Volume 57, Numbers 2, 3, 4

Proceedings of the West Virginia Academy of Science

1985

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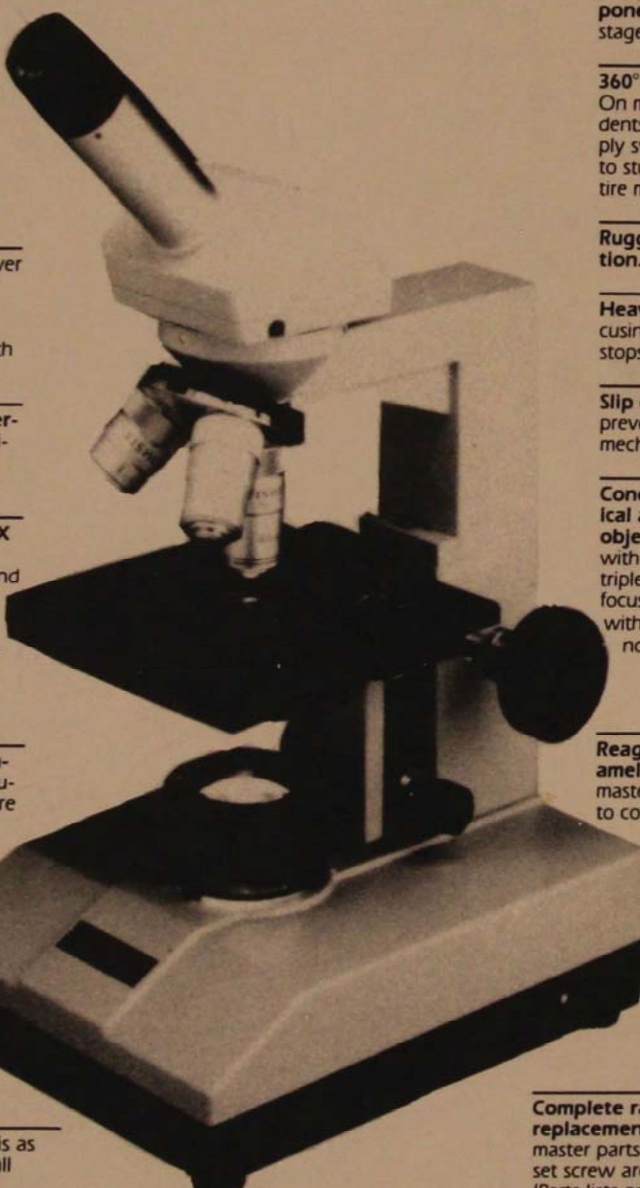

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Proceedings of the West Virginia Academy of Science 1985

Vol. 57—Nos. 2, 3, 4

PAPERS OF THE SIXTIETH ANNUAL SESSION

Fairmont State College

Fairmont, West Virginia

April 13, 1985

Printed by
McClain Printing Company
Parsons, West Virginia
June, 1987

Cover Design
Meredith Pearce
West Virginia University
Office of Publications
Morgantown

West Virginia Academy of Science, Inc.

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Biology Section

Small Mammal Surveys in West Virginia

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Abstract

This paper summarizes the results of several small mammal trapping studies. The objective is 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 species belonging to the following families: 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, Clethrionomy 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.*

Introduction

The literature contains few publications dealing with small mammals in West Virginia. Brooks (1912), Kellogg (1937), Wilson (1948), and McKeever (1952) described the distribution and general habitat of all species of mammals found in West Virginia. Kirkland (1977) studied the effects of clearcutting on small mammal populations, and more recently thesis research of several graduate students at West Virginia University involved trapping small mammals. This paper summarizes the results of several small mammal trapping studies in West Virginia which presented relative abundance data.

Objectives of this paper 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 representatives of Soricidae, Sciuridae, Cricetidae, Muridae, and Zapodidae.

Methods

Trapping techniques were not identical for all studies summarized, but they were similar enough to permit comparisons of results (Table 1). All studies used paired trap lines, with trap stations 10-15 m apart. Most studies used 3 traps per station, although two studies had only one trap per station. Trapping was conducted for 2-5 consecutive nights per trap session, although most were trapped for 3 nights. Snap traps were used in all studies; Kirkland (1977) used Museum Specials, and all other researchers used regular mouse traps. All traps were baited with a peanut butter oatmeal mixture. A few researchers trapped only once per year but most trapped 2-3 times.

Most major habitats were sampled, but all regions of West Virginia were not surveyed. Most trapping occurred in the northern and central mountainous portions, with none in the western valley or eastern panhandle region. The dominant vegetation in habitats included in this study is: (1) coniferous forest:red spruce (*Picea rubens*), (2) deciduous forest:maple (*Acer* spp.), oak (*Quercus* spp.), and yellow poplar (*Liriodendron tulipifera*), (3) clearcuts:grasses, sedges, ferns, and blackberries (*Rubus* spp.), (4) highway rights-of-way:crown vetch (*Coronilla varia*), sericea lespedeza (*Lespedeza cuneata*), and Kentucky fescue (*Festuca arundinacea*), (5) upland shrub: viburnum (*Viburnum* spp.), and hawthorn (*Crataegus* spp.), (6) shrub swamp:alder (*Alnus* spp.), viburnum and spirea (*Spiraea* spp.), (7) reclaimed surface mine:Kentucky fescue, (8) old field:grasses, ferns, and goldenrod (*Solidago* spp.).

Results and Discussion

Results from all studies (79,063 trapnights) were averaged to obtain the mean capture frequency, by species, for each habitat type. Several researchers lumped all individuals of the genus *Peromyscus* and did not attempt to separate them into different species. Thus, data are presented to the genus *Peromyscus*, rather than for *P. maniculatus* and *P. leucopus*, the two species common in West Virginia. *Tamias striatus*,

Table 1. Sources of Small Mammal Trapping Data Summarized in This Paper

Citation	*Year trapped*	*Traps/ station*	*Nights/ session*	*Distance between traps (m)*	*Months trapped*	*Habitat trapped**
Forren (1981)	1980	3	3	10	July	RSM
Hahn (1980)	1979-80	3	3	15	May, July	DF, DFC
Hansen (1982)	1980-81	3	3	10	July, Nov.	DF
Kirkland (1977)	1974-75	3	2,3	15	July, Oct.	CF, CFC, DF, DFC
Knight (1982)	1980-81	3	3	10	May, Oct.	DF, OF, US, SS
Kosten (1980)	1977-78-79	1	3	10	May, July, Nov.	DF, HROW
McConnel (1985)	1983	3	3	10	July, Oct.	SS
Michael (1975)	1975-76	1	5	10	May, July, Nov.	DF, HROW
Michael (1983)	1982-83	3	4	15	Sept.	OF, SS
Mindell (1978)	1977-78	3	4	10	March, Sept.	OF, RSM
Rewa (1984)	1983	3	3	10	July	SS
Udevitz (1982)	1980-81	3	3	10	July	US, SS
Wilmers (1982)	1980-81	3	3	10	July	RSM

*CF=coniferous forest, CFC=coniferous forest clearcut, DF=deciduous forest, DFC=deciduous forest clearcut, HROW=highway rights-of-way, OF=old field, RSM=reclaimed surface mine, US=upland shrub, SS=shrub swamp

Glaucomys volans, and *Condylura cristata* were trapped only 1-2 times and are not included in the results.

