap between two of the

terrestrial species (P. cinereus and D. ochrophaeus). Surface densities of both terrestrial and aquatic forms showed monthly fluctuations. Only the terrestrial salamanders selected artificial cover objects more frequently than natural objects. Species composition and density showed no relationship to aspect and elevation.

S. CRAIG STAMM and E.C. KELLER, JR., Department of Biology, West Virginia University, Morgantown, WV. Associations of *Bdellovibrio* and Other Non-colony Forming Lytic Organisms with Aquatic Environmental Parameters

A survey was performed at eight river sites in the upper Monongahela River Basin from August through October, 1988. The objective of this survey was to examine the frequency of occurrence and the environmental relationships of predatory Bdellovibrio (and other small bacteria and bacteriophage) in the aquatic environments. The river sites ranged from Philippi on the Tygart River to Shinnston on the Westfork River to Morgantown on the Monongahela River. The water was examined for lytic non-colony forming bacteria and bacteriophage from water filtered through 1.2 um Millipore filters and plated in an overlay fashion with suitable Bdellovibrio host bacteria viz., *E. coli* (B) (ATCC 15144) and *Pseudomonas putida* (ATCC 12633). Also, nonfiltered river water was examined for environmental parameters such as pH, total bacteria, conductivity, and water temperature. Once these organisms were isolated and propagated on their respective host culture, lytic isolates were placed on overlays of host bacteria which had been mutated to streptomycin resistance. In all, 370 isolates were recovered from the *E. coli* (**Ec.**) hosts and 343 from the *Pseudomonas putida* (**Ps.**) hosts. Of these confirmed isolates, 72 on **Ec.** and 113 on **Ps.** were streptomycin sensitive.

Our studies showed three general levels of Bdellovibrio/small bacterial isolates. The Westfork River yielded high numbers of lytic isolates, the Monongahela intermediate levels, and the Tygart low numbers.

The correlation matrices showed high correlations for two environmental parameters with the numbers of Bdellovirio/-small bacteria detected. The total number of bacteria had a correlation of r=0.97 with the number of Bdellovibrio/small bacteria isolates obtained on **Ps.** The correlation of the number of isolates of Bdellovibrio/small bacteria on the **Ec.** host with the number of total bacteria was r=0.89. Conductivity had a correlation of r=0.94 with the number of isolates of Bdellovibrio/small bacteria on the **Ps.** host and r=0.87 for the number of isolates of Bdellovibrio/small bacteria on the **Ec.** host. Also of interest is the high correlat ion between most of the historic divalent cation levels for those sites with the number of lytic Bdellovibrio/small bacteria present in the river environment.

STEVEN L. STEPHENSON and JOHN W. NEVILLE, Dept. of Biology, Fairmont State College, Fairmont, West Virginia 26554. A preliminary study of Myxomycetes in the litter microhabitat.

The moist chamber culture technique was used to study the myxomycete communities associated with the litter microhabitat in temperate forest communities in eastern North America. Primary emphasis was on analyzing patterns of species composition and species diversity. Samples of leaf litter collected from twelve study sites in North Carolina, Virginia, and West Virginia were used to prepare a total of 1214 moist chamber cultures, with each study site represented by at least 100 cultures. At least 50 species representing 20 different genera appeared in these cultures, including one species new to science and two species that are new records for North America. Arcyria cinerea was exceedingly common and appeared in 46% of all cultures. Diderma effusum, Comatricha lurida, Cribraria microcarpa, Echinostelium minutum, Diderma testaceum, Stemonitis herbatica, and Comatricha laxa were the other species represented by more than 20 collections. The number of species recorded for a given study site ranged from 5 to 20 (mean = 13.5), whereas species diversity (Shannon's formula) ranged from 0.34 to 0.96 (mean = 0.69).

STEVEN L. STEPHENSON and LAURA J. FRIDLEY, Dept. of Biology, Fairmont State College, Fairmont, West Virginia 26554. Interspecific associations and niche relationships in Myxomycetes.

