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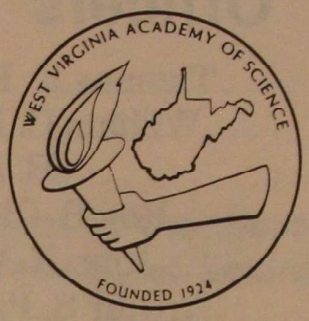

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Proceedings of the West Virginia Academy of Science

E. C. Keller, Jr., Editor

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Contents

Abstracts of Papers

for the 1985 Meeting

Symposium:

Conservation of Species Diversity in West Virginia

RODNEY L. BARTGIS, The Nature Conservancy, 1100 Quarrier St., Room 215, Charleston, WV 25301. Information Analysis and Application in Rare Species Conservation in West Virginia.

Biologically- and cost-effective efforts to conserve rare species require adequate information gathering and analysis methodologies. The Nature Conservancy, a private organization specializing in rare species conservation, uses a national system of data bases to indicate which species and populations in the United States and West Virginia are conservation priorities. Manual files provide detailed information on species biology, population structure and viability, landowner information, and current protection given a population. With an array of protection options available, decisions are then made by Conservancy staff concerning future protection needs of the species or population. In West Virginia, the information is most complete and methodology best developed for vascular plants and vertebrates, while current efforts include information and methodology development for natural communities and invertebrates. Beside their values as tools for the Conservancy's protection programs, the methodologies are useful in public lands planning, environmental impact analyses, endangered and threatened species planning, and identifying research needs.

BRIAN R. MCDONALD, WV Dept. of Natural Resources, P. O. Box 67, Elkins, West Virginia 26241. West Virginia's Natural Heritage: An Inventory.

The Department of Natural Resources, Wildlife Resources Division, has an ongoing program that monitors the locations of rare, threatened and endangered plants and animals. Information was initially derived from various secondary sources such as museum collections, herbaria, literature and amateur and professional biologists. Once this information had been gathered, lists of animals and plants which appeared to be rare in the state were compiled. These lists presently contain species which have been labeled as "species of special concern"; they could be lost from the fauna or flora of the state through various means, such as habitat loss. All known locations for these listed

species are pinpointed on topographic maps. Manual and computer files of information on each species' biology and history in the state are maintained. New locations are continually being sought as well as checks made on historical records and known populations. These data are used to monitor the presence of the species within the state. "Species of special concern" are ranked according to their known state and global status, and those with the highest rank are given priority for extensive field surveying and monitoring. Uses of the data include: mine permit application reviews, base information for environmental impact statements and other environmental assessment documents, identification of high quality natural areas, and scientific research.

KENNETH B. KNIGHT, WV Dept. of Natural Resources
P. O. Box 67, Elkins, WV 26241. Threatened and endangered wildlife in West Virginia.

The Wildlife Resources Division of the West Virginia Department of Natural Resources (WVDNR) is responsible for the management and conservation of threatened and endangered species in the state. The terms "threatened" and "endangered" are defined in the Federal Endangered Species Act of 1973, as amended. Seven animals found or formerly found in West Virginia are listed as endangered in West Virginia. These include the bald eagle (Haliaeetus leucocephalus), Virginia big-eared bat (Plecotus townsendii virginianus), Indiana bat (Myotis sodalis), peregrine falcon (Falco peregrinus), eastern cougar (Felis concolor couguar), and two freshwater mussels, Epioblasma t. torulosa, and Lampsilis o. orbiculata. One species, the flatspired 3-toothed land snail (Triodopsis platysayoides) is listed as threatened. Funds obtained through federal matching grants (Sec. 6, Endangered Species Act) and the WV Nongame Wildlife Fund enable research and management projects for these species. Current and historic distribution of each of these species in West Virginia, as well as research, management, and protection measures instituted by WVDNR and the U. S. Fish and Wildlife Service, are discussed.

Botany

THOMAS E. WEAKS, Dept. of Biological Sciences, Marshall University, Huntington, WV 25701. A study of wetland types of the Ohio River floodplain.

Nine wetland types were studied along the Ohio River in Wayne, Cabell, Mason, and Jackson Counties of West Virginia. Most wetlands were found to be shallow seasonally flooded basins of flats and all had a pH of 7.0 or higher. Periphyton cell densities and species diversity were found to be generally higher for permanent wetlands than for those that were seasonally flooded. Net primary productivity and periphyton species diversity were strongly correlated with turbidity.

Because of the paucity of wetlands in that segment of the Ohio River floodplain studied, it was suggested that both seasonal and permanent wetland types represent a valuable resource worthy of preservation. While the permanent wetlands probably make a greater contribution to the algae of the Ohio River, some species of periphyton were found to occur only in seasonal pools.

STEVEN L. STEPHENSON and MATTHEW T. GALL, Dept. of Biology, Fairmont State College, Fairmont, West Virginia 26554 and HAROLD S. ADAMS, Dabney S. Lancaster Community College, Clifton Forge, Virginia 24422. A dendroecological study of an old-growth spruce stand.

Dendroecological (tree-ring) analysis of increment growth cores collected from 21 red spruce (*Picea rubens* Sarg.) trees in an old-growth stand (mean age $\pm$ SD of cored trees was 189 $\pm$ 50 yrs) in Pocahontas County indicates that a marked decline in growth rates occurred during the period of 1880-1889. Annual rings produced during this period have a mean width of only 0.872 mm. This is appreciably less than the average ring-width values recorded for the periods of 1870-1879 (1.440 mm) and 1890-1899 (1.102 mm). This late 19th century period of growth trend decline generally coincides with the time period during which extensive mortality of red spruce is known to have taken place in the mountains of central West Virginia. The general pattern of the decline is similar to that reported for red spruce in the high-elevation forests of the northern Appalachians during the past 20 years. However, the trees cored in this study recovered from this earlier period of decline, whereas trees affected by the more recent decline show no evidence of recovering.

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

During the past year, the following five species of vascular plants have been identified or verified at the West Virginia University Herbarium as new records for the state of West Virginia: Hosta ventricosa (Salisb.) Stearn, Kochia scoparia (L.) Roth, Hedera helix L., Hieracium umbellatum L. and Onopordum acanthium L.

STEVEN L. STEPHENSON, Dept. of Biology, Fairmont State College, Fairmont, West Virginia 26554. Ecological relationships of Myxomycetes and beetles in temperate forest ecosystems.

Among the most commonly encountered animal associates of Myxomycetes in the temperate forests of North America are beetles. Members of the staphylinoid family Leiodidae, particularly species of Anisotoma and Agathidium, have been collected repeatedly from myxomycete fruiting bodies and (less frequently) plasmodia. A number of these would seem to be obligate myxomycete specialists and feed only upon the fruiting bodies and/or plasmodia of Myxomycetes. There has been little recognition in either the American entomological or ecological literature of this guild of "slime mold" beetles, even though Myxomycetes constitute an important element of the mycoflora of decaying plant material in temperate forest ecosystems and their beetle associates are not uncommon. For example, based upon field observations made during the summers of 1983 and 1984, it is unusual not to find one or more beetles (either adults or larvae) associated with large fruitings of some of the more common species of Myxomycetes (e.g., Stemonitis axifera and Fuligo septica). Whether or not beetles (particularly leiodids) commonly occur as associates of Myxomycetes in other types of ecosystems is not known because of the almost complete lack of data.

JOHN R. HAMILTON, FRANK H. HENGEMIHLE, EARL H. TRYON, Division of Forestry, College of Agriculture and Forestry; and E. JAMES HARNER, JR., Department of Statistics and Computer Science, College of Arts and Science, West Virginia University, Morgantown, WV, U.S.A. 26506.

Radial Response of wind-exposed red spruce.

Radial growth and the formation of compression wood was examined in six red spruce trees (Picea rubra L.) growing on an exposed mountain summit in West Virginia. Significantly greater radial

growth occurred on the lee side of all trees. In addition, compression wood was observed in all trees. Although somewhat erratic, this wood was most abundant on the lee side often extending into the normal sides and rarely completely encircling the tree. Although more branches were on the lee side of trees it was shown that branch origin around the bole did not influence eccentric radial growth.

STEVEN L. STEPHENSON, Dept. of Biology, Fairmont State College, Fairmont, West Virginia 26554, HAROLD S. ADAMS, and MICHAEL L. LIPFORD, Dabney S. Lancaster Community College, Clifton Forge, Virginia 24422. Indigenous stands of red pine in West Virginia.

During the 1984 field season, quantitative data on composition and structure of all strata of vegetation were obtained from red pine (Pinus resinosa Ait.) stands at the two localities (Helmick Rock on South Branch Mountain in Hardy County and Pike Knob on North Fork Mountain in Pendleton County) where indigenous populations of this species occur in West Virginia. In addition, data were obtained on soil physical and chemical characteristics at these two sites. Red pine (with an overall importance value of 97.3) occurs in a nearly pure stand at Pike Knob, but the species is somewhat less dominant (IV of 68.7) at Helmick Rock, where ten other species are present in the tree stratum. Although the stands sampled in this study would seem to be ecologically similar to red pine-dominated stands in the northeastern United States, they occur at significantly higher elevations (945 m at Helmick Rock and 1,290 m at Pike Knob). In fact, at the Pike Knob locality red pine actually occupies a site that is ecologically similar to those on which red spruce can be found in various other portions of the mid-Appalachians.

KATHARINE B. GREGG, Department of Biology, West Virginia Wesleyan College, Buckhannon, WV 26201. Reproductive strategy in a West Virginia Population of Cleistes divaricata (L.) Ames.

A population of Cleistes divaricata (L.) Ames has been observed in an acidic, grassy meadow in Barbour County, West Virginia from 1930-1984. The flowers are pollinated by several species of Bombus. A hinged anther deposits a mass of loosely-aggregated pollen tetrads onto the bee's dorsal surface. This mechanism allows more than one bee to collect pollen from a single flower. To determine the effectiveness of this strategy, plants were caged in bud and artificial pollinations carried out using pollen from sequential pollen dumps. Pods produced from the first three pollen dumps were significantly larger and heavier and contained more seeds than those from later pollen deposits with fewer tetrads. Decreasing pollen dosage did not affect capsule set, capsule maturation, or percentage of healthy-looking embryos per fruit, which averaged 85%, 25% higher than for naturally-pollinated pods. Set for artificial pollinations was 93% for pollen dumps 1-3 and 97% for dumps 4-18. As natural field set was only 54%, low pollinator frequency apparently limits seed production. Efficacy

of available bees can be maximized, however, because pollination with low pollen dosage results in some seeds. Flower fading in plants receiving low pollen dosage was as slow as that in caged, unpollinated controls, thus increasing opportunity for additional pollination.