The mean capture frequency for all small mammals in all studies summarized was 7.2/100 trap nights (T.N.) (Table 2). The highest frequencies were reported for clearcut coniferous forest (12.77) and clearcut deciduous forest (10.51). Lowest frequencies were in old field (3.78), reclaimed surface mine (4.30), and shrub swamp (4.64).

Peromyscus spp. was the most abundant (2.22/100 T.N.). However, because this included both *P. maniculatus* and *P. leucopus,* it appears that *Microtus pennsylvanicus, Clerthrionomys gapperi, P. maniculatus,* and *P. leucopus* were the most abundant species (1.0/100 T.N.) captured. The species captured least frequently were *Mus musculus* (0.01), *Zapus hudsonius* (0.04), *Sorex dispar* (0.05), and *Synaptomys cooperi* (0.05).

Highest frequency for any species within individual habitats was again *Peromyscus* spp., which had a mean of 4.5/100 T.N. in deciduous forest and 4.0 in highway rights-of-way. Because *Peromyscus* included two species, it appears that *Microtus pennsylvanicus* (3.07 on reclaimed surface mines) and *Clethrionomys gapperi* (3.95 on coniferous forest clearcuts) are locally the most abundant species in West Virginia.

Insectivora comprised 22.6% of the small mammals collected and Rodentia the remaining 77.4%, for all studies combined. Insectivora comprised the largest percentage in coniferous forest (37.2%) and shrub swamp (33.0%). Rodentia comprised the largest percentage in upland shrub (88.8%) and in deciduous forest (84.2%). Several species previously reported in West Virginia were not trapped in the studies summarized. These included: *Sorex palustris, S. longirostris, Cryptotis parva, Reithrodontomys humulis, Microtus pinetorum, M. ochrogaster,* and *Ochrotomys nuttali* (WVDNR, 1983).

Capture frequency may not indicate a species' relative abundance within a community. Disparate catchability definitely exists among species (Hahn, 1980). Most shrews, because of their small size, are especially difficult to capture in snap traps and are probably more abundant than these data indicate. Other small mammals, such as *Neotoma floridana,* and *Tamias striatus,* are too large for the snap traps used in these studies. Behavior of others, such as *Glaucomys volans, Condylura cristata* and *Parascalops breweri,* reduces or eliminates the possibility they will be captured by snap traps.

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Table 2. Relative Abundance (captures/100 trapnights) of Small Mammals Within Various Habitats Throughout West Virginia

	Habitat types									
	Coniferous forest clearcut	*Deciduous forest clearcut*	*Highway rights-of-way*	*Deciduous forest*	*Coniferous forest*	*Upland shrub*	*Shrub swamp*	*Reclaimed surface mine*	*Old field*	*MEAN*
Total trapnights	1,416	10,464	8,492	21,796	2,102	2,700	12,509	16,176	3,408	8,785
Rodentia										
Peromyscus spp.	2.05	3.37	4.00	4.50	1.14	3.11	1.17	0.33	0.27	2.22
Clethrionomys gapperi	3.95	2.98	0.60	1.66	2.81	1.35	0.30	——	——	1.52
Microtus pennsylvanicus	0.14	0.70	1.50	0.07	——	0.20	1.62	3.07	1.66	1.00
Microtus chrotorrhinus	2.54	0.08	——	0.06	0.67	——	——	——	——	0.37
Napaeozapus insignis	——	1.00	0.05	0.13	0.05	0.03	0.03	——	——	0.14
Synaptomys cooperi	0.21	0.25	——	0.02	——	——	——	——	——	0.05
Zapus hudsonius	——	——	0.05	0.04	——	0.11	0.07	0.07	0.05	0.04
Mus musculus	——	——	0.05	0.01	——	——	——	0.03	——	0.01
Insectivora										
Blarina brevicauda	0.14	0.40	1.50	0.70	0.90	0.44	0.73	0.80	0.90	0.72
Sorex cinereus	2.12	0.87	——	0.14	0.86	0.16	0.72	——	0.90	0.64
Sorex fumeus	1.27	0.86	0.50	0.38	0.86	0.16	0.72	——	——	0.43
Sorex dispar	0.35	——	——	——	0.14	——	——	——	——	0.05
Subtotal Rodentia	8.89	8.38	6.25	6.49	4.67	4.81	3.19	3.50	1.98	5.35
Subtotal Insectivora	3.88	2.13	2.00	1.22	2.76	0.60	1.45	0.80	1.80	1.84
Total	12.77	10.51	8.25	7.71	7.43	5.41	4.64	4.30	3.78	7.19
Range upper	12.77	11.02	11.60	12.60	7.43	5.41	6.54	5.12	4.12	
Range lower	12.77	10.01	5.51	2.41	7.43	5.41	2.75	3.64	3.60	

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Physical Parameters and Aesthetic Values of Wetlands Along West Virginia Highways

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Abstract

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 parameters were noted for each wetland: (1) classification, (2) size, (3) shape, (4) position in relation to highway, (5) presence of standing water, (6) depth of standing water, and (7) presence of a stream in or near the wetland. The majority of existing wetlands were wet meadows or cattail wetlands. Size ranged from 0.1 to 73 acres. Most wetlands were characterized by the following features: (1) oblong in shape, (2) parallel to highway, and (3) no standing open water. Forty-nine wetlands had a stream associated with them. 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 associated with high aesthetic value were diverse vegetative life form and standing water.

Introduction

Values of wetlands to man are widely recognized, although actual economic evaluation has been determined only in limited situations. The U.S. Department of Transportation (1979) lists the following contributions of wetlands: (1) productivity of vegetative matter, (2) habitat for waterfowl, fur-bearing mammals, and fishes, (3) reduce severity of flooding and control erosion, (4) filter solids from polluted waters, (5) recharge groundwater, (6) recreation such as hunting, fishing, and bird-watching, (7) outdoor classrooms for environmental study and research, and (8) aesthetics.

Although the value of wetlands to humans has been demonstrated in many areas, these wetlands are disappearing at an alarming rate. Land areas occupied by wetlands (an estimated 127 million acres) in the continental United States had decreased 35% by 1963 (Mosby, 1963), 45% by 1975 (Goodwin and Neiring, 1975), and 54% by 1983 (Arnett, 1983). Annual net losses over the past 20 years have been estimated at over 370 thousand acres (Frayer, et al 1983). Loss of wetlands has been widespread as a result of changes in land use such as agriculture, highway construction, and urban development (Landin, 1978; Weller, 1978).

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 aesthetic values of existing wetlands.

Methods

Five hundred eleven miles of controlled-access highway were surveyed in 19 West Virginia counties. Both lanes were driven for a total of 1022 miles. This included the entire length of Interstates 64, 77, 79, 81, and U.S. 48 and U.S. 50, and that portion of the West Virginia Turnpike from Beckley to the Virginia state line (Table 1). Inventories were conducted by slowly driving along the highway berm. One person drove and another observed the area adjacent to the highway. The area within the highway fence and that area associated with highway construction was the study area.