Cole's index of interspecific association was used to evaluate associations between different species of Myxomycetes (plasmodial slime molds) occurring together in 1214 moist chamber cultures prepared with leaf litter collected from twelve study sites in North Carolina, Virginia, and West Virginia. Based on values computed with this index, associations between species were relatively weak. Nevertheless, some degree of resource partitioning among different species would seem to exist, since most species were found to display distribution patterns that seemingly reflect differences as to their ecological optima. In an effort to quantify resource partitioning, values of niche breadth (the Levins equation) and niche overlap were calculated for 10 quantitatively important species of litter-inhabiting Myxomycetes, using data from 507 cultures prepared with litter collected from five study sites in southwestern Virginia.

ALAN TURNER and DONALD TARTER, Dept. of Biological Sciences, Marshall University, Huntington, West Virginia. Influence of brine pollution upon macroinvertebrates in three streams of the Pocatalico River, West Virginia.

Physico-chemical conditions and benthic macroinvertebrate community structure were compared among three headwater streams influenced by oil field brines within the Pocatalico River Basin in West Virginia. The River Continuum Concept model was applied to distinguish oil field brine influences from the natural influences acting upon the benthic macroinvertebrate community. Community structure was quantitatively related to the physico-chemical conditions by Analysis of Variance and Ecological Community Analysis.

Salinity was unique for each stream, from highly saline or brackish water at McKown Creek, to moderately saline water at Johnson Creek, to fresh water at Flat Fork. Flow acted in conjunction with salinity to maintain low density populations within the saline streams. Reduced abundance without a corresponding change in richness created diversities within high and moderate salinities that equaled or exceeded those within fresh water.

Although richness remained fairly constant, the taxonomic composition tended to be highly variable among the streams. Hemimetabolous species with well developed or protected tracheal gills replaced insects without gills within moderate salinitites. Holometabolous replaced hemimetabolous forms within high salinities. Structural and functional characteristics of the stream communities appeared to be conserved through the replacement of brine-intolerant forms with brine-tolerant forms as long as replacement species existed within the streams.

The Ecological Community Analysis identified as predominance of burrowing invertebrates, mainly oligochaetes, existing within the saline streams. Turbidity, total suspended solids, and percent burrowing community values recorded for the saline streams did not conform to predictions of the River Continuum model. This is maybe due to greater siltation occurring within the saline streams. Brine influences adversely affect benthic macroinvertebrate community structure within lower salinities than previously identified by toxicity testing and biological indices.

Zoology

JAMES AMRINE and TERRY STASNY, Division of Plant and Soil Sciences, P.O. Box 6108, West Virginia University, Morgantown, West Virginia 26506. The eriophyid mite, Paraphytoptus pannolus K. on giant ragweed, Ambrosia trifida L.

The eriophyid mite, Paraphytoptus pannolus K. was described by H.H. Keifer in 1962 from giant ragweed, Ambrosia trifida L in Charlottesville VA. Keifer found it in July on the lower surfaces of leaves. The biology of this mite is of special interest because the plant is a cool temperate zone annual. The vast majority of eriophyid mites occur on biennials or perennials and overwinter as adults in protected sites on the host plant. How does P. pannolus overwinter? Terry Stasny found a few specimens of this mite on leaves and larger numbers in pistillate flowers of giant ragweed in Morgantown in the summer of 1988. Additional collections were made in other locations in Ohio and West Virginia. In August and September, we found large numbers of developing mites in the pistillate flowering heads which are clustered in the axils of the upper bract-like leaves. All stages of the mite were abundant on the small bract-like leaves surrounding the fruit. Development continued until late October, 1988, when frosts caused browning of the foliage. In late September, each pistil shriveled within the apical tube on the fruit, resulting in an opening large enough for mites to enter. We found mites inside two of several dozen fruits examined in November. We are continuing studies on this mite and its host plant to determine if the mites are able to overwinter within the fruits. Seeds will be collected from sites where mites were present and will be germinated to see if mites appear on the seedlings. The mites did not appear to cause injury to the flower heads or to the seeds. This mite-weed relationship should be carefully studied for the potential of finding a biocontrol agent for giant ragweed. Perhaps a population of the mites will be found that damages flowering parts and thus may help reduce reproduction of this noxious weed.