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. Dictyostelid cellular slime molds from southwestern Virginia.

Soils from five study areas near the University of Virginia Mountain Lake Biological Station in Giles County, Virginia, were examined for the occurrence and distribution of dictyostelid cellular slime molds (CSM). Eight forms representing at least six recognized species were isolated, with Dictyostelium discoideum appearing at the highest relative frequency and density. Also occurring, at decreasing frequency and density, were D. minutum, Polysphondylium violaceum, D. sphaerocephalum, P. pallidum, and D. mucoroides. Two other forms isolated in this study bear some resemblance to species not previously reported from the temperate zone in the western hemisphere. Absolute density of the recovered CSM microflora was lower than that previously reported from similar southern Appalachian forests. The pattern of distribution of CSM in this study suggests correlations to certain biotic and physical characteristics of the five study areas.

Biology

DONALD C. TARTER, Dept. of Biological Sciences, Marshall University, Huntington, West Virginia 25701. Impacts of mining on the benthic macroinvertebrates in the Upper Shavers Fork Basin, West Virginia.

The benthic macroinvertebrate population structure and the impact of mining activities on the benthos were investigated in the Upper Shavers Fork Basin in Pocahontas and Randolph counties, West Virginia. Based on the Shannon-Weaver index of diversity (d_2= 2.8), the number of taxa ($\bar{x}$ = 16.8) and the number of specimens/ft^2 ($\bar{x}$ = 60.1), the Upper Shavers Fork Basin is moderately polluted by natural acidity and uncontrolled logging and mining activities. A total of 13,503 benthic macroinvertebrates, representing 13 orders, 46 families and at least 62 genera, were collected from 31 stations in the watershed. The order Plecoptera ranks first in percentage frequency (31.6) (N = 4265). Other major taxa are the orders Trichoptera (23.7%, N = 3205), Ephemeroptera (20.7%, N = 2789) and Diptera (17.2%, N = 2326). There is no significant difference (0.05 level) for the mean biological parameters (S-W index, number of taxa, mean number/ft^2) between Little Black Fork, a nearby undisturbed watershed, and the Upper Shavers Fork Basin, a disturbed watershed. Using the biological parameters for 20 stations in the Upper Shavers Fork Basin, discriminant analysis indicates that the stations fall into three clusters (mainstream, unmined and mined tributaries) with some degree of overlap. Analysis of variance showed the canonical means of the mined and unmined tributaries are significantly different from each other (p = 0.05). However, the means of mined and unmined tributaries are not significantly different from the mainstream (p = 0.05). Using only the 17 chemical parameters, discriminant analysis indicates that the 20 stations group into three distinct clusters which correspond to mainstream, unmined and mined tributaries. The canonical means of the mined and unmined tributaries are not significantly different from each other (p = 0.05).

EDWIN MICHAEL and LINDA SMITH, Div. of Forestry, West Virginia University, Morgantown, WV 26506. Physical parameters and aesthetic values of wetlands along West Virginia highways.

Objectives of this study were: (1) locate all existing wetlands situated adjacent to controlled-access highways in West Virginia, (2) identify physical parameters of existing wetlands, and (3) determine the aesthetic values of existing wetlands. All controlled-access highways (511 miles) in West Virginia were surveyed. A total of 96 wetlands (0.1 acre or larger) were located. The following physical parameters were noted for each wetland: (1) classification, (2) size, (3) shape, (4) position in relation to highway, (5) per-

centage of area covered with standing water, (6) depth of standing water, (7) presence of a stream in or near the wetland, and (8) presence of highway runoff or mine drainage into the wetland. The majority of existing wetlands were wet meadows or cattail wetlands. Size ranged from 0.1 to 73.2 acres. Most wetlands were characterized by the following features: (1) oblong in shape, (2) parallel to highway, and (3) no standing open water. The presence of the highway caused the formation of 60 of the 96 wetlands. Forty-nine wetlands had a stream associated with them and 53 received direct runoff from the highway. Emergent narrow-leaf hydrophyte was the most frequently occurring vegetative growth form and cattails (Typha spp.) and alder (Alnus spp.) were the most abundant plant species. Marsh, riparian, shrub swamp, and wooded swamp wetlands had the highest aesthetic value. Variables correlated with high aesthetic value were: (1) large size, (2) alder-dominated vegetation, (3) diverse vegetative life form, (4) standing water present, and (5) dead trees or "snags" present.

SUMAN SINGHA AND TARA AUXT BAUGHER. Division of Plant and Soil Sciences, West Virginia University, Morgantown, WV 26506. Comparative seasonal variations in foliar nutrient concentrations of two apple and peach cultivars.

This study was undertaken to compare nutrient variations in apple and peach cultivars during the growing season. Leaf samples were collected at weekly intervals during June through September from the apple cvs. Red Delicious and York, and peach cvs. Redhaven and Loring. Nutrient concentrations were determined with an ICP spectrograph. Foliar nutrients showed similar trends in the two apple cultivars. With the exception of calcium, macronutrient levels were higher in Red Delicious than in York. Seasonal nutrient trends in the two peach cultivars were similar, but unlike apples, nutrient differences between them were neither large nor consistent. The nutrient variations in apple cultivars can be attributed either to differences in cultural practices based on production for fresh or processing markets, or to variations in cultivars per se.

ROGER SEEBER, ROSEMARIE BENTO & D. F. BLAYDES
Dept. of Biology, West Virginia University,
Box 6057, Morgantown, W. Va., 26506
Possible Purine Interactions in Plant Growth Systems

Nicotiana glauca callus cultures grow rapidly on Miller's medium with ∝ napthalene acetic acid (NAA), 2.0 mg/l as an auxin. Under these conditions our cultures do not require a cytokinin and at 0.5 mg/l. kinetin is inhibitory.

Interactions between purines, both hormonal (kinetin) and non hormonal (adenine) is of interest. In callus culture experiments we find that adenine (50 mg/l) is not as inhibitory as kinetin and that when adenine (50 mg/l.) and kinetin (0.5 mg/l) are added

simultaneously the inhibition is slightly greater than when kinetin is added alone.

Certain cultivars of Lactuca sativa cv Grand Rapids require either red light or cytokinin for germination and we will present data on the interaction of purines in the germination of the seed.

The role of the purines (hormonal and non hormonal) will be discussed especially with reference to plant development.

WILLIAM W. MUCKLOW, HABEEB RANA. West Virginia State College, Institute WV 25112.

The Enucleation and Cross Transplantion of Amphibian Nuclei.

The technique of the enucleation of amphibian nuclei was initially developed by Briggs and King done in the early 1950's. The technique of the enucleation of the haploid egg is taken from the process as discribed by J.P. Gurdon. The project now being undertaken is the eventual cross transplantion of amphibian nuclei between irradiated eggs of different species. The question is, "Does a part of the irradiated egg other than the nucleus, play any direct role in the development of the organism?"

The technique of interspecific chimerism (the using of more comman organisms as surregates to embryologicly develop more rare species) has been achieved in mammals, but as of yet not in amphibians. It is hoped that the project now being undertaken will eventually lead to more and better understandings of the processes of development.

While we intend to cross transplant nuclei, we also intend to observe the effects of using different types of tissue in transplantion. Work by Briggs and King into the use of differentiated tissues have raised some questions, as to the usage of more specialized cells in transplantion. Hopefully, the work being done will answer the question of cellular speciality, and whether more specialized cells (i.e. muscle, and nervous) have lost their genetic makeup of the organisms in trade for their specialization.

VERNON E. REICHENBECHER, JR., Dept. of Biochemistry, Marshall University School of Medicine, Huntington, West Virginia 25704.

Lectin-resistant mutants of Chinese hamster cells.

Abrin, ricin, and modeccin are toxic lectins derived from the jequirity bean, the castor bean, and Modecca digitata roots, respectively. Each toxin consists of two polypeptide subunits linked by a disulfide bond. The B subunit is responsible for binding to galactose residues on the cell surface. Following internalization, the A subunit enzymatically inactivates 60S ribosomal subunits. In this study, lectin toxicity towards Chinese hamster lung (CHL) and Chinese hamster ovary (CHO) cells was examined and lectin-resistant mutants of the two cell lines were selected. Abrin completely inhibited colony formation by CHL cells at a concentration of 3 ng/ml, while 30 ng/ml abrin was required to kill CHO cells. Modeccin proved toxic

to CHL cells at a concentration of 0.1 ng/ml, while 1.0 ng/ml modeccin was required to kill CHO cells. Both cell lines, following ethylmethane sulfonate mutagenesis, were used for the selection of lectin-resistant mutants. CHL cell mutants were obtained with a 30-fold-higher resistance to abrin than that of the parent, and CHO cell mutants were obtained with a 100-fold-higher resistance. These mutants showed cross-resistance to the related toxic lectin, ricin. Both CHL and CHO cell mutants were obtained with a 1000-fold-higher resistance to modeccin than that of the parental lines. Investigations are currently under way to determine if the mutants contain alterations in their surface carbohydrate residues, internalization process, or protein synthesis machinery. (Supported in part by the State of West Virginia and NIH grant RR05870.)

VALENTIN ULRICH AND BERNADETTE M. HABOWA. Plant and Soil Sci. Div., College of Agriculture, West Virginia University, Morgantown, WV 26506, and Mt. Makulu Res. Station, P/Bag 7, Chilanga, Zambia, respectively. RNA Synthesis in Mesophyll Protoplasts of a Sunflower Hybrid and Its Parents with and without the Addition of Exogenous Phytohormones.

Total RNA synthesis in protoplasts derived from two parental lines (RNA 297 and 290X89) and their hybrid progeny were compared in their response to the phytohormones, indole acetic acid (IAA), naphthalene acetic acid (NAA) and to 6-benzyl-aminopurine (BAP). Significant differences were found in responses which were dependent upon genetic background. Inbreds and hybrid displayed lower levels of synthesis in response to 10^{-6} M IAA when compared to controls; the greatest reduction occurred in 290A X 89B. BAP and NAA at 10^{-6} M produced a significant increase in RNA synthesis in the hybrid over that of its parents.