Wetlands exhibit one or more of the following 3 attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is composed of poorly drained or very poorly drained soils, and (3) the substrate contains organic soils and is saturated with water or covered by shallow water at some time during the growing season each year (Cowardin, et al 1979).

The major criterion we used to identify wetlands was the presence of hydrophytic vegetation. When standing water and/or hydrophytic vegetation was sighted a more careful examination of the site determined if it qualified as a wetland for the purposes of this study. Only those wet areas at least 0.1 acre in size were considered to be wetlands.

Wetlands were classified using a modification of the West Virginia Department of Natural Resources classification system (Evans, et al 1982) and the U. S. Fish and Wildlife Service system (Shaw and Fredine, 1956). Definitions for the wetland categories used in this study are as follows: *Cattail*=area having temporary water regime, where cattails are the dominant vegetation. *Wet Meadow*=area having temporary water regime, with dominant vegetation being herbaceous emergents other than cattails. *Riparian*=area having no permanent standing water, although the water table is near the surface. Dominant vegetation is woody, either trees or shrubs. *Marsh*=area with permanent standing water, with dominant vegetation being herbaceous emergents. *Shrub Swamp*=area having permanent standing water with shrubs covering 50% or more of the area. *Wooded Swamp*=area having permanent standing water with trees covering 50% or more of the area.

Table 1. Abundance of Wetlands Along Controlled-access Highways in West Virginia

Highway	*Number of wetlands*	*Percent of total*	*Number per mile*	*Highway miles surveyed*
Turnpike*	19	19.8	0.4	44.3
U. S. 48	11	11.5	0.3	32.1
U. S. 50	6	6.3	0.1	71.7
I-64 E*	7	7.3	0.3	27.8
I-64 W*	6	6.3	0.1	58.8
I-77	16	16.7	0.2	89.8
I-79	31	32.2	0.2	160.5
I-81	0	0	0	26.0
Total	96	100	0.2	511.0

*I-64 E = Greenbrier County
*I-64 W = Kanawha, Putnam, Cabell, and Wayne Counties
*Turnpike = Beckley to Virginia state line

Physical features determined for each wetland included: (1) classification, (2) size, (3) shape, (4) position in relation to the highway, (5) presence of standing water, (6) depth of standing water, and (7) presence of a stream in or near the wetland. Biotic features determined for wetlands included vegetative life form and most abundant vegetation.

Each wetland that had been located and classified, was evaluated in the field for aesthetics. Aesthetic value was ranked by 5 biologists while observing the wetland from the highway. A numerical rating was given to each wetland with values from 1 to 9, 9 being the rating given for the wetland having the greatest aesthetic appeal. These ratings resulted from each individual's perspective on wetland aesthetics based on a background of experience with various wetlands in West Virginia and with all existing highway wetlands.

Results and Discussion

A total of 96 wetlands were located (Table 1). The greatest number of wetlands per mile were found on the WV Turnpike, U.S. 48, and I-64E. No wetlands were found on I-81. The majority of the 96 wetlands were classified as either wet meadow or cattail wetlands (Table 2).

Size of the wetlands ranged from 0.1 acre to 73 acres (Table 2). The largest wetland found was a 73-acre shrub swamp in Preston County. There were 5 wetlands greater than 10 acres in size and 68 wetlands under 1 acre (73% of all wetlands) (Table 2). The 5 largest wetlands were of 3 types; wooded swamp, shrub swamp, and riparian (Table 2).

Most wetlands were either oblong or long and narrow in shape and were parallel to the highway (Table 3). All wetlands showed some degree of wetness on or near the soil surface and 33% had water standing above the surface at least part of the year (Table 4). The depth of water in these 32 wetlands average 8 inches. There were 7 wetlands with open non-vegetated water, which covered an average of 11% of the wetland area (Table 4). Forty-nine wetlands had a stream associated with them. There were 33 wetlands that had a stream within 500 yards (Table 5). This stream was in addition to a wetland-associated stream, if present.

Table 2. Sizes of Various Wetland Classes Along All Controlled-access Highways in West Virginia

	Size Class (acres)							
Wetland class	0.1-0.5	0.6-1.0	1.1-2.0	2.1-5.0	5.1-10.0	10.1-25.0	>25	Total
Cattail	24	3	1	2				30
Marsh	4	5		2				11
Riparian	4	2	5	1		1		13
Shrub swamp	4	0	1	4	1	2	1	13
Wet meadow	18	3	2	2				25
Wooded swamp	1		1	1		1		4
TOTAL	55	13	10	12	1	4	1	96

Table 3. Occurrence of Various Position (in Relation to Highway) x Shape Categories of Wetlands Along Controlled-access Highways in West Virginia

	Position in relation to highway			
Shape	*Parallel*	*Perpendicular*	*Other*	*Total*
Irregular	3	0	1	4
Long and narrow	20	4	3	27
Oblong	26	8	1	34
Other	2	0	2	4
Oval	5	2	3	10
Patchy	6	4	0	10
Round	0	0	2	2
Square	1	2	1	4
Total	63	20	13	96

Table 4. Occurrence of Various Water Regime X Abundant Vegetation Categories of Wetlands Along Controlled-access Highways in West Virginia

	Most abundant vegetation				
Water regime	*Cattail*	*Alder*	*Sedge*	*Other*	*Total*
No standing water	34	9	15	6	64
Standing water without vegetation	5	1	0	1	7
Standing water with vegetation	4	2	2	5	13
Standing water with and without vegetation	4	5	0	3	12
Total	47	17	17	15	96

The most frequently occurring vegetative growth form in highway wetlands was emergent narrow-leaf hydrophytes (Table 5). Live tall shrubs occurred next in frequency of occurrence as the most dominant vegetative growth form. Of all wetland plant species present in each wetland, one was usually more abundant than any other. Cattail (*Typhus* spp.), alder (*Alnus* spp.), and sedges (Cyperacea) were the most abundant wetland plant species (Table 4).

Aesthetic values ranked highest for marsh, riparian, shrub swamp, and wooded swamp (Table 6). Diverse vegetative structure in wetlands is usually aesthetically appealing. The majority of the highway wetlands (68) were dominated by emergent narrow-leaf hydrophytes and these wetlands were ranked low for aesthetics. Most of these were cattail and wet meadow wetlands. Those wetlands were shrubs and dead trees as the dominant vegetative subform ranked the highest.