LISA BURGESS and DONALD TARTER. Dept. of Biological Sciences, Marshall University, Huntington, West Virginia. New state record of the mayfly Baetisca gibbera Berner for West Virginia (Ephemeroptera:Baetiscidae).

Baetisca gibbera is reported for the first time from West Virginia. Nymphs were collected from Indian Creek in Summers County. Available records from the literature indicate a disjunct distribution. The species occurs in Alabama, Florida, Georgia, Mississippi, South Carolina, Tennessee, and Virginia. Additionally, state distribution records of the genus Baetisca are reviewed from the literature.

DONALD TARTER, KIMBERLY RUGGLES, and SANDRA GILLENWATER, Dept. of Biological Sciences, Marshall University, Huntington, West Virginia and DIANE NELSON, Dept. of Biology, East Tennessee State University, Johnson City, Tennessee. First records of water bears (Phylum:Tardigrada) from West Virginia.

Fourteen species of tardigrades, representing nine genera (Diphascon, Hypechiniscus, Hypsibius, Isohypsibius, Itaquascon, Macrobiotus, Milnesium, Minibiotus, Pseudechiniscus), were collected from mosses (Atrichum augustatum, A. serpens, Brachythecium salebrosum, Dicranum scoparium, Endodon cladorrhizans, Hedwigia ciliata, Hypnum pratense, Platydictya subtile, Ulota crispa) on the ground, rocks and trees (beech, elm, red and sugar maples, red spruce) on Spruce Knob Mountain, West Virginia. The collections were from elevations of 2800, 3800 and 4800 feet. These species constitute the first records of tardigrades from West Virginia.

LAURA TORRES-MILLER, Dept. of Biological Sciences, Marshall University, Huntington, West Virginia 25701. New records of lace bugs from West Virginia (Hemiptera: Tingidae).

Thirteen new state records of lace bugs are presented for West Virginia. County distribution, host plants and distinctive morphological features of genera are discussed.

Symposium on Upland Forests

ROBERT E. ACCIAVATTI, Research Associate, and ROBERT L. DAVIDSON, Collection Manager, Section of Invertebrate Zoology, Carnegie Museum of Natural History, Pittsburgh, Pennsylvania 15213.
Some aspects of beetle ecology in upland forests.

Snail-hunting ground beetles, family Carabidae, tribe Cychrini, offer excellent opportunities to study ecological factors influencing insect zoogeography. These insects possess specialized adult morphology, feeding behavior and habitat preference to exploit their niche. Their highly adapted mouthparts help them search for and feed on snails, whereas their flightlessness and apparent capability for walking at cool ambient temperatures permits them to remain active within cooler, high-elevation forests in search of prey and mates. The presence of several species together at one place suggests different periods of adult activity as a means of avoiding direct competition for their obligatory predation on snails. Initial studies concentrated on species occurrence and their periods of adult activity. Barrier pit-fall traps efficiently surveyed for adult beetles in several localities within the spruce and northern hardwood forests of West Virginia at various years from 1981 to 1987. Spatial and temporal distribution data combined for all localities indicate the presence of three genera and ten species, including three endemics, in the upland forest habitat types of West Virginia. The data indicate that Sphaeroderus adults are widespread and most abundant starting in the spring through the summer, Scaphinotus adults are more restricted in distribution with subgenus Scaphinotus (Irichroa) found beginning early in the summer and subgenus Scaphinotus (Steniridia) midway through the summer, and adults of Maronetus are widespread and most abundant starting late in the summer into the autumn.