P.C. BACIU, E.C. KELLER, JR., and J.D. TUCKER. Department of Biology, West Virginia University. Genotoxicity in SRCII coal liquefication heavy distillate as determined in Human Peripheral Lymphocytes using sister chromatid exchange assay.

The basic, neutral, and polynuclear aromatic subfractions of a SRCII coal liquefication heavy distillate has shown increased frequencies of sister chromatid exchanges in human peripheral lymphocytes. These results are in agreement with earlier reports of increased mutagenicity using the ames assay found in subfractions of the heavy distillate.

STEVEN L. STEPHENSON and GREGORY A. CHRISLIP, Dept. of Biology, Fairmont State College, Fairmont, West Virginia 26554 and STEWART COLLEY, Route 2, Box 241-A, Haysi, Virginia 24256.
Notes on the use of large-area flight-intercept traps to collect insects in temperate forests.

During the period of June 11-July 2, 1984, large-area flight-intercept or "window" traps of the type described by Peck and Davies (Coleopterists Bulletin 34:237-239, 1980) were set up and maintained in five different upland forest communities (oak-hickory, red oak, beech-red oak-hickory, mixed oak-red maple, and spruce-hemlock) in the Mountain Lake area of southwestern Virginia. Such traps are thought to be exceptionally good for collecting beetles and were used in the present study to sample the populations of slime mold beetles (mostly species of Anisotoma) at the five sites. In addition, other material collected in the traps was sorted and the number of specimens for each major arthropod group recorded. The total catch from all five traps during the entire study consisted of approximately 9,750 individual specimens, including 8,700 insects and 1,050 various other arthropods. Coleoptera and Diptera were the predominant groups encountered, accounting for 43.7% and 28.9% of the total number of individuals respectively, with Hymenoptera representing another 4.6%. As expected, slime mold beetles were present in relatively small numbers, comprising only 0.7% of all Coleoptera collected.

R. GERBER, E.C. KELLER, JR., D. HINTON, R. WARGACKI and D. WERNER,. Departments of Biology and Anatomy, West Virginia University, Morgantown, WV. Association of Water Chemistry and Fish Condition and Gill Histopathology in Three West Virginia Streams.

Comparisons of fish condition among sites in Hominy Creek and Mud River, in north central and south western WV, respectively, indicated significant differences among the condition of Blacknose Dace (among sites in Hominy Creek) and Striped Shiners and Bluntnose Minnows (among sites in Mud River). These differences were primarily associated with differences in iron and alkalinity levels in Hominy Creek and with acidity, dissolved oxygen, and aluminum levels in Mud River. Numerous significant associations were observed for the water chemistry parameters and the V_v mucous (the volume compartment of gill arch and filament epithelium occupied by mucous cells) and % SO/SI (the percentage surface density of lamellar outer surface (SO) divided by the surface density of the inner lamellar surface (SI)). Two of the major water chemistry factors were associated with the % SO/SI histopathology parameter.

JOAN SCHRAMM and DONALD TARTER, Dept. of Biological Sciences, Marshall University, Huntington, West Virginia 25701. Age and growth determinations of the Black Bullhead in West Virginia.

Age and growth studies were conducted on the black bullhead, Ictalurus melas, from an oxbow pond of Twelvepole Creek, Wayne County, West Virginia. These bullheads were aged by counting annular rings of pectoral spine cross-sections and vertebra centra. Annular radii of spines and vertebrae were determined with a traveling microscope. Statistical comparisons (95% confidence level) of the two methods of aging indicated no significant differences occurred. Linear relationships were expressed between spine and vertebral radii with total length. Radial measurements correlated highly with total length and with age. High variability was seen in ranges of lengths and annular radii among different age classes. Backcalculated growth shows the greatest growth to occur in the first age class. A gradual decline in incremental growth occurs with each age group up to age class IV, then an increase in the amount of growth for age classes V, VI and VII is seen.

EDWIN MICHAEL, Div. of Forestry, West Virginia University, Morgantown, WV 26506 and KENNETH KNIGHT, West Virginia Dept. of Natural Resources, Elkins, WV 26241. Small mammal populations in West Virginia.

This paper summarizes the results of several small mammal trapping studies, which presented relative abundance data. Objectives are to compare relative abundance and species composition of small mammal communities in various habitats throughout West Virginia. Small mammals, as used in this paper, include: Soricidae, Sciuridae, Cricetidae, Muridae, and Zapodidae. Most major habitats were sampled, but all regions of West Virginia were not surveyed. Mean capture frequencies for all small mammals in all studies summarized was 7.2/100 trap nights. Highest frequencies were reported for clearcut coniferous forest (12.77), and clearcut deciduous forest (10.51). Next highest frequencies were recorded in highway rights-of-way (8.25) deciduous forest (7.71), and coniferous forest (7.43). Lowest mean frequencies were in old field (3.78), reclaimed surface mines (4.30), and shrub swamps (4.64). Microtus pennsylvanicus, Clethrionomys gapperi, Peromyscus maniculatus, and Peromyscus leucopus were the most abundant species (1.0/100 trap nights) captured. The species captured least frequently were Mus musculus (0.01), Zapus hudsonius, (0.04), Sorex dispar (0.05), and Synaptomys cooperi (0.05). Insectivora comprised 22.6% of the small mammals collected and Rodentia the remaining 77.4%, for all studies combined. Species previously reported in West Virginia, but not trapped in studies summarized included: Sorex palustris, S. longirostris, Cryptotis parva, Reithrodontomys humulis, Microtus pinetorum, M. ochrogaster, and Ochrotomys nuttali.

KELLY NAPIER and DONALD TARTER, Dept. of Biological Sciences, Marshall University, Huntington, West Virginia 25701. Diel and seasonal feeding habits of the Johnny Darter, Etheostoma nigrum Rafinesque from Mud Run, Mason County, West Virginia.

The food and feeding habits of the Johnny darter, Etheostoma nigrum Rafinesque, were investigated from Mud Run, Mason County, West Virginia. The fish were carnivorous. Dipteran larvae, based on dry weight, numbers, and frequency of occurrence, were the most important food item. Copepods and ostracods, based on numbers and frequency of occurrence, were also important. Ephemeropterans, based on dry weight, were important food items throughout the year, while plecopterans were important during the late fall and winter. Isopods and oligochaetes, based on dry weight, were also important food items. Absence of terrestrial insects and the presence of inorganic material in the diet suggested these fish were benthic feeders. Diel feeding periodicities occurred throughout the study. Feeding occurred primarily during the daylight hours, which suggested feeding was stimulated by visual cues. Seasonal feeding intensities indicated feeding was heaviest during the late fall and winter and lightest during the spring. Ivlev's electivity index suggested fish were opportunistic feeders. Several factors could have resulted in biased electivity index values.

D. WERNER, E.C. KELLER, JR., and R. GERBER. Department of Biology, West Virginia University, Morgantown, WV. Chemical and Phytoplankton Aspects of the Waters of Five Moderate to High pH Streams in West Virginia.

The five streams were selected for their mine drainage input under moderate to high pH levels. Each stream was unique in its chemical profile. Factor analyses defined three major groupings of the chemical environments. The first factor was comprised of zinc, dissolved oxygen, and water temperature. The second factor was comprised of sulfate and hardness and the third factor was comprised of cold acidity and iron. Regression analyses showed that the number of phytoplankton present was also associated with pH, alkalinity, and hardness levels. The phytoplankton biomass was associated with hardness and iron levels. The phytoplankton diversity indices and the total numbers of organisms were associated primarily with hardness levels. The three chemical factors were each associated with different aspects of the phytoplankton community viz., the zinc/dissolved oxygen/water temperature factor was not directly associated with any plankton factor. The sulfate/hardness factor was associated with the level of phytoplankton biomass. The cold acidity/iron factor was associated with the levels of the diatom portion of the phytoplankton communities.

E.C. KELLER, JR. and A.J. BECKER, Jr. Department of Biology, West Virginia University, Morgantown, WV. Oxygen Consumption of Amphipods and Crayfish as Functions of Iron, Aluminum, pH, and Temperature.

Stresses measured by oxygen consumption rates (VO_2) related to low pH and elevated iron and aluminum levels were studied in the amphipod Gammarus minus. pH alterations were evaluated in the crayfish (Procambarus clarkii). Lower pH levels in the water increased the oxygen consumption rates in Gammarus minus. Further, total iron increases were found to produce increased oxygen consumption rates. At levels below pH 6, there was a significant increase in oxygen consumption, however, this increase was decreased under the addition of aluminum in Gammarus.

THOMAS K. PAULEY, Department of Biology, University of Pittsburgh at Bradford, Bradford, PA 16701. Amphibians and Reptiles with Limited Ranges in West Virginia.

There are 43 species of amphibians (29 salamanders and 14 frogs) and 42 species of reptiles (15 turtles, 5 lizards, and 22 snakes) known to exist in West Virginia. Of these 85 species, records show that 9 salamanders, 1 toad, 2 frogs, 9 turtles, 3 lizards, and 6 snakes have a limited range and distribution within the State. The limited reported range and distribution of some species may be attributed to the fact that they are simply uncommon in the State. In other cases it may be that herpetological surveys have either not been conducted in habitats where these species exist, or the surveys were done during times of the year when the species are not active (above ground).

These 21 uncommon species of amphibians and reptiles will be discussed and maps will be presented showing their distribution within West Virginia.

Chemistry and Computer Science

E.C. KELLER, JR., G. HOBBS, D. CHILCO, D. WERNER, and R. GERBER. Departments of Biology and Statistics and Computer Science, West Virginia University, Morgantown, WV. Statistical Assessment of the Distribution of Total Iron Content of the Waters of West Virginia.

Recent data were gathered on the total iron content of natural waters* throughout West Virginia. The main objective of the project was to estimate the distribution of total iron extreme values throughout the state. The secondary objective was to see if the total iron levels were associated with coal mining activities. From the 4356 data points, the analyses revealed that considerably different values of total iron can be expected in the various waters of West Virginia dependent upon the number of coal mines that exist in the areas under consideration. It was concluded that for the waters of the state there is an overall chance of about 30% that a water sample taken from streams, rivers, or reservoirs at random, will contain a total iron content in excess of the existing regulatory limit of 1 mg/l.