Table 5. Occurrence of Various Vegetative Growth Form X Stream Nearby Categories of Wetlands Along Controlled-access Highways in West Virginia

	Stream nearby		
Vegetative growth form	*No*	*Yes*	*Total*
Dead trees or shrubs	0	1	1
Emergent broad-leaf hydrophytes	1	0	1
Emergent narrow-leaf hydrophytes	44	24	68
Live deciduous trees	4	1	5
Live low shrubs	0	1	1
Live tall shrubs	13	6	19
Nonvegetated water	1	0	1
Total	63	33	96

Table 6. Aesthetic Rating For Various Types of Highway Wetlands

Wetland class	*Number of wetlands*	*Aesthetic rating*
Shrub swamp	13	5.06
Wooded swamp	4	4.70
Marsh	11	4.67
Riparian	13	4.59
Cattail	30	2.88
Wet meadow	25	2.52

Wetlands must be visible to passing motorists if aesthetic values are to be maximized. Many existing wetlands are not visible because of their location—usually below the road and hidden by the guard rail and road embankment. Approximately 50% of all existing wetlands are visible to passing motorists.

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Age and Growth Determinations of the Black Bullhead in West Virginia

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Abstract

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. Back calculated 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.

Introduction

The purpose of this study was to determine the age and growth of a local population of black bullhead catfish, *Ictalurus melas* (Rafinesque). The age of each fish was determined by two methods, pectoral spine cross-section and vertebral centrum annuli counts. Comparisons of age and growth calculations by the two aging methods were made to determine how much the two methods differed.

Lewis (1949) presented the vertebral method of aging the black bullhead. This study was later followed by a life history study of the black bullhead by Forney (1955). Forney compared dorsal spine and vertebrae aging methods suggesting either method could be used for aging the black bullhead. Marzolf (1955) found agreement in pectoral spine and vertebra age and growth determining methods in the channel catfish, *Ictalurus punctatus* Rafinesque, but also considered the vertebrae method more accurate.

The black bullhead has been noted for its tolerance to turbid water and overcrowded conditions (Trautman, 1957). Oxbow ponds of diverted streams provide favorable habitats for the black bullhead. The black bullheads were collected from an oxbow pond (approx. 0.1 ha) of Twelvepole Creek at Shoals, in Wayne County, West Virginia. The pond is well vegetated with *Cephalanthus occidentalis* L. The average depth during the study period was 0.64 m (range 0.4-0.7 m).

Methods

Monthly collections of the black bullheads were made from March 1979 to January 1980. The February collection was excluded due to a thick cover of ice on the pond. Collections of black bullheads were made at the southern end of the pond that was surrounded by buttonbush. A minnow seine (4 x 10 ft.) of 0.64 cm mesh was used to capture the fish. All fish were returned to the laboratory and fixed in 10 percent formalin for at least one week, washed and preserved in 70 percent ethanol.

All measurements were taken from preserved specimens. The total length of each fish was measured. The fish were weighed to 0.01 g on a single pan balance. The first ten vertebrae and both pectoral spines were removed from each fish, placed in scale envelopes and allowed to air dry.

Pectoral Spines

Pectoral spines were carefully cleaned of dried extraneous tissue with forceps and inserted in a stick of corn pith to the basal groove. The corn pith served as a holder for the spine while cutting. To assure presence of all annuli, the spine was cross-sectioned to less than a millimeter thickness at the distal end of the basal groove. Cutting was done with a mounted variable speed Dremel Moto-tool (Model 380.5), with an emery cutting wheel (No. 409). Some spines were lost in the cutting process due to brittleness of the tissue. In this case the opposite spine was used. Occasionally, pectoral spine annuli were not present or visible when annuli appeared on the vertebra. These missing annuli, which were not counted, were indicated by large intervals. Loss of the earliest annulus, due to erosion of the basal groove, was apparent on spines of older black bullheads.

Cross-sections of pectoral spines were left in the pith section when possible, and were mounted on glass microscope slides with a drop of glycerol. The glycerol served to adhere the cross-section to the slide and to clear the spine section for easier reading of the annuli.

Spine cross-sections can be viewed with bright transmitted light on a low power (40X) microscope. Annuli appear as translucent rings alternating with opaque bands of summer growth. False rings, formed by irregularities in seasonal temperatures, can be distinguished from true annuli by their incompleteness and closeness to the true annuli.

Vertebra Centrum

Since the first five vertebra were fused, the age of the fish was averaged from the annuli counts of the 6th, 7th or 8th vertebrae. Dried tissue was removed from the vertebra with forceps and a knife blade, but care was taken not to scratch the surface of the centrum. Annuli were viewed with a binocular dissecting scope using reflected light of varying intensities. Annuli appeared as thin dark rings slighly depressed between lighter bands which represented summer growth. The concave side of the centrum was aged and measured since it had a shallower funneled surface. The first annulus was chosen from the outermost ring of several indistinct rings within the center of the centrum. False annuli were more prevalent and less distinguishable in the vertebra than in the pectoral spines.

Annular Radii Measurements

A traveling microscope (10X) with a vernier scale was used to measure annular radii to 0.01 mm on spine cross-sections and vertebrae. Annuli were measured from the estimated center of the lumen of the spine cross-section along the long axis of the spine. Centrum annular radii were measured from both lateral edges to the estimated center. The radial measurements were averaged from both sides of the vertebra. Each measurement was checked once for repeatability.

Length Relationships

Frequency distributions were determined for total length per age class. Length-weight relationship was described by the equation, $\text{Log } W = \text{Log } a + b \text{ Log } L$, derived from the formula $W = a L^b$ (Lagler, 1956). Weight is represented by W; total length is L; a and b are constants. Relationships between length and pectoral spine radius, and length and vertebrate centrum radius were plotted in addition to the length-weight relationship. From age classes I-IV, a relationship was determined for each graph.

Linear regressions of total length-radius for all fish and linear regressions of total length-age were calculated using the formula $S_t = a + bL_t$ (S_t = radius of pectoral spine or vertebra centrum; L_t = total length) (Lagler, 1956). All linear regressions were done for both pectoral spine and vertebra centrum radii.

Dahl-Lea Backcalculation

The Dahl-Lea direct proportion method was used to backcalculate length at each annulus per age group and for a grand average of each annulas (Lagler, 1956). Paired t-tests compared means of pectoral spine and vertebra backcalculations with growth of the final annulus for each age class and also with the growth at each annulus of the grand average. An analysis of variance was used to compare mean length per age group to backcalculated lengths of the corresponding last annulus of the grand average. This was done on both sets of data (pectoral spine and vertebra) to determine if backcalculated lengths were comparable to true lengths.

From both pectoral spine and vertebra backcalculations, the ranges and means of growth increments from the last annulus to the edge are compared by age group and by season.

Results and Discussion

With few exceptions, age classes determined from both aging methods were similar. Winter ring formation was completed in May. Pectoral spine determined age groups were 0-VI, while vertebra determined age groups were 0-VII.

Total length frequencies for each age group as determined from spines and vertebrae were compared. A considerable overlap in the total length ranges between age classes was seen (Tables 1, 2). Length frequencies appear not to be representative of age class distribution in these black bullheads due to variability in growth.

The total length-weight relationship is represented by $\text{Log } W = -4.928 + 3.020 \text{ Log } L$ where W is weight in grams and L is length in millimeters (Figure 1). The length-weight regression ($W = 21.13 + 0.3625 L$) showed a high correlation of $r = 0.82$.