HAROLD S. ADAMS, Dabney S. Lancaster Community College, Clifton Forge, Virginia 24422 and STEVEN L. STEPHENSON, Dept. of Biology, Fairmont State College, Fairmont, West Virginia 26554.
Decline of red spruce in the upland forests of West Virginia.

Quantitative data from a number of studies recently conducted in subalpine spruce and spruce-fir forests throughout the eastern United States indicate that red spruce has shown a pattern of reduced growth and increased mortality since the 1960s. The exact cause of this decline is still unknown, although acid deposition (commonly known as acid rain) has been suggested as a major contributing factor, since the affected forests are located in areas receiving high atmospheric inputs of acidic substances and other pollutants. However, the possibility that various natural factors are responsible

(or at least play some role) cannot be ruled out. Although spruce decline has not been studied intensively in West Virginia, a survey of the red spruce forests of the Monongahela National Forest and adjoining state and private lands conducted by the Forest Service during the summer of 1985 reported that more than 30% of the red spruce trees were either dead or declining. Dendroecological (tree-ring) analysis of increment cores we have collected at a number of localities in West Virginia indicates that red spruce has exhibited a growth-trend decline during the past two decades, with no evidence of amelioration. Although it is apparent that pervasine changes are taking place in West Virginia's red spruce forests, it is still too early to assess the ultimate consequences of these changes. A much clearer picture should emerge over the next decade.

RONALD H. FORTNEY, Engineering & Science Division, West Virginia College of Graduate Studies, Institute, WV 25112. The replacement of a red spruce (Picea rubens) forest by northern hardwoods in Canaan Valley, West Virginia.

The destruction of the original forest of the Allegheny Mountains of the Appalachian Plateau Province in West Virginia has been documented by Clarkson (1958), Allard and Leonard (1952) and others. An evergreen forest dominated by red spruce (Picea rubens) once capped mountainous areas above 3,000 feet elevation. With nearly total clear-cut of this forest, followed by fires which burned slashings and soils high in organic matter and erosion of mineral soils by wind and water, softwoods, e.g. big tooth aspen (Populus grandidentata), became short-lived dominants, only to be replaced by Northern Hardwood species.

During the 1973 and 1974 collecting season, an ecological study of the plant communities in Canaan Valley, WV was conducted, during which time data were collected on the composition of the forest communities by a combination of point-quarter and quadrat samples. The results showed few occurrences of mature and seedling-aged individuals of red spruce within most mature stands of Northern Hardwood species.

It is concluded that the once nearly nonotypic red spruce forest in Canaan Valley has been successfully replaced by Northern Hardwood communities. Further, red spruce is unlikely to soon recover its dominant status since Northern Hardwood species are generally long-lived and since red spruce requires an open, moist seed bed on which to germinate; the current forest cover in Canaan Valley and other high elevation areas in the Allegheny Mountains have produced a densely shaded habitat unsuitable for seedling survival.

GEORGE A. HALL, Department of Chemistry, West Virginia University, Morgantown, West Virginia 26506. The birds of West Virginia's upland forests.

Of the approximately 300 species of birds that occur in West Virginia some 85-90 nest or have nested in the forest above 900 m. Of these approximately 35 are limited to this region. Most of these latter have the center of their distribution to the North and

represent the boreal avifauna far south of the main boreal region. Thirteen of these species have until recently not nested south of West Virginia but some of them are moving farther south.

Most of these boreal forest birds are insectivores or if granivores they feed their young on insects. The largest group of these belongs to the so-called Neotropical Migrants, species which spend the winter in tropical America. The Wood Warbler family is the major component of this group. A smaller group consists mostly of permanent residents.

The species occurring on any one tract with be determined by the diversity of plant forms in that tract and the age of the stand. No one tract of limited size will have more than about 40 species nesting in it. Indeed a mature forest with little understory will have an even lower species list.