*By natural waters we refer to the water in the streams, rivers, and reservoirs of West Virginia.

Janice Baker, IBM Corp., Gaithersburg, Maryland, 20879, Frank Hiergeist and George Trapp, Department of Statistics and Computer Science, West Virginia University, Morgantown, West Virginia. A Recursive Algorithm To Invert Multiblock Circulant Matrices.

Circulant and Multiblock Circulant Matrices have many important applications, and therefore their inverses are of considerable interest. The complete structure of the inverse matrices is given, and a simple recursive algorithm is presented to compute the inverse of a multiblock circulant matrix. The algorithm only requires the use of complex roots of unity and the standard matrix/vectors operations. Because the algorithm is recursive, the associated computer program is very compact.

B. Das Sarma, R. Turley and R. Wickline, West Virginia State College, Institute, West Virginia, 25112. Gasoline Sold at the Gas Stations in the Kanawha Valley: Their Price, Octane Number and Composition.

Gasoline samples from a large number of gas stations were collected. Comparative data on the octane number, lead content and price in different samples will be presented. Unleaded "regular" and "premium" gasoline were anlayzed by gas chromatography for a comparative study of different brands. The analytical data from gas chromatography, atomic absorption, ultraviolet absorption and NMR will be used to get a better look at these amazingly complex mixtures we use every day.

BERNARD KRABACHER, Chemistry Dept., West Virginia State College, Institute, West Virginia 25112. Getting Started with a Microcomputer in the Chemistry Department of a Small College II.

The original goals set for the first year's use of a microcomputer in the Chemistry Department at West Virginia State College were found to be far too ambitious. In the second year some priorities have been set that are more realistic. These goals are being met to a large extent. Some of the accomplishments are: Listing of Chemistry and Chemical Technology majors along with their addresses, option, class; beginning computerized inventory of chemicals; a workable grading system; sign making for announcements of speakers, student awards luncheons, CRC handbook sales, etc.; providing help to other faculty in the use of a microcomputer. A short course for beginners and others (faculty, staff, and students in the department) has been initiated - a non-credit hands-on course that includes programming in basic, writing a tutorial program, use of a word processor, use of a modem, use of a data base system, and writing programs in assembly language. These accomplishments will be addressed along with a consideration of student use of the department's computer.

ELIZABETH D. SWIGER. Department of Chemistry, Fairmont State College, Fairmont, West Va. 26554. Microcomputer Programming in the Freshman Chemistry Laboratory.

The Chemistry Department at Fairmont State College has been teaching computer programming in the freshman course for science majors for over fifteen year. During this time the project has evolved from FORTRAN on punch cards to BASIC on microcomputers near the laboratory. After an introductory lecture outlining a common flow diagram and the elements of BASIC necessary

for its accomplishments, each student writes a program for a particular laboratory experiment. After entering and debugging the program she/he creates a data file containing data for that experiment from each class member. A print out of the results is submitted for a grade.

After the initial experience the computers are available to the students for other uses. For example, a number of related programs, most written by students, are available to process and plot data from a series of kinetics experiments. Several other uses of the Division microcomputers will be outlined as well as examples of student projects.

Geology

MATTHEW B. WATSON, KENT ADKINS, GREG A. SMITH, AND RONALD L. MARTINO, Department of Geology, Marshall University, Huntington, West Virginia, 25701. Sedimentology and Paleohydrology of the Fluviodeltaic Conemaugh Group (Late Pennsylvanian) along the Big Sandy River, West Virginia - Kentucky.

The Conemaugh Group of West Virginia has been interpreted by previous workers as consisting of a lower delta plain assemblage of facies - the Glenshaw Fm. - succeeded by upper delta plain deposits of the Casselman Formation. Extensive new exposures of the Glenshaw and Lower Casselman Fms. along Kentucky Rt. 23 south of Cattletsburg complement existing localities near and along the Big Sandy River providing an unusually complete 3-dimensional perspective of the local depositional history and paleogeography. At least 3 transgressive-regressive cycles averaging 49m thick are present within the Glenshaw Fm. Marine zones are distinguished by invertebrate body and trace fossils. The cycles are fewer in number and thicker than those described farther north in Ohio and Pennsylvania in the same stratigraphic interval. These differences may be explained by a higher rate of terrigenous influx and basin subsidence and more proximal location for the study area than for more northerly localities.

Exceptional outcrops of several paleochannel sandstones with epsilon cross-strata provide width and depth values for lower delta plain distributaries and upper delta plain alluvial channels. Width/depth ratios (channel form indices) are then used to estimate paleohydraulic and paleogeomorphic characteristics of the respective channel systems. Among these, the Grafton Sandstone of the lower Casselman Fm. contains fluviodeltaic channels whose morphology and hydrology are compared with previous estimates for the same depositional systems in northern West Virginia.

The results of this study are generally consistent with the paleogeographic view of northwestward prograding fluvially-dominated deltas fed by suspended to mixed load meandering rivers.

WM. CHRISTOPHER ALGER, Department of Geology and Geography, West Virginia University, Morgantown, West Virginia 26506. Petrography of the Upper Devonian Chemung and Hampshire Formations, Elkins, WV

The upper Devonian 'Chemung' and Hampshire siltstones and sandstones, exposed east of Elkins, West Virginia represent a progradational shelf to nearshore to shoreface to fluvial sequence. Thick fluvial sandstone units in the upper portion of the section are rare. Commonly only thin, fine-grained sandstones are observed surrounded with red mudstones. The shoreline and nearshore sediments are believed to represent a segment of a tidally dominated coastline with strong storm influences. The more distal shelf deposits are characterized by repetitive fining and thinning upward turbidite sequences.

The variety of depositional environments observed at the Elkins exposure on an outcrop scale is somewhat more conspicuous than the variety of constituents observed on a microscopic scale. The framework constituents are composed dominantly of quartz (monocrystalline 30% to 63%, and polycrystalline 2% to 20%) and lithic fragments 9% to 28% (which include: metamorphic and sedimentary rock fragments), with commonly less than 10% feldspar (both plagioclase and orthoclase).

The variety observed on a microscopic scale is chiefly related to the variability of the interstitial cementing materials. According to x-ray diffraction studies, 10Å illite/sericite/mica constituents are the chief phyllosilicates present in most samples; but several samples also contain relatively large concentrations of 7A kaolinite and/or chlorite. Carbonates, where present, occur in several forms (calcite, dolomite/ankerite, and siderite). Carbonate replacement of fossil fragments is commonly observed in several samples obtained from various locations at the Elkins exposures. The presence and amount of these clays and carbonates in specific portions of the outcrop appear to be strongly influenced by depositional processes.

ERIC C. TISSUE, Dept. of Geology, West Virginia University, Morgantown, West Virginia 26506.
Environmental Analysis of the Shallow Marine Regressive Sequence at the Greenbrier-Mauch Chunk Transition in Garrett County, Maryland.

Three highly fossiliferous stratigraphic sections of the upper Greenbrier-lower Mauch Chunk transition (Upper Mississippian) were measured at a quarry exposure six kilometers southwest of Oakland, Maryland. Massive and shaly limestones of the uppermost Greenbrier limestone and red shaly limestones and calcareous shales of the lowermost Mauch Chunk Formation were examined macroscopically and petrographically to interpret paleoenvironmental changes across the formation transition.

Petrographic analysis of the massive and shaly limestones of the Greenbrier indicates a spatial variability in microfacies between skeletal packstones and wackestones. Several of the shaly intervals contain lenses of skeletal grainstone. The packstones and wackestones are attributed to relatively quiet waters on an open carbonate shelf, whereas the generally mud-free lenses of grainstone, which also contain current-oriented shells, are products of higher energy conditions. A diverse fauna occurs in these limestones and includes crinoids, brachiopods, bryozoans, foraminifers, ostracods, trilobites, and molluscs. This high diversity is indicative of low-stress conditions in an open ocean environment. Algal grains are also common indicating water depth was within the photic zone and perhaps less than twenty meters.

Towards the top of the stratigraphic section, faunal diversity and abundance of some organisms, such as brachiopods, bryozoans, and foraminifers, decreases. Concurrently, algal-grain content increases. These changes are indicative of transition from non-stressful to stressful conditions where algae are more tolerant. Changes in physical parameters, such as increased sediment influx, decreased salinity, or a more soupy substrate, may account for the decrease in faunal diversity.

WILLIAM H. GILLESPIE, Dept. of Geology, West Virginia University and U. S. Geological Survey, 916 Churchill Circle, Charleston, WV 25314, LARRY RHEIMS and LARRY BARNETT, Alabama Geological Survey, Tuscaloosa, AL 35401, and CORTLAND F. EBLE, West Virginia Geological and Economic Survey, Morgantown, WV 26505. *Plant biostratigraphy of the coals of Alabama (Pottsville, Pennsylvanian).*

The cooperative coal quality sampling program of the United States and Alabama Geological Surveys has resulted in the collection of hundreds of plant megafossils and dozens of coal samples from outcrop locations, surface mines, and deep-well coring operations in the Warrior and Cahaba coal basins of Alabama. The analyses of these materials, from throughout the several thousand feet of geologic column, all indicate that the relative age of these strata is Lower Pennsylvanian (=New River) when compared with the Proposed Pennsylvanian System Stratotype of Virginia and West Virginia, and Westphalian A when compared with published chronostratigraphic zonations of western Europe and the Donetz basin. Additional refinement into subzones may be possible when the palynological studies are completed. However, miospore assemblages from both the oldest coals (J-group and older stringers) and the youngest coals (Brookwood and Guide) clearly indicate that the strata are neither the oldest nor youngest Westphalian A; rather, they occur in the middle portions of this age zone.

ALISON M. BELL, Dept. of Geology, West Virginia University, Morgantown, West Virginia 26506. Identification and Correlation of Fluvial Terraces in the Upper Shenandoah Valley.