Isometric growth is exhibited between total length and pectoral spine radii (Figure 2) and between total length and vertebrae radii (Figure 3). The straight line is based on coordinates of mean radii to corresponding mean lengths of age classes I, II, III and IV. Mean dimensions of age classes 0, V and older were not used due to low sample numbers of these age groups.

Total length-spine radius relationships are represented by the equations: $S_n = 0.0818 + 0.0096 L$ and $S_n = 0.2324 + 0.1129 L$. Linear regressions of total length to pectoral spine and vertebra radii show high correlation coefficients of 0.89 and 0.95, respectively. High correlation in total length and age relationships determined for both age determining methods ($r_p = 0.83$ and $r_v = 0.81$) was observed in this study.

Dahl-Lea Backcalculations

Since radii (of spine and vertebra) showed a linear relationship with total length, the Dahl-Lea direct proportion method of backcalculation of length at the nth annulus is appropriate for this study.

Spine and centrum determined backcalculated lengths (mm) for each annulus of all age groups, and for the grand average length of all annuli, are given in Tables 3 and 4, respectively. The greatest growth is exhibited by the first age class. Growth increments decrease steadily with age except in age groups V and VI for pectoral spine determined growth. This unexpected reversal in trend in mean increments may result from small sample sizes of these age classes; however, Marzolf (1955) saw this same trend in channel catfish.

Table 1. Length Frequencies of Each Age Class as Determined From Pectoral Spines of *Ictalurus melas*

Length (mm)	Age Class 0	I	II	III	IV	V	VI
20-29	14						
40-49		2					
50-59	5	5					
60-69		3					
70-79		4	1				
80-89		5	6				
90-99		4	35				
100-109		6	31	4			
110-119		2	11	8	2		
120-129			7	7			
130-139				5	4		
140-149			1	7	4	1	1
150-159						1	1
210-219						1	2
N	19	31	92	33	10	3	4
$\overline{X}$	33	78	102	126	135	171	182
Range	22-59	47-110	74-129	105-155	111-148	144-217	142-215

Table 2. Length Frequencies of Each Age Class as Determined From Vertebra Centra of *Ictalurus melas*

Length (mm)	Age Class 0	I	II	III	IV	V	VI	VII
20-29	14							
30-39								
40-49		2						
50-59	5	5						
60-69		3						
70-79		4	1					
80-89		5	6					
90-99		6	33					
100-109		9	28	4				
110-119		1	12	8	2			
120-129			6	8				
130-139				5	4			
140-149			1	7	3	2	1	
150-159				1	1	1	1	
210-219							1	2
N	19	35	87	33	10	3	3	2
$\overline{X}$	33	81	102	125	136	150	170	216
Range	22-59	47-110	74-145	105-152	116-155	144-158	142-215	215-217

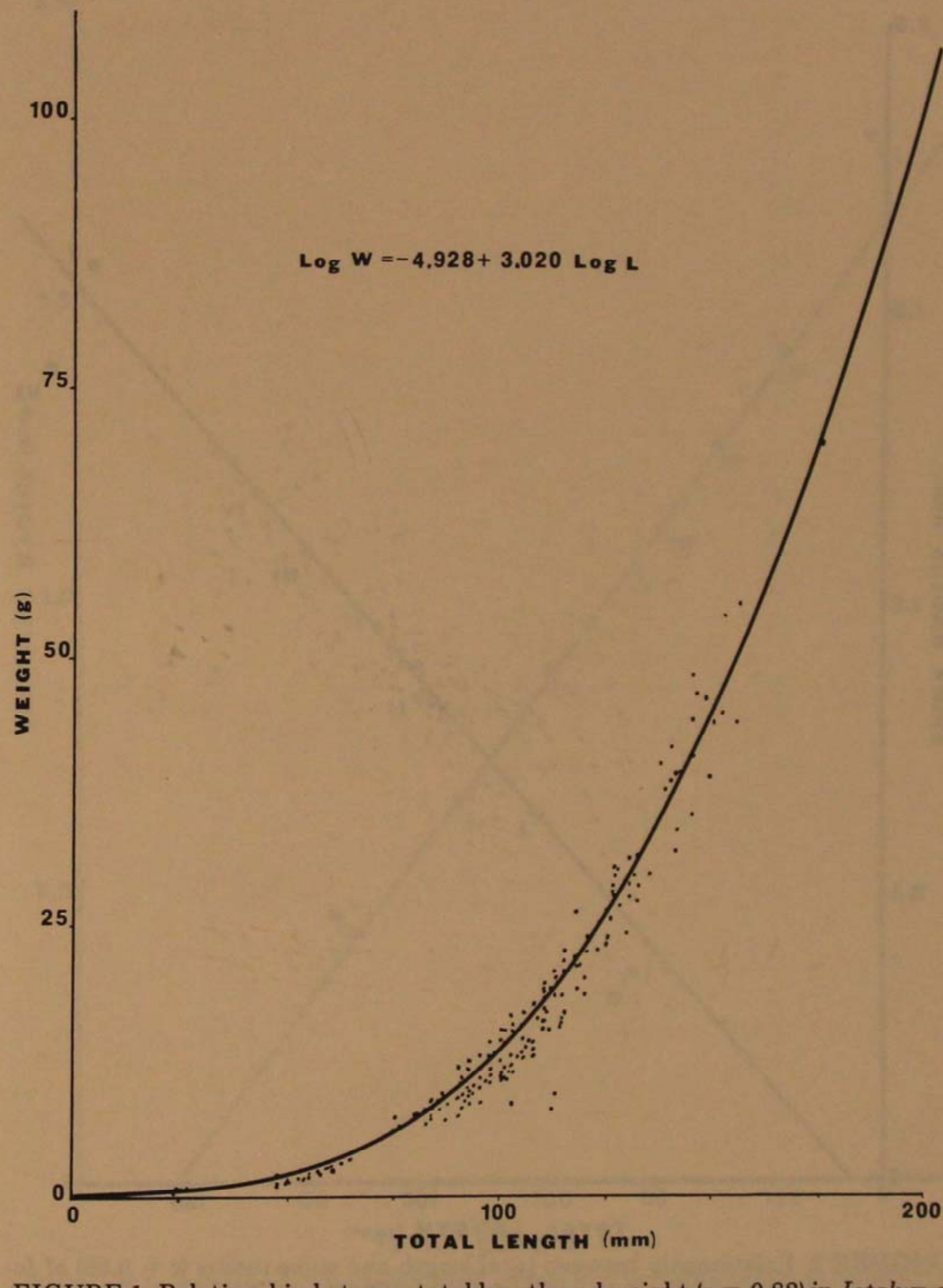

FIGURE 1. Relationship between total length and weight (r = 0.82) in *Ictalurus melas* from an oxbow pond of Twelvepole Creek, Wayne County, West Virginia.

Paired t-tests for total length at the final annulus between mean pectoral spine and vertebra backcalculated lengths at each age group indicated no significant differences ($p < 0.05$) in age groups II, III, IV, V and VI. Vertebra calculated length was 12 mm greater than spine calculated length for age class I.