Many of these species have quite high populations. Perhaps the Appalachian race of the Dark-eyed Junco is the most numerous species although some of the warblers also occur in large numbers.

In winter the situation will be much different with only a handful of those insectivores that feed on insects overwintering in the egg or pupa stage. None of these have large populations. The ubiquitous junco may be present except at the very highest elevations.

This interesting avifauna faces several threats including the destruction of this forest both by man and by nature as well as the loss of winter habitat in the tropics.

MARY ETTA HIGHT, Dept. of Biological Sciences, Marshall University, Huntington, West Virginia 25755. Mammals of the Mountain Forests of Eastern West Virginia.

The West Virginia mammalian fauna is a mosaic of animals derived from four geographic sources: boreal species whose ancestors were displaced southward with the advance of glaciers, the descendants surviving in cool upland habitats; southern species which have spread northward with post-glacial warming; species of generally mid-western distribution which have immigrated in historical times as clearing and agriculture altered habitat; indigenous species which have become more widespread, and numerous owing to human development and activity.

Mammals restricted to the upland forests of eastern WV belong to the boreal group. These include the Northern Water Shrew, Sorex palustris, the Northern Flying Squirrel, Glaucomys sabrinus, the Yellow-nose Vole, Microtus chrotorrhinus, and the Snowshoe Hare, Lepus americanus which are confined to the moist, cool spruce and northern hardwoods forests. A subspecies (nubiterrae) of the deer mouse, Peromyscus maniculatus, is abundant in the higher elevations, but primarily in the drier parts of the mixed northern hardwoods.

The Red-backed Vole, Clethrionomys gapperi, a boreal species, is mainly an inhabitant of both conifers and northern hardwoods, but extends to bald mountain summits and bogs. This colorful forest vole has successfully invaded moist and cool woodland at lower elevations.

Of the two common high-elevation mammalian predators the Least Weasel, Mustela nivalis, has an indigenous subspecies; the other, the Long-tailed Weasel, Mustela frenata, has a wider distribution in the state.

Insectivores constitute a large segment of the mammalian fauna in the high elevation forests. The Northern Water Shrew (Sorex

palustris) is confined to the highest elevations where it is found living around bogs and along small streams. The endemic subspecies is presumably a glacial relict. Populations are localized and small. Common shrews include the Smoky Shrew, Sorex fumeus, the Masked Shrew, S. cinereus, and the Short-tailed Shrew, Blarina brevicauda, which are also found throughout the state.

Mammals of the Allegheny Highlands have interested scientists for many years; a majority of specimens examined in a study of museum collections represents this area. The upland forest fauna includes most of the 65 species of mammals that occur in West Virginia.

PREHISTORIC HIGH ALTITUDE ADAPTATION IN HIGHLAND WEST VIRGINIA

W. Hunter Lesser and Janet G. Brashler
USDA Forest Service
Monongahela National Forest
200 Sycamore Street
Elkins, West Virginia 26241

Numerous prehistoric archeological sites at high elevations have been identified within the unglaciated Appalachian Plateau and Ridge and Valley provinces of eastern West Virginia. The sites appear to consist predominantly of sparse lithic scatters with limited potential for retrieval of chronological or settlement/subsistence data. The distribution, function and environmental relationships of these high altitude sites are discussed and their research potential is assessed.

BRIAN R. MCDONALD, Natural Heritage Program, West Virginia Department of Natural Resources, P.O. Box 67, Elkins, West Virginia 26241. Plants of limited distribution in the upland forests of West Virginia.

The West Virginia Natural Heritage Program maintains site specific records for species considered rare in the state. Data from the Program are used to analyze the number and distribution of rare plant species occurring above 915 meters. Comparisons are made to the total statewide complement of listed species. High elevation plant communities harboring the rare species are discussed along with thoughts of what will be necessary to protect representative examples of our natural heritage.