Field studies in Rockingham County, Virginia, have revealed a sequence of terraces flanking the South Fork of the Shenandoah River. The terrace deposits are underlain by Cambrian and Ordovician carbonates, shales, and sandstones. Identifying and correlating different aged terrace surfaces is complicated in several ways by karst solution of the carbonate bedrock. Firstly, the uneven karst reduction of surface elevations results in terrace deposits of similar age existing at different elevations above the present river. Secondly, colluviation of the alluvium due to karst collapse mixes the fluvial deposits. Lastly, many of the soil profiles contain a lithologic discontinuity; the in situ chemical weathering of the carbonate bedrock produces a residual clay subsoil beneath a pedogenically active alluvial soil. The alluvial soil may be removed by physical processes, or become incorporated into the subsoil, and the profile appears to become predominantly residual through time. The latter process reduces the usefullness of soil units as terrace indicators.

This study attempts to identify variables within soil and sediment profiles that can be used to correlate terrace deposits of unknown age. A terrace chronosequence is used to establish those variables that exhibit trends with time. Clay mineralogy will be studied throughout individual profiles, and compared with profiles representing different aged deposits. Trends in clay mineralogy

can be considered as time sensitive within the confines of constant parent material and climate. Partical size distribution, specifically clay accumulation in the developing B horizon, can be considered time dependent. Variations within heavy mineral populations can be used to differentiate between separate fluvial episodes, either because of a change in provenance, or because of the minerals exhibiting differential weathering rates. The latter can be utilized as an index of terrace age. In the case of some older surfaces, field observations could not be used to distinguish between soils partially derived from fluvial deposits and those that are completely residual. Therefore, heavy mineral analysis will be used to determine the soil parent material. Each formation underlying the soils contain distinct populations of heavy minerals, including specific varieties of zircon. The presence of zircon varieties in the solum differing from those found in the bedrock suggests that the soil was partially derived from the alluvium of the South Fork of the Shenandoah River.

CORTLAND F. EBLE and WILLIAM C. GRADY, West Virginia Geological and Economic Survey, P. O. Box 879, Morgantown, WV 26507, and WILLIAM H. GILLESPIE, U. S. Geological Survey, 916 Churchill Circle, Charleston, WV 25314. *Palynology and Paleoecology of the Redstone coal (Upper Pennsylvanian) in West Virginia.*

Palynological analyses of ten increment columns of Redstone coal from Barbour, Upshur, Lewis, and Monongalia Counties in northern West Virginia have isolated 81 species assignable to 37 small spore genera. The occurrence and relative abundance of several of the taxa present indicate the existence of twelve more-or-less discreet spore and pollen assemblage zones, some of which are laterally continuous in the study area. Published natural affinities for many of the recovered taxa in conjunction with coal petrographic and analytical data provide a basis for interpreting the paleobotany and paleoecology of the ancient Redstone swamp.

Various species of *Fabasporites*, *Punctatosporites*, *Punctatisporites* and *Laevigatosporites* comprise the majority of the small spore flora indicating that tree ferns and arborescent calamites were the dominant types of vegetation. The herbaceous fern spore genera *Triquitrites*, *Lophotriletes*, *Leiotriletes*, and *Acanthotriletes* are common and occasionally abundant throughout the vertical extent of the bed. *Endosporites*, the dispersed spore genus of *Polysporia*, a robust herbaceous lycopod, makes up a conspicuous, but vertically inconsistent element of the spore flora, being most common in the basal portions of the bed and in zones of relatively impure coal. These factors suggest that *Polysporia* was a pioneer-type plant in the Redstone swamp inhabiting stressed areas not generally conducive to good preservation and deposition.

RAY BOSWELL, Dept. of Geology and Geography, West Virginia University, Morgantown, West Virginia 26506. The Upper Devonian Catskill sequence of north-central West Virginia; a comparison between an outcrop and the subsurface.

The Upper Devonian 'Catskill' sequence of north-central West Virginia is an assemblage of fluvial, paralic and marine sedimentary rocks in facies relationship. Regional subsurface correlations, in

conjunction with field study of an outcrop near Rowlesburg, West Virginia, have allowed these units to be better understood.
The facies present at Rowlesburg consist of brown marine shales of the Upper Chemung Formation; shoreline sandstones, dark shales and marine-influenced redbeds of the lower Hampshire Formation, fluvial sandstones and terrestrial redbeds of the Upper Hampshire Formation; and grey, tabular, marine fossiliferous sandstones and siltstones of the Pocono Formation.
Subsurface units from the Warren/Bayard interval up through the Weir have been recognized in outcrop. Warren sands are relatively clean and coarse and represent shoreline systems. Thin sands and redbeds with occasional brackish water fossils indicate back-barrier conditions for the equivalents of the Fourth and Fifth sands. Fluvial environments for the Gordon and Thirty-Foot equivalents are suggested by lenticular sands with cut-and-fill features interbedded with pseudoanticlined red mudstones. Hampshire Formation redbeds abruptly stop at the top of the Thirty-Foot interval and are overlain by open marine sandstones of the Fifty-Foot interval. This transgression culminates in a thick brown shale and siltstone interval just above the conglomeratic Gantz. Above this shale and just below the Greenbrier Limestone is a massive sand with fluvial characteristics correlating to the Weir interval.

WILLIAM H. GILLESPIE, Dept. of Geology, West Virginia University and U. S. Geological Survey, 916 Churchill Circle, Charleston, WV 25314, THOMAS CRAWFORD, Dept. of Geology, West Georgia College and U. S. Geological Survey, Carrollton, GA 30117, and CORTLAND F. EBLE, West Virginia Geological and Economic Survey, Morgantown, WV 26505. *Plant biostratigraphy of the coals of Georgia (Pottsville, Pennsylvanian).*

Coal samples, along with associated plant megafossils and invertebrate fossils, from the Pennsylvanian System in northwest Georgia were collected during an intensive geologic mapping program of several years duration, sponsored by the United States Geological Survey. The palynological assemblages from the eleven coals, and their associated plant megafossils, indicate that the strata in question are all of Lower Pennsylvanian age (=New River) when compared with the Proposed Pennsylvanian System Stratotype of Virginia and West Virginia, and Westphalian A when compared with European chronostratigraphic zonations. Although some of the plant megafossil and miospore taxa may be of local significance only, zones of equivalent age are identified worldwide by the *Lyginopteris hoeninghausi-Nueralethopteris pocahontas* megafossil assemblage and the *Schulzospora rara-Radiizonates striatus* palynological assemblage, which characterize these strata. Additional work in progress may result in further refinement into subzones. The lithological and fossil evidence, which indicates a gradual transition from the underlying Upper Mississippian Pennington Formation, raises the question of whether Pocahontas-age sediments were ever deposited in this part of the Appalachian basin.

Mining and Engineering Science

H. FAIRBANKS, Dept. of Chemical Engineering, West Virginia University, Morgantown, WV 26506. W. MORTON, Heritage Industries, Inc., Bridgeport, WV 26330, and J. WALLIS, Consultant, Morgantown, WV 26505. Mineral Recovery Enhanced with Ultrasound - Theory

This paper discusses the theory of using ultrasound for enhancing the processing of minerals. The unit consists of an ultrasonically vibrated inclined metal trough. The dimensions of the trough are determined by the type of slurry and by the capacity desired. The pulverized solid is put into a water slurry which flows onto the trough.

Deagglomeration of the particles takes place along with a cleaning action on the surfaces of the particles. This cleaning action breaks the surface tension with the water, thereby producing: 1) better settling of the particles, 2) better particle compaction, and 3) better water drainage.

Making use of the above factors, the following processes have been investigated: 1) recovery of coal from refuse piles, 2) heavy mineral recovery, and 3) pond water clarification.

STEVEN McCLELLAND, W.Va. Geological and Economic Survey, Box 879, Morgantown, West Virginia 26507 Using fractals to measure the progress of erosion.

Mountain front sinuosity is a method of measuring the progress of erosion by measuring the ratio of the length of the mountain-piedmont junction to the length of the mountain front. A higher ratio means a greater length of junction which implies more erosion. Measurements in the Eastern Panhandle of West Virginia show, however, that the value of the ratio depends on the scale of the map and on the method of measurement. Fractals show promise as a means of obtaining a quantitative measure of erosion which is independent of map scale and measurement method.

ALAN D. SMITH, Dept. of Business Administration
Eastern Kentucky University, Richmond, Kentucky
40475. Engineering and Strength Properties of Selected Silty-Clay Mixtures Derived From Madison County, Kentucky

Engineering properties of six representative sites of silty-clay mixtures in and around Richmond, Kentucky were investigated to help understand and qualify functional relationships among common soil strength and consistency measures in this area. Since all the sites are scheduled for future development in terms of a variety of construction projects, and the silty-clay mixtures, classified by the uniform classification system as SC, are common through Madison County, extensive laboratory tests were performed. On all sample sites, standard and modified energies of compaction, via the Proctor Compaction Density Laboratory Test, were completed a total of three times. In addition each layer, three in the standard and five in the modified, in the compaction mold was sampled a total of three trials for water content, vane shear, and compressive strength, as measured by the penetration test. Atterberg Limits were performed on three representative samples to determine the variability of the plastic range.

Multiple linear regression techniques were applied in the hypothesis testing process, which resulted in 13 hypothesis being statistically significant (Table 1). In general, higher energies of compaction were associated with lower water content, less void space, higher shear and compressive strengths, lower water contents were found to be related to higher maximum dry densities, higher compressive strengths with greater maximum dry densities, and vane shear strengths positively related to compressive strengths as measured by the penetration test.

Table 1 - Summary of models tested, R^2, degrees of freedom for both numerator and denominator, F-ratio, mean square, probability levels, and statistical significance for each research hypothesis that tested for predictive relationships and the engineering parameters associated with SC (silty-clay) samples derived from the Richmond area.