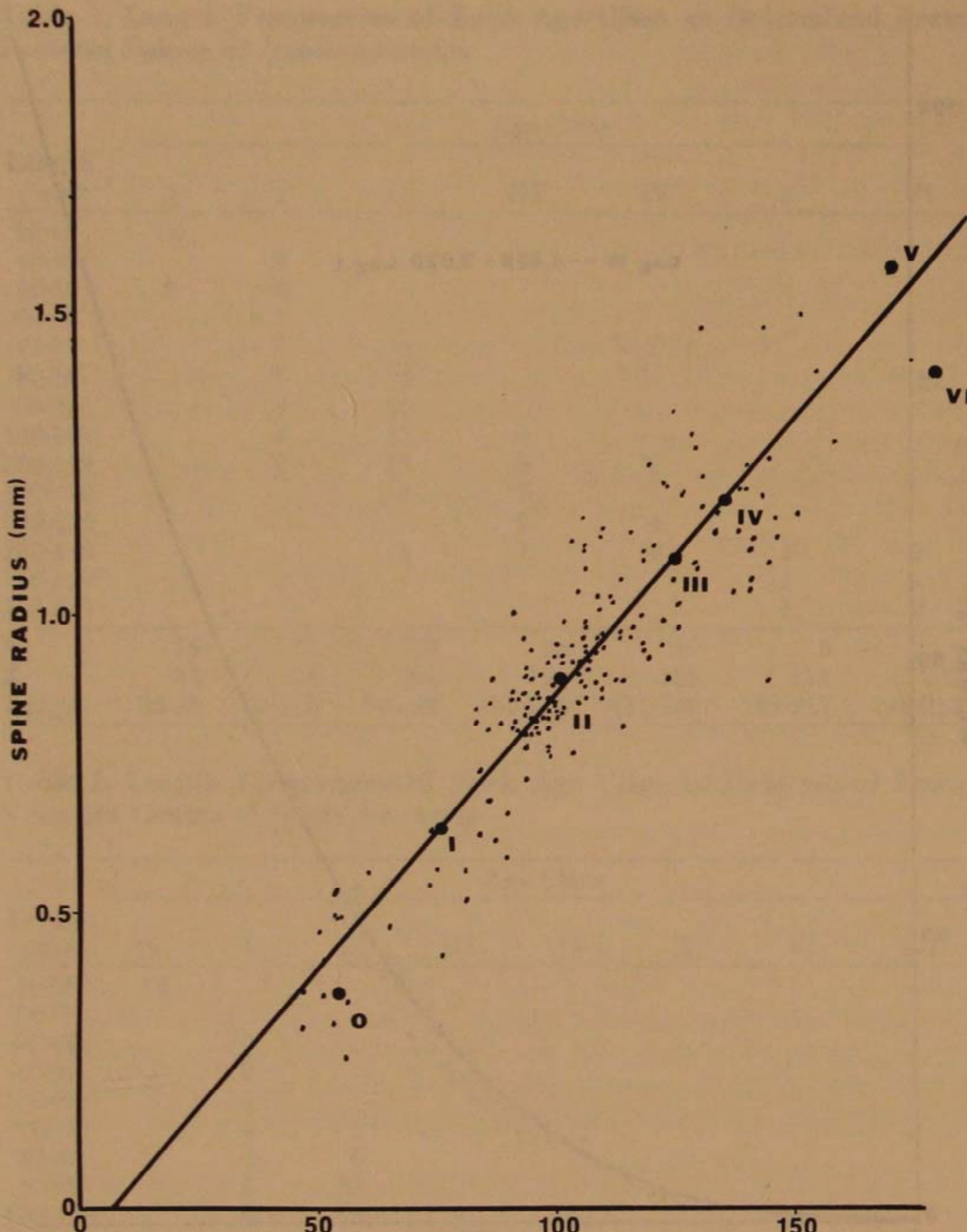

FIGURE 2. Relationship between total length and spine radius (r = 0.89) of *Ictalurus melas* from an oxbow pond of Twelvepole Creek, Wayne County, West Virginia.

Paired t-tests for total length at the nth annulus between mean pectoral spine and vertebra centrum backcalculations at each annulus of the grand average demonstrated no significant difference ($p < 0.05$) between annuli 3, 4, 5 and 6. Vertebra calculated lengths for annuli 1 and 2 were significantly greater than spine calculated lengths. Perhaps the differ-