THOMAS K. PAULEY, Dept. of Biological Sciences, Marshall University, Huntington, West Virginia 25701. The effects of high elevations on the distribution of amphibians and reptiles in West Virginia.

Amphibian and reptile distributions are often restricted by moisture and temperature regimes which are, in part, determined by geological features such as elevation. The higher elevations (over 3,000 ft or 914.4 m) of the mountainous regions of West Virginia are

cooler and wetter than other regions of the state. The annual average temperature in these high mountains is 49.4° F (9.7° C) and the annual average precipitation is 53.8 inches (136.6 cm). This results in temperatures that are 3.4 to 4.2° F cooler and precipitation that is 10.4 to 17.2 inches greater than the rest of the state.

The present report surveys the distribution of amphibian and reptile species in the higher elevations of West Virginia. It presents hypotheses on factors which could influence their distribution and briefly discusses interactions that occur among some salamander species in relation to vertical (altitudinal) distribution.

The Cheat Mountain salamander (Plethodon nettingi) is the only amphibian in West Virginia restricted to higher elevations. Seven amphibian species probably do not occur in the higher elevations. These include the marbled salamander (Ambystoma opacum), the ravine salamander (Plethodon richmondi), the longtail salamander (Eurycea l. longicauda), Fowler's toad (Bufo woodhouseii fowleri), cricket frogs (Acris c. crepitans and Acris c. blanchardi), Upland chorus frog (Pseudacris triseriata feriarum), and the leopard frog (Rana pipiens).

One subspecies of reptile, the mountain earth snake (Virginia valeria pulchra), is restricted to the upland areas. No turtles or lizards have been found above 3,500 feet (1066.8 m). Several species of snakes are also apparently restricted to lower elevations. These include the queen snake (Regina septemvittata), eastern hognose snake (Heterodon platirhinos), eastern worm snake (Carphophis a. amoenus), black racer (Coluber c. constrictor), and the kingsnakes (Lampropeltis g. getulus and Lampropeltis g. nigra). There is just one record in West Virginia of a northern copperhead (Agkistrodon contortrix mokasen) occurring above 3,000 feet (914.4 m), and the timber rattlesnake (Crotalus horridus) is not known to be common above 3,500 feet (1066.8 m). However, several specimens of the timber rattlesnake have been recorded along the Allegheny front in the Dolly Sods area. Some species of snakes which occur over a broad range of elevations are apparently more abundant above 3,000 ft. These include the smooth green snake (Opheodrys v. vernalis), the redbelly snake (Storeria o. occipitomaculata), the northern ringneck snake (Diadophis punctatus edwardsii), and the eastern garter snake (Thamnophis s. sirtalis).

HARRY PAWELCZYK, USDA Forest Service, 200 Sycamore Street. Elkins, West Virginia 26241. Projects and surveys concerning endangered, threatened and sensitive species underway on the Monongahela National Forest.

A number of projects and surveys currently underway on the Monongahela National Forest will be discussed. The most important of these are listed below.

(1) Hacking of Peregrine Falcons on the Monongahela National Forest.

(2) A study of the occurrence and distribution of the Virginia northern flying squirrel on the Monongahela National Forest.

(3) A study of the occurrence of the Cheat Mountain salamander, the Virginia northern flying squirrel and cave use by endangered and sensitive bats on the recently acquired 40,000 acre Mower tract on the Monongahela National Forest.

(4) An extensive survey of endangered and sensitive plants on

the Gauley Ranger District of the Monongahela National Forest.

(5) A study of sensitive fish, birds, small mammals, cave invertebrates, and plants of the 40,000 Mower tract of the Monongahela National Forest.

(6) Surveys being conducted in timber sale areas for the Virginia northern flying squirrel and the Cheat Mountain salamander on the Monongahela National Forest.