Engineering Parameters Dependent	Independent	R^2	df	MS_{Reg}	F-ratio	Prob.	Sign.
Proctor Compaction Energy	Water content, Dry Density, Vane Shear, Penetration	0.5810	4/31	1.3073	10.7470	0.0000	S
	Water Content[a]	0.2499	1/34	2.2498	11.3322	0.0019	S
	Dry Density[a]	0.4836	1/34	4.3522	31.8368	0.0000	S
	Vane Shear[a]	0.2421	1.34	2.1785	10.8582	0.0023	S
	Penetration	0.3513	1/34	3.1619	18.4146	0.0001	S
Water Content	Proctor Compaction Energy, Dry Density, Vane Shear, Penetration	0.3438	4/31	17.9084	4.0611	0.0092	S
	Dry Density[b]	0.2964	1/34	61.7463	14.3214	0.0006	S
	Vane Shear[b]	0.0886	1/34	18.4577	3.3051	0.0779	NS[e]
	Penetration[b]	0.10236	1/34	21.38773	3.8773	0.0521	NS[e]
Dry Density	Proctor Compaction Energy, Water Content, Vane Shear, Penetration	0.6289	4/31	334.3553	13.1371	0.0000	S
	Vane Shear[c]	0.1055	1/34	224.3704	4.0108	0.0532	NS[e]
	Penetration[c]	0.4063	1/34	864.0287	23.2711	0.0000	S
Vane Shear	Proctor Compaction Energy, Water Content, Dry Density, Penetration	0.3426	4/31	7.0604	4.6025	0.0049	S
	Penetration[d]	0.2911	1/34	22.0668	13.9639	0.0007	S

Penetration	Proctor Compaction Energy, Water Content, Dry Density, Vane Shear	0.5458	4/31	3.1177	9.3118	0.0000 S

Note: An F-test was utilized to test for statistically significant relationships among the various engineering parameters associated with the silty-clay samples derived from the Richmond area. The assigned alpha for a two-tailed, nondirectional test was used before each specific hypothesis was considered significant. However, a correction for multiple comparisons was deemed necessary in a number of cases in the hypothesis testing process. The alpha level was corrected using the Newman and Fry (13) Method. The following are the corrected alpha levels:

a	0.0125	d	0.05
b	0.0167	e	denotes hypothesis approaching statistical significance at the 0.05 alpha level for a two-tailed test
c	0.025		

RICHARD D. BEGLEY, Division of Technology, Fairmont State College, Fairmont, West Virginia 26554 and A. WAHAB KHAIR, Dept. of Mining Engineering, West Virginia University, Morgantown, West Virginia 26505. Determination of mechanical properties of coal/rock specimen using laser holometry and nondestructive tests.

Nondestructive tests were performed on coal and rock specimen in order to investigate their physical material properties such as Poisson's Ratio, Young's Modulus, anisotropy and inhomogeneity. The tests were performed in order to analyze the feasibility of utilizing a fairly new optical technique of displacement analysis called holographic interferometry (holometry), in these types of experiments.

This technique, which was not practical until after the laser was invented in 1960, has been widely accepted as a valuable technique of surface displacement analysis. However, holometry has been applied to rock mechanic experiments only recently and therefore, only limited documentation is available. But the technique has a high potential in rock mechanics because a full field quantitative displacement analysis can be performed on any object as long as optical access is provided. This capability eliminates the need for surface instrumentation such as strain gages.

The experiments consisted of uniaxial compression tests performed on cubical and cylindrical coal and rock specimens. Sequential holographic interferograms were constructed at various stages during the loading process while surface strains were monitored by strain gages. The resultant interferograms were analyzed quantitatively and qualitatively and compared to displacements recorded by the strain gages.

This paper will describe the experimental procedures and results and will also present typical interferograms that have been recorded.

ALAN D. SMITH, Dept. of Business Administration, Eastern Kentucky University, Richmond, Kentucky 40475. Dimensional Analysis of Coal Pillars: An Application of Cost-Sensitive Mine Planning Principles to a Southeastern Kentucky Mine

The cost-sensitive mine planning involves spatial projection of the geological and economical conditions that will have the greatest impact on cost and coal quality for a particular mine site. A comparison of actual, maximum safety, and recommended pillar dimensions and their associated factors of safety, based on the theories of Salamon (1968), Salamon and Munro (1967), Bieniawski (1973), Bieniawski (1973), Bieniawski, Rafia, and Newman (1980), and Skelly, Wolgamott, and Wang (1977), which cover a broad spectrum of mining conditions, were made for a small coal mine near Leatherwood, Kentucky in southeastern Kentucky (Table 1). From a preliminary and economic forecasting viewpoint, the traditional 40 foot square pillar appears to be too large, at least from the standpoint in the eastern Kentucky coal fields (Table 2). The alternative system of room-and-pillar mining with 36 foot pillars and conservative 20 foot entries would allow for 5 entries to be developed in the same area of coal, which would result in an increase of 320 tons of raw coal per move up. Assuming the price of coal is $32 per ton and standard coal preparation losses at 20 percent, additional revenue of about $8,200 per move up would be realized. This increase in cash flow is especially important in developmental stages of underground mining, due to the shortage of cash flows.

TABLE 1. Factors of Safety Associated with 40 Foot Square Pillars, Maximum Safety, and Recommended for Safe-Rigid Pillars.

Pillar Design Theory	Factors of Safety for a 40 Foot Square Pillar[a]	Factors of Safety for Maximum Safety Pillar	Factors of Safety for Recommended Safe-Rigid Pillar
Salamon (4), Salamon and Munro (5)	3.79	1.9	1.6
Bieniawski (6), Bieniawski, Rafia, and Newman (7)	3.48	3.0	2.0
Skelley, Wolgamott, and Wang (8)	2.53	3.0	2.0

[a] Factors of safety is equal to the ultimate strength of the pillar (S_p) divided by the actual stress on the pillar (σ_p), assuming the ultimate strength approach as defined by Peng (10).

TABLE 2. Comparison of the Actual, Maximum Safety, and Recommended Dimensions for a Square Pillar at the Leatherwood Mine.

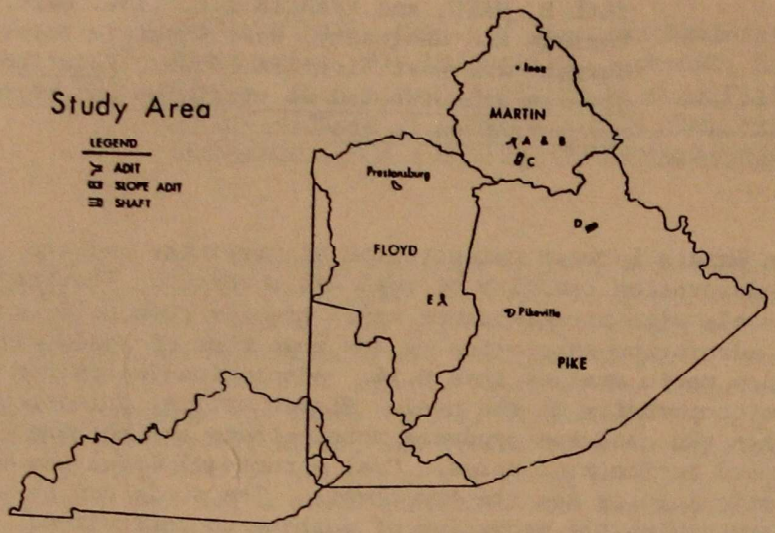
Pillar Design Theory	Square Pillar Dimensions in Feet (Meters)		
	Actual	Maximum Safety	Recommended
Salamon (4), Salamon and Munro (5)	40 (12.19)	24 (7.32)	21 (6.40)
Bieniawski (6), Bieniawski, Rafia, and Newman (7)	40 (12.19)	36 (10.97)	28 (8.53)
Skelley, Wolgamott, and Wang (8)	40 (12.19)	45 (13.72)	34 (10.36)

PAUL B. WANG, and FRANCIS T.C. TING, Dept. of Geology and Geography, West Virginia University, Morgantown, West Virginia 26506. Relationship between anisotropism of vitrinite and methane concentration in coal.

Correlation exists between anisotropism of vitrinite and the adsorption-desorption capacity of coal was observed. When ranks are the same, coals with bireflectance ratio greater than 0.17 tend to have lower adsorption-desorption values than that of coals with bireflectance ratio smaller than 0.14. Adsorption-desorption value indicates microporosity of the coal. Higher optical anisotropy suggests that the coal has produced more methane and methane produced is not trapped inside micropores. Coal structural model can be used as a theoretical basis for the hypothesis. The study can be used to aid in understanding the mechanism of methane concentration. It also has a potential application in the exploration of coal gas as natural gas.

ALAN D. SMITH, Dept. of Business Administration, Eastern Kentucky University, Richmond, Kentucky 40475. Statistical Evaluation of Floor Heave, Condition and Time of Failure of Roof Falls in Coal Mines.

The stability of coal-mining tunnels, entries, rooms, and associated openings plays a major role in the success of any underground project. The mechanical design of a roof-support system is basically a matter of a working knowledge of statics and dynamics, assuming that the imposed loads and mining conditions are known. However, in the Appalachian Coal Fields, the general conditions are known well enough for the majority of mining operations, including traditional room-and-pillar as well as long wall mining, to occur. Unfortunately, roof falls frequently occur, causing injury and valuable time and money in repairing or restructuring entries, hallways, and lost production. Two important factors, namely floor heave and length of time that failure occurred after initial coal extraction, were statistically evaluated in a series of hypotheses with a host of failure criteria, such as sloughing of coal ribs, roof-bed characteristics, coal seam characteristics, pillar dimensions, and size factors of the roof fall itself. A total of 250 roof falls in five coal mines in Pike, Martin, and Floyd Counties, Kentucky were examined. In general, the results of the hypotheses testing were: less time of the mine-roof fall occurrence after initial coal excavation was significantly associated with increased sloughing of coal ribs before failure of roof, less distance from the working face, and greater occurence of mechanical-anchor bolts used for initial support as compared to full- or partial-column bolts; and increased presence of water and sloughing of ribs was significantly related to increased floor heave condition. In addition, frequency and descriptive statistics were used to create profiles of failure areas.