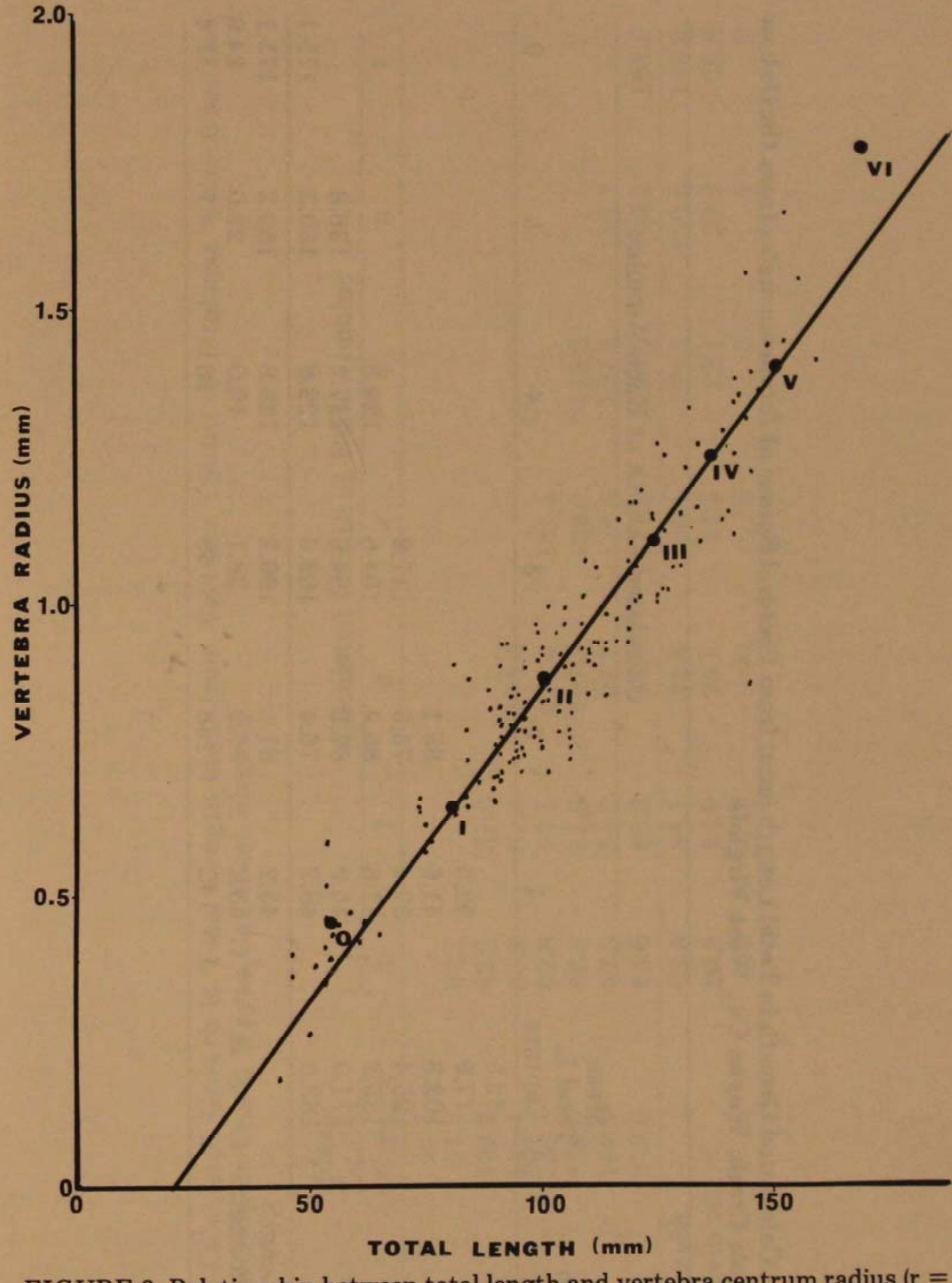

FIGURE 3. Relationship between total length and vertebra centrum radius (r = 0.95) of *Ictalurus melas* from an oxbow pond of Twelvepole Creek, Wayne County, West Virginia.

ences in the comparisons of the early age class backcalculations can be accounted for by the inability to distinguish the first annuli of the vertebrae.

Error in pectoral spine measurements tends to make backcalculated

Table 3. Dahl-Lea Calculated Growth in Total Length (mm) from Pectoral Spines of *Ictalurus melas* from the Oxbow Pond of Twelvepole Creek, Wayne Co., West Virginia

Age Class	Fish No.	Mean Total L. At Capture	Calculated Length at Each Annulus 1	2	3	4	5	6
0	19	32.5						
I	31	77.9	52.5					
II	91	102.3	41.6	85.1				
III	33	126.4	37.4	75.5	111.9			
IV	10	135.3	37.6	66.9	104.6	129.8		
V	3	171.0	35.9	67.2	94.6	117.2	136.8	
VI	4	182.5	48.2	76.4	109.6	129.8	160.3	175.1
Grand Average Length			43.2	81.1	109.2	128.8	150.2	175.1
Mean Growth Increment			43.2	37.9	28.1	19.0	22.0	24.9
Number of Fish			142	138	49	16	7	4

Table 4. Dahl-Lea Calculated Growth in Total Length (mm) from Vertebra Centra of *Ictalurus melas* from the Oxbow Pond of Twelvepole Creek, Wayne Co., West Virginia

Age Class	Fish No.	Mean Total L. At Capture	Calculated Length at Each Annulus						
			1	2	3	4	5	6	7
0	19	32.5							
I	36	81.0	64.1						
II	85	102.2	62.1	87.9					
III	33	125.4	66.2	89.4	114.4				
IV	10	136.0	62.8	91.1	111.4	131.1			
V	3	150.0	66.9	81.8	107.1	124.8	145.6		
VI	3	169.7	67.3	81.0	97.7	116.6	131.0	152.2	
VII	2	216.0	53.6	80.2	95.4	117.6	138.0	169.2	195.8
Grand Average Length			63.5	88.1	111.6	126.1	138.2	159.0	195.8
Mean Growth Increment			63.5	24.6	23.5	14.5	12.1	20.8	36.8
Number of Fish			172	136	50	18	8	5	2

lengths lower than the actual length (Marzolf, 1955). This is supported by the smaller backcalculated values obtained from the pectoral spine in comparison to actual lengths of fish of corresponding age categories and to vertebra backcalculated lengths. Analysis of variance between mean length per age group and the backcalculated length to the corresponding annulus of the grand average showed no difference in variance from the means in either age method ($p = < 0.05$). One exception was age class VII of vertebral determination. There was only a 2 mm variance in lengths of the two fish in this age group, while the calculated length was about 20 mm shorter than the mean length of the two bullheads.

Means and ranges of growth increments determined from backcalculations of the last formed annulus to the edge of the spine and centrum per season indicate a general increase in mean growth from spring to winter. The greatest rate of growth occurred in summer and fall; limited growth occurred in spring and winter. Generally, the black bullheads exhibit a decrease in growth with age, with the exception of spine age classes IV and V and vertebra age groups VI and VII. Size selective mortality or low sample numbers of older age groups may have resulted in the increase of growth with age in these age groups.

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Notes on the Use of Large-area Flight-intercept Traps to Collect Insects in Temperate Forests

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Abstract

During the period of June 11-July 2, 1984, large-area flight-intercept or "window" traps of the type described by Peck and Davies (1980) were set up and maintained in five different upland forest communities 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 insect order recorded. The total catch from all five traps during the entire study consisted of 9,745 individual specimens, including 8,707 insects and 1,038 various other arthropods. Coleoptera and Diptera were the predominant insect orders encountered, accounting for 43.7% and 28.9% of the total number of individuals respectively, with Homoptera (5.4%) and Hymenoptera (4.7%) next in abundance. As expected, slime mold beetles were present in relatively small numbers, comprising only 0.4% of all Coleoptera collected.

Introduction

One of the methods commonly used to collect those species of insects that fall upon encountering an obstacle during flight is the "window" trap (Southwood 1978). Such a trap basically consists of nothing more than a large sheet of glass or plastic held vertically over a collecting trough containing a killing/preserving fluid. Although window traps have been shown to work well for a number of different groups of insects (Chapman and Kinghorn 1955), they are particularly good for collecting Coleoptera, including various species of small, and especially crepuscular, beetles (e.g., Leiodidae) that are usually taken only in small numbers and often with great difficulty by other methods (Peck and Davies 1980, Wheeler 1984). However, window traps of the type generally used also have certain major disadvantages. First of all, the surface area that is actually intercepting the flight paths of insects is comparatively small. Furthermore, such traps tend to be bulky, heavy, and susceptible to damage from high winds.

Peck and Davies (1980) recently described a modified design which would seem to largely eliminate the disadvantages of window traps without decreasing their effectiveness. They used a single large piece of small-mesh netting stretched between two vertical poles as a flight-intercepting "window," with a trough containing the killing/preserving fluid placed on the ground underneath. In addition to providing for a much larger surface area, the modified trap design would seem appropriate for a wider range of field applications than the type of window trap traditionally used.

In the present study, large-area flight-intercept or "window" traps of the type described by Peck and Davies (1980) were used in an effort to sample the populations of slime mold beetles (mostly species of *Anisotoma*) present in five different upland forest communities in the Mountain Lake area of southwestern Virginia. Although the primary intent of this study was to obtain some preliminary data on the distribution patterns and relative abundance of slime mold beetles in these communities, we also used this opportunity to assess the overall productivity and effectiveness of the large-area flight-intercept traps as a collecting method for various other groups of insects. The data obtained as a result of the latter form the basis of this paper.