STEVEN L. STEPHENSON, Dept. of Biology, Fairmont State College, Fairmont, West Virginia 26554 and HAROLD S. ADAMS, Dabney S. Lancaster Community College, Clifton Forge, Virginia 24422. Upland forest vegetation of West Virginia.

The upland forest communities that occur at higher elevations (generally considered as above 915 m) in the mountainous eastern portion of West Virginia are characterized by considerable compositional diversity. On the whole, site factors related to topography, elevation, and human disturbance (e.g., logging history) would seem of primary importance in determining the pattern of vegetation. Subalpine coniferous forests dominated by red spruce (Picea rubens) generally occur at the highest elevations (usually above 1219 m but sometimes as low as 975 m). At a few localities, balsam fir (Abies balsamea) is present as an associate of red spruce. Spruce forests once occurred over large areas (estimated at more than 200,000 ha in the late 19th century), but these original forests were almost completely eliminated by fire and logging. The spruce forests that exist today are much more limited in extent (probably no more than about 45,000 ha) and commonly contain admixtures of various hardwoods such as yellow birch (Betula lutea) and red maple (Acer rubrum). At somewhat lower elevations (approximately 915-1219 m, but sometimes higher or lower), the predominant forest type (usually referred to as "northern hardwoods") is one in which both deciduous and mixed deciduous-coniferous communities occur. Sugar maple (Acer saccharum), beech (Fagus grandifolia), hemlock (Tsuga canadensis), and black cherry (Prunus serotina) are among the characteristic dominants. Average annual precipitation in the mountains of West Virginia ranges from less than 115 cm to more than 165 cm and is generally well distributed throughout the year with no pronounced dry seasons.

ROGER J. STERN, The Nature Conservancy, P. O. Box 3754, Charleston, WV 25337. Biodiversity Conservation of High-elevation Ecosystems in West Virginia: The Nature Conservancy Approach

High-elevation ecosystems in West Virginia are threatened by a variety of quasi-natural and human disturbances. Chief among these are spruce timbering, acid rain, gypsy moth suppression, and real estate development. The Nature Conservancy has protected significant acreages of high-elevation habitat in West Virginia through direct acquisition and by pass-throughs to the federal government. Non-acquisition activities, undertaken in co-operation with federal programs for Research Natural Areas and the USDA-Forest Service Sensitive Species List, may protect much of the remaining high-elevation habitat. However, threats to the ecosystem are many, and in aggregate are a challenge to the Conservancy's protection capabilities.

PROCEEDINGS OF THE WEST VIRGINIA ACADEMY OF SCIENCE

INSTRUCTIONS TO AUTHORS
Revised February 1982

1. *General Policy*

The publications policy of the Academy is intended to implement the goal of publication of the *Proceedings* by the Academy, namely, stimulation of research on the part of West Virginia scientists and Academy members by providing an outlet for publication of their research results. Within the limits of available resources, the Academy will attempt to maximize the number of articles it can publish, while maintaining standards by the peer review process. Where selection must be made, the sole criterion for judgment shall be the quality of the research involved. Articles of a local or regional nature, as well as those of broader scope, will be encouraged. Articles will not be discriminated against because of their subject matter, as long as they satisfy the requirement of the By-Laws that they be ". . . of a scientific nature" (Section VII, Article 1).

The Academy will consider papers that report the results of original research or observation. The Academy will not publish papers that have been published elsewhere. Each manuscript will be reviewed by the Publications Committee and by referees. Manuscripts longer than 15 pages* of double spaced typed copy normally will not be accepted. Membership in the Academy is a requirement for publishing in the Proceedings. In the case of joint authorship, at least one author must be a member of the Academy, and the author presenting the paper must be a member of the Academy. No author, or co-author, may submit more than two papers for any volume of the Proceedings. Ordinarily, papers offered for publication must have been presented at the annual meeting of the Academy. Publication is not automatic. The Proceedings editors also solicit outstanding expository papers.