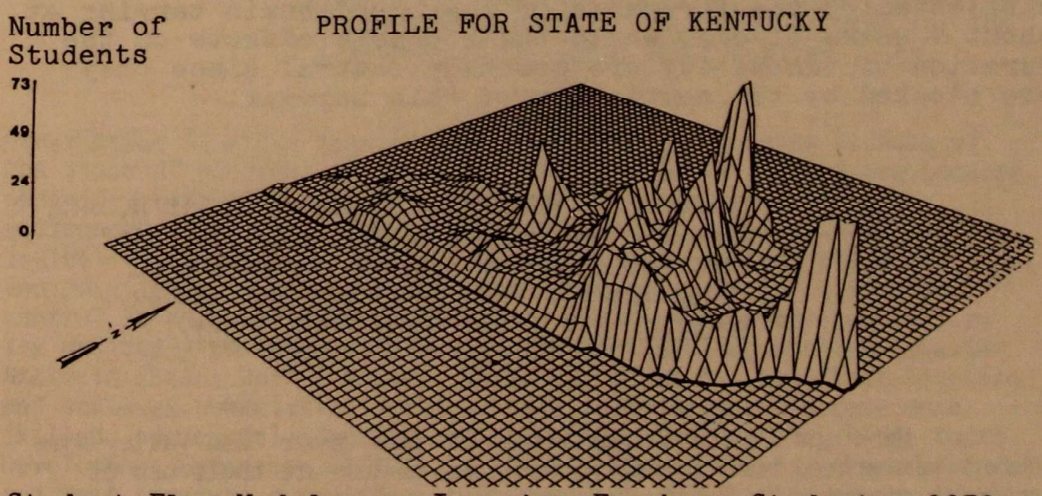
GRADY, WILLIAM C., West Virginia Geological and Economic Survey, P.O. Box 879, Morgantown WV

HEAVY MINERAL OCCURRENCES IN WEST VIRGINIA COALS

A scanning electron microscope utilizing a backscatter electron detector (BSED), a cathodoluminescence (CL) detector and an energy dispersive x-ray detector (EDX) was employed in a search of 23 samples of West Virginia coals for heavy minerals. The samples were prepared by binding -20 mesh coal in an epoxy pellet, polishing the pellet, and mounting the polished surface on a 1 1/4 inch specimen stub which was then gold coated. The threshold of the BSED was adjusted to pass only signals from minerals with a combined atomic weight greater than those of common quartz and clay minerals. Using this technique, only heavy minerals appeared on the BSED display. The sample surface was systematically scanned and all minerals appearing on the BSED display were analyzed using EDX. Pyrite and common carbonate minerals were ignored but all other minerals were analyzed for elemental composition, CL intensity, size, crystal form and mineral-maceral associations. In 23 samples 1150 heavy mineral occurrences were analyzed and 27 different elemental associations were recognized. Most of these could be correlated with known minerals or mineral groups. Titanium oxide, both a CL luminescent and a nonluminescent variety, were the most common heavy minerals encountered and averaged 50.8% of the heavy mineral assemblage and was observed in all 23 samples. The TiO_2 was probably in the forms of the minerals Rutile and Anatase. Other minerals observed in significant percentages were Monazite (Ce,La phosphate 13.0%:21 = average 13.0% and observed in 21 samples), Chalcopyrite (Fe, Cu sulfide 10.7%:17), Zircon (Zr silicate 10.4%:23), Xenotime (Y phosphate 2.3%:13), Alunite group minerals (Sr,Ba,Ce,La phosphates 1.6%:11), Clausthalite (Pb selenide 1.3%:5), Apatite (Ca phosphate (0.8%:6), Galena (Pb sulfide 0.3%:2), Barite (Ba sulfate 1.3%:9) Sphalerite (Zn sulfide 1.3%:5) and numerous probable oxides of Fe, Cr, Zn, Cu, Pb and Sn.

ALAN D. SMITH, Department of Business Administration, Eastern Kentucky University, Richmond, KY 40475. Mathematical Modeling of Student Flows for a Large Residential University

The research in the literature on the problematic effects of attrition in higher education has been well documented in the past. Obviously, the nature and purpose of the colleges/universities involved have a significant impact on the dropout problem, and there may be many factors that post-secondary institutions can control in order to curb attrition. The attempt to delineate those factors require models to be generated to provide additional information on the interruption of student flow toward degree completion, in order to produce forecasting tools. Since most of the attrition appears to be during the first year of college attendance, the spatial distributions of incoming freshmen students coming to Eastern Kentucky University, a large residential university, were inspected to determine if detectable patterns of enrollment trends existed. The University has a regional mission, thus spatial characterization of student flows are important to determine stability of enrollment in its service area and surrounding counties. Student flow models were created and statistically tested for enrollment data from 1979 through 1982, inclusively, as well as change in enrollment from 1981 to 1982, based on data obtained from 117 counties in Kentucky. Three-dimensional modeling techniques as well as hypotheses testing and model comparisons of polynomial trend surfaces were utilized in modeling the spatial distributions of incoming freshmen students. Powerful and statistically significant predictive models of student flow were generated and graphically portrayed for the years studied. The best fit surfaces accounted for a low 56.32 to a high of 61.61 percent of explained variance in predicting student flows as a function of geographic distribution in Kentucky. However, no such relationship was found to be significant for student change from one year to the next, as evident from the analysis of the change in 1981/1982.



Student Flow Models --- Incoming Freshmen Students, 1979.

Psychology and Social Science

CHARLES W. HENNIG, WILLIAM C. STEINHOFF and JEANNE V. BOOTH, Psychology Department, Salem College, Salem, West Virginia 26426. Differential effects by serotonin on the susceptibility and the duration of immobility responses in chickens.

Tonic immobility is a form of motor inhibition which can be induced in various species by physical restraint. Several studies have implicated the serotonergic system with this immobility response, but injections of this chemical have had varied effects on duration of tonic immobility. Moreover, it is unclear whether the action by serotonin on the immobility response is produced through central or peripheral mechanisms. The present study attempts to answer this question and interpret other unexplained effects by serotonin on immobility.

The subjects were 54 Production Red chickens. Half the animals were tested at 10 days of age and the others at 45 days. The chickens in each age condition were subdivided into three equal groups which received IP injections of water, 0.5 mg/kg of serotonin, or 15.0 mg/kg of serotonin. The number of inductions required to produce immobility and the duration of each response were recorded. Statistical analyses revealed that high doses of serotonin made immobility easier to induce, regardless of age; while serotonin had no effect on immobility duration at 45 days of age, but produced biphasic effects on duration of immobility with low and high dosages of serotonin in younger chickens.

The present results suggest that susceptibility to immobilization is due to a peripheral effect, since it is unaffected by the formation of the blood-brain barrier at about 4 weeks of age, while the biphasic effects on the duration of immobility are probably central since they are blocked by the completion of this barrier.

AUGUSTINE J. KELLIS and ALBERT R. BUCKELEW, JR., Dept. of Biology, and JOHN H. HULL, Dept. of Psychology, Bethany College, Bethany, West Virginia 26032. Use of growth hormones by weightlifters in the upper Ohio Valley.

Male and female weightlifters at four upper Ohio Valley gyms were administered questionnaires designed to measure their use of anabolic steroids, knowledge of anabolic steroid side effects, and why they lifted weights. About one-third of male respondents, but

none of the female respondents, reported using anabolic steroids for at least one cycle. Typical steroid users had use cycles from 6-8 weeks, were not under a doctor's supervision, had obtained the steroids illegally, and were using the steroids in an attempt to increase muscle mass rather than to increase sport proficiencies. Steroid users reported, and demonstrated, significantly greater awareness of steroid use side effects than did nonusers.

H. LYNN CLINE, DARCI A. SEMBER, and JOHN H. HULL, Dept. of Psychology, Bethany College, Bethany, West Virginia 26032, and DEBRA BEERY HULL, Dept. of Psychology, Wheeling College, Wheeling, West Virginia 26003. Factors influencing dual career and commuter marriage decisions.

British and American male and female college students read paragraphs which described two graduating college students (called John and Mary), engaged to be married, who had received job offers in different cities. Paragraphs varied in the starting salaries John and Mary were offered, and the availability of jobs for each person in the city where the other had received a job offer. Findings included: British subjects were significantly more accepting of John and Mary establishing a commuter marriage, but less optimistic about the possibility of a happy marriage; males were significantly more likely than females to think that Mary should go with John if he insisted upon taking the job he was offered; starting salaries offered and job availability for each person in the city where the other had received a job offer were significant factors in determining where subjects thought the couple ought to locate, and whether Mary of John should accompany the other if she or he insisted upon taking the job she or he was offered.

TIMOTHY FREEMAN, Dept. of Psychology, and THOMAS CRITCHFIELD, Dept. of Educational Psychology, West Virginia University, Morgantown, WV 26506. Behavioral engineering as a humanistic endeavor: a non-institutional, behavioral program for the treatment of troubled and troubling youth.

Behaviorism is often seen as the antithesis of Humanism because of the issue of behavior control. The distinction is a false one because behavior, like other natural phenomena, is a function of its environmental context, making behavior without external control a logical impossibility. The only choices are to control planfully and positively, control through aversive means, or to relinquish control to an uncaring and disorderly world. The latter two choices are decidedly contrary to a humanistic perspective. Applied Behavior Analysis (Baer, Wolf & Risley, 1969) has opted for the first approach and achieves humanistic ideals by helping individuals become more skilled, successful adaptive and satisfied. The Pressley Ridge Youth Development Extension (PRYDE), a private agency based in Pennsylvania and West Virginia exemplifies this approach. PRYDE places behaviorally and emotionally disturbed adolescents in the private homes of couples

recruited from the community and trained to implement a 24-hour, behaviorally-based treatment program. The couples, while serving technically as foster parents, apply incentive-based techniques commonly referred to as "behavior modification" as well as counseling and analytical skills which are also behaviorally taught and defined. Additionally, all aspects of the system are data-based. The data from PRYDE's first three years indicate that the PRYDE system produces excellent results in terms of traditional measures such as frequency of appropriate behavior and discharge and follow-up status, as well as in terms of humanistic variables such as youth satisfaction with the degree of caring and personal interest inherent in the program. PRYDE is offered as an example of behavioral engineering as a humanistic endeavor.

JEFFREY D.CROSS and KIMBERLY MATHOS
Departments of Psychology and Biology
Allegheny College
Meadville, Pa. 16335

Interspecific discrimination of odor of reward and non-reward.

The production of goal-event related odors has been demonstrated in several rodent species. Several procedures have been employed to study this phenomenon, the most common being to run a squad of three or four conspecifics, in a fixed order, in a straight alleyway. All squad members experience the same goal event (reward or non-reward) in the goal box of the alleyway. Odors produced in the goal area of the apparatus provide discriminative cues to subjects in later squad positions. Discrimination of reward and non-reward odors is demonstrated by running speeds with faster run speeds occurring on reward trials than on non-reward trials. The odors appear to accumulate across subjects, the effect being that subjects in later squad positions run faster on reward trials and slower on non-reward trials than preceeding subjects.

The present experiment assessed the possibility of interspecific discrimination of odors of reward and non-reward. Two squads of subjects were established. The first squad consisted of three rats followed by a mouse (Rat-Mouse). The second squad consisted of three mice followed by a rat (Mouse-Rat). Evidence of interspecific discrimination between odor conditions was demonstrated by the Mouse-Rat squad ($p < .05$) but was not evident in the Rat-Mouse squad. Other interspecific comparisons will be discussed.

JOHN R. WARNER, JR., Department of Sociology and Anthropology, and EDWARD H. PIPER, Department of Psychology, West Virginia Wesleyan College, Buckhannon, WV 26201. Youth Services: Ten Years of a Unique Academic Discipline at West Virginia Wesleyan College.

Since the creation of the Youth Services major at West Virginia Wesleyan College in 1974, more than 70 students have fulfilled the requirements of this unique academic major. Many of those students have made careers in the profession of child and adolescent care, and are highly satisfied with their academic preparation.

Because the Youth Services major at West Virginia Wesleyan College is unique in this nation, and because the program has been in operation for more than ten years, it seems appropriate to describe the program and to report the results of three triennial surveys mailed to graduates in 1978, 1981, and 1984.

It is argued here that most workers in the field of child and adolescent services are inadequately prepared for this most significant task, and that the movement towards professionalization in that field requires the complementary development of an academic discipline founded upon the growing base of literature in the field. Perhaps the Youth Services major is a first step in that direction.

THOMAS CRITCHFIELD, Dept. of Educational Psychology, and TIMOTHY FREEMAN, Dept. of Psychology, West Virginia University, Morgantown, WV 26506. The emergence of Behavior Analysis as a natural science.

Historically, the maturation of a science is characterized by a movement away from religious, magical or mystical assumptions which discourage experimental analysis, and toward an empirical search for order in functional relations. Sciences such as Chemistry, Biology and Physiology, which illustrate this pattern of advancement, have provided us with a generally orderly view of the phenomena observed in our world. It can be argued that behavior is the last great frontier of science, the last bastion of pre-scientific thought. We currently know little about the functional relations governing behavior. Psychology, defined as the study of the "mind," focuses on a scientifically invalid construct and thus is inadequate for the task of revealing those relations. The young field of Behavior Analysis--the study of behavior--respects the canons shared by modern natural sciences and has a result has made promising strides toward identifying lawful rpinciples of behavior. Both the history and methods of Behavior Analysis parallel those of the natural experimental sciences and the argument is made that Behavior Analysis as a functionally independent field--deserves status as an immature but valid science of behavior.

PROCEEDINGS OF THE WEST VIRGINIA ACADEMY OF SCIENCE

INSTRUCTIONS TO AUTHORS
Revised February 1982

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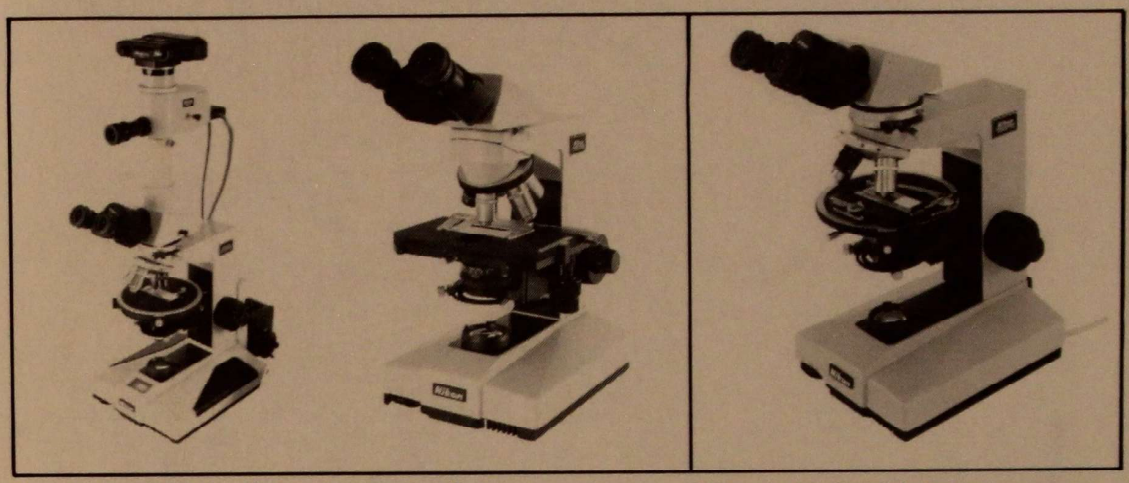

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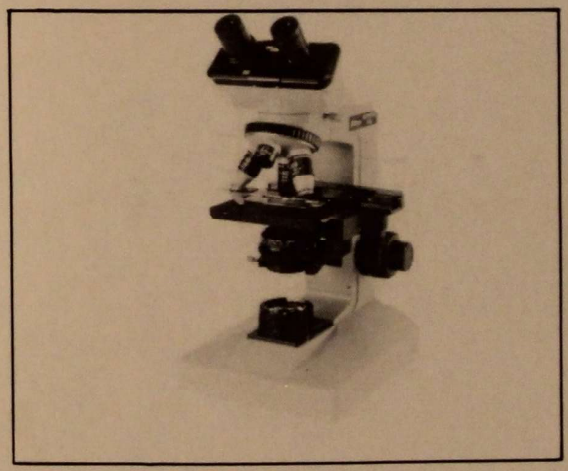

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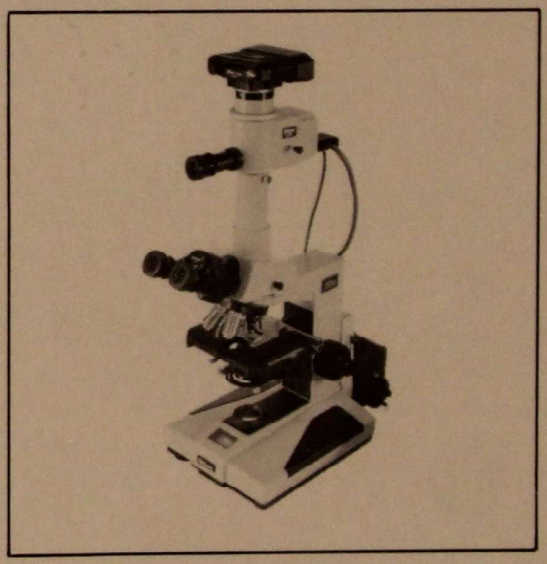

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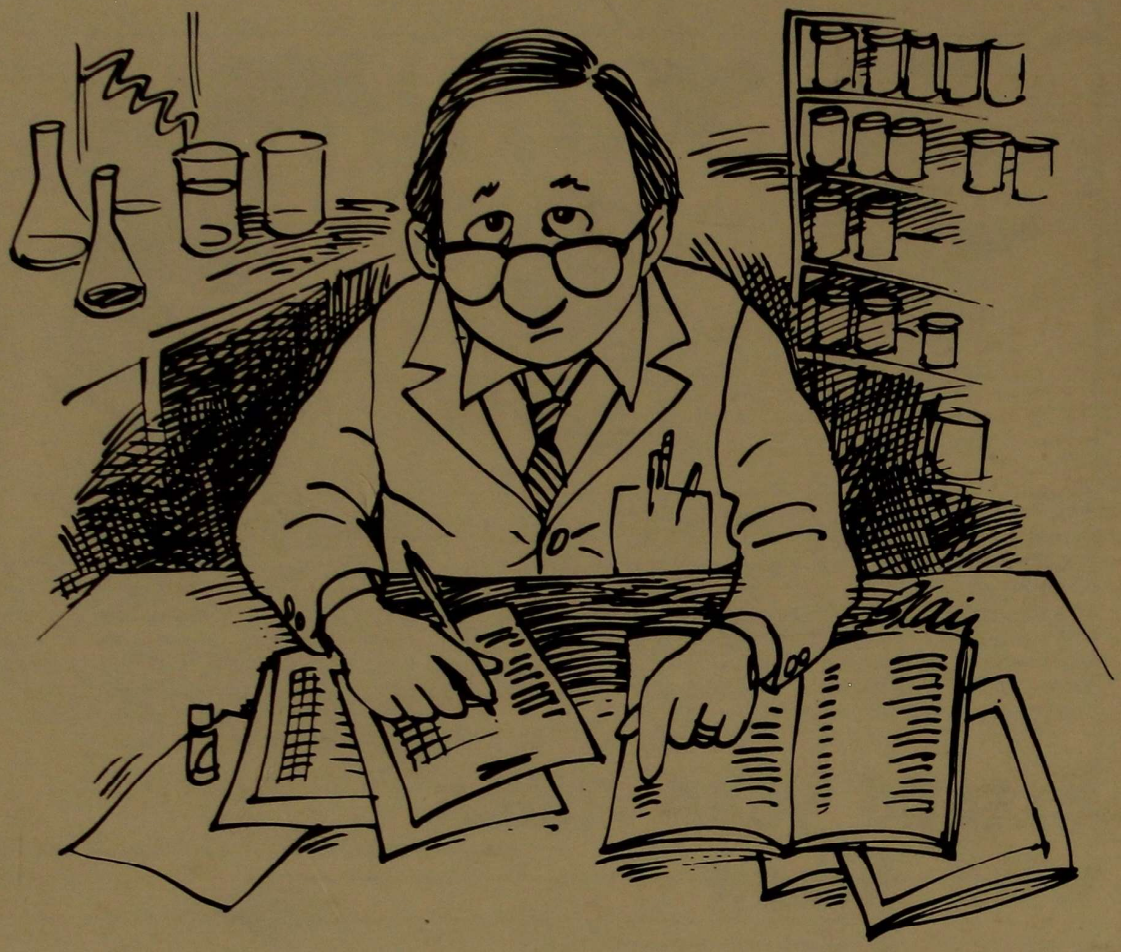

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