2. *Preliminary Abstract*

A preliminary abstract, summarizing the results of the investigation must accompany the application for a place on the program of the annual meeting. The preliminary abstract must be typed on a special form, available from the Academy officers or editor, and will be published in the first number of the volume for that year. There is a $2 fee for each abstract submitted.

3. *Organization of Manuscripts*

Each manuscript shall start with an abstract (no more than 250 words) which should summarize the primary results. The following sequence is suggested for organizing a paper: Introduction, Materials

*The 15-page count refers to typewriter text and pages of figures, graphs, photos, and abstracts.

and Methods, Results, Discussion, Acknowledgments, and references cited. With the exception of the introduction, each division of the manuscript should be labelled. Sub-headings may be used. In general, the introductory abstract will replace a summary. This abstract should be suitable for sending to international abstracting services for immediate publication in the event that the paper is accepted for publication in the Proceedings.

4. *By-Line*

The author's name, department, institution, city, state, and zip code should follow the title.

5. *Form*

Manuscripts shall be typed double spaced on white bond paper. A dark undamaged ribbon should be used on typewriters in order to produce clear copy for the editor and the printer. Pages of copy should be numbered consecutively in the top right-hand corner of each page of the manuscript, preceded by the author's last name. *Two copies, the original typed copy and a Xerox,* together with a set of original photos, figures and/or drawings, should be given to the Section Chairman on the day of the Annual Meeting. Each table or figure should be supplied with a legend sufficiently complete to make the table or figure intelligible without reference to the text. Footnotes may be used in connection with tables and figures where necessary and may save space. Footnotes should be avoided wherever possible in the text itself. Complicated formulas should be prepared with care in a form suitable for *camera copy reproduction.* Avoid such formulas in a line of text.

6. *Illustrations and Special Symbols*

Line drawings should be carefully made on good rag paper for direct photo reproduction. Each figure should be numbered. While drawings may be of any convenient size, they will be reduced to 3 x 4 inches. Letters, symbols, and figures should be not less than 1 mm. high *after reduction* to printing size. In exceptional instances, a full page drawing (4½ x 6½ inches) may be used. Either original drawings or glossy photographs (mounted on illustration board with rubber cement) may be submitted. Photographic prints should be on glossy paper and have good contrast. Each drawing should be labelled on the back with the author's name and the appropriate legends. Camera copy will be used to reproduce mathematical formulas as far as practicable.

7. *Literature Cited*

References shall be collected at the end of the manuscript as "Literature Cited," and must be cited in the text.

The title of the papers cited and the inclusive page numbers must be given. References in the text may be either by year or by number. Examples: Hall and Campbell (1957) or [5]. Square brackets are recommended for references so that numbers in parentheses may be used to denote formulas in the text.

Example of a journal citation at the end of paper:

5. Hall, J. L., and R. Campbell. 1957. Polarization of ethanol in benzene. Proc. W.Va. Acad. Sci. 29:53-57.

Example of a book citation:

6. Stacey, M., and S. A. Barker. 1960. Polysaccharides of microorganisms. Oxford Univ. Press. London. 228 pp.

8. *Proof*

Galley proofs will be sent to authors for corrections. Make corrections on the margins of the proof. Proofreader's marks may be found in dictionaries, or in style manuals (e.g., "Style Manual for Biological Journals"). Changes in text after the manuscript is in galley proof are quite expensive and in general are not permitted. Galley proofs must be corrected and returned promptly (within ten days).

9. *Reprints*

A reprint order will be sent with the galley proofs. This should be returned with the corrected proof.

10. *Cost of Publication*

Authors will be billed by the Academy for pages in excess of the maximum allowed, see item 1. The cost of figures which require halftone screens, such as photographs, will also be billed to the authors. Currently, a page charge of $10.00 per page is in effect, and the author will be sent a *pro forma* invoice to see if payment can be secured from the author's institution, company, research grant, etc. Failure to honor page charges will not prevent publication of a paper, but will greatly assist the publication program of the Academy.