The Study Area

The research reported in this paper was carried out in the general vicinity of the University of Virginia Mountain Lake Biological Station in Giles County in southwestern Virginia, which is within the Ridge and Valley physiographic province of the southern Appalachian Mountains (Fenneman 1938). Braun (1950) included this area within the Ridge and Valley section of the Oak-Chestnut Region. The major species of trees present are various species of oak, of which chestnut oak (*Quercus prinus*) and northern red oak (*Q. rubra*) are the most important. A more complete description of the forest vegetation of the general study area is provided by Stephenson (1982).

The following is a brief description of the location and vegetation of the five sites used in the present study. Nomenclature used for vascular plants follows that of Radford et al. (1968).

(1) Beanfield Mountain; oak-hickory forest dominated by pignut hickory (*Carya glabra*), chestnut oak, and white oak (*Quercus alba*); elevation 1115 m on an open, south-facing slope.

(2) Bald Knob; red oak forest with some black birch (*Betula lenta*), shadbush (*Amelanchier arborea*), and red maple (*Acer rubrum*) also present; elevation 1243 m on an open, north-facing slope.

(3) Pond Drain; mixed mesophytic forest dominated by beech (*Fagus grandifolia*) with red oak and shagbark hickory (*Carya ovata*) the most important associates; elevation 1170 m on a protected, east-facing slope.

(4) War Spur; mixed oak-red maple forest with white oak, black oak (*Quercus velutina*) and chestnut oak the major species of oak present; elevation 1135 m on an open, south-facing slope.

(5) Spruce Bog; red spruce (*Picea rubens*)-hemlock (*Tsuga canadensis*) streamside forest with an admixture of some hardwoods such as red maple; elevation 1130 m in a shallow, northeast-facing ravine.

Methods

Between June 11 and July 2, 1984, large-area flight-intercept traps (Figure 1) were set up and maintained at the five study sites described in the previous section. In each case, the trap was placed in a portion of the study site that was both relatively homogeneous (i.e., with respect to the structure and floristics of the vegetation) and typical of the community as a whole. These traps were constructed in the manner described by Peck and Davies (1980). The flight-intercept surface or "window" of each

FIGURE 1. Large-area flight-intercept or "window" trap.

of our traps consisted of a single piece of fine-mesh netting approximately 1.8 m long and 1.3 m high. The trough used with each trap was constructed from a section of galvanized metal heating duct, approximately 160 cm in length. To make the trough, the duct was first spread open (i.e., to achieve the necessary "U"-shape) and then a rectangular metal baffle was soldered on each end. A 50:50 solution of water and ethylene glycol-based automobile antifreeze, to which a small amount of sodium benzoate was added, was used as a killing/preserving fluid. All specimens collected in the traps were removed at weekly intervals, taken to the laboratory, and sorted according to the major taxonomic groups represented. After sorting, counts were made to determine the number of specimens in each group, these figures were recorded, and then the specimens were placed in 70% ethanol for permanent storage. In addition, all slime mold beetles were identified and separated from the various other Coleoptera in the samples. Nomenclature used for insects and other arthropods follows that of Borror et al. (1981).

Results and Discussion

The total catch from all five traps during the entire study consisted of 9,745 individual specimens, including 8,707 insects and 1,038 various other arthropods (Table 1). Because some of our collections from the War Spur study site for the first week were lost during processing, these data were not considered in this paper. Consequently, the totals given for this study site in Tables 1 and 2 are based only upon collections made during the second and third weeks of the study.

Table 1. Distribution of the Total Catch as to the Major Taxonomic Groups Represented

Group	Bean-field	Bald Knob	Pond Drain	War Spur*	Spruce Bog	Total	Relative abundance (%)
Coleoptera	863	2415	534	268	178	4258	43.69
Diptera	967	626	418	445	362	2818	28.92
Homoptera	24	457	17	28	1	527	5.41
Hymenoptera	157	100	96	74	26	453	4.65
Lepidoptera	79	79	33	18	35	244	2.50
Plecoptera	0	0	2	0	224	34	2.32
Mecoptera	3	2	7	6	16	34	0.35
Orthoptera	9	3	1	0	2	15	0.15
Odonata	0	0	1	0	1	2	0.02
Neuroptera	0	1	0	0	0	1	0.01
Immatures	111	8	0	0	10	129	1.32
Non-insects	50	955	10	22	1	1038	10.65
Totals	2263	4646	1119	861	856	9745	100.00

*no collections made during Week 1

Ten different orders of insects were represented in our collections. Overall Coleoptera and Diptera were the predominant groups encountered, accounting for 43.7% and 28.9% of the total catch, respectively. Homoptera (5.4%) and Hymenoptera (4.7%) were the only other orders present in appreciable numbers. Non-insect arthropods comprised more than 10% of the total catch; their presence in such numbers was certainly unexpected. Presumably, the majority of these crawled up the sides of the trap, although some probably fell into the trap from above. As such, the trough essentially served as a "pitfall" trap. Members of the order Opiliones (harvestmen) were the most commonly encountered non-insect arthropods and were exceedingly abundant in collections from the Bald Knob study site. Various Araneae (spiders) made up the bulk of our other non-insect arthropod collections.

As shown in Table 1, striking differences in abundance among the five study sites were apparent for most orders of insects. For example, the number of Coleoptera collected at Bald Knob exceeded the combined total for the four other sites. Our collections of Homoptera exhibited the same general pattern, whereas Diptera and Hymenoptera were most abundant at the Beanfield study site. In contrast, virtually all of our collections of Plecoptera were from Spruce Bog. However, since these insects are usually encountered near water and the trap at this study site was located adjacent to a stream, such a pattern would not be unexpected. Differences in abundance for the various other orders of insects are not so readily explained, except to suggest that apparently they reflect appreciable differences in insect species diversity and community structure among the five study sites.

Table 2. Weekly Totals from the Five Study Areas at Mountain Lake for the Period of June 11 to July 2, 1984

Study area	Week 1	Week 2	Week 3	Mean value	Total catch
Beanfield	1016	866	381	754	2263
Bald Knob	2164	1579	903	1549	4646
Pond Drain	741	213	165	373	1119
War Spur*	—	301	560	430	861
Spruce Bog	504	261	91	285	856

*no collections made during Week 1

Weekly totals for collections made in the five study sites were highest for the first week of the study and, except for the War Spur study site, show a progressive decrease for each succeeding week (Table 2). Although it seems likely that the effects of continuously collecting at the same study site over a period of time would tend to produce such a pattern, there was at least one other contributing factor in the present study. Weather conditions were quite different during each of the three weeks of the study. For example, the daily mean temperature during the third week was 4.5° C lower than for the first week. Moreover, measurable precipitation did not occur during the first week, but the third week was rather "wet," with a total precipitation of 4.9 cm (Stephenson, unpublished data).

Slime mold beetles (Leiodidae) were relatively uncommon in our collections, comprising only 0.4% of all Coleoptera collected. Thirteen of the 16 specimens we encountered came from the Beanfield study site, with single specimens recorded from Bald Knob, Pond Drain, and Spruce Bog. Although no attempt was made to completely analyze all of our collections of Coleoptera, the families Histeridae, Staphylinidae, Cerambycidae, Silphidae, and Scarabaeidae were generally the predominant groups present.

In summary, based on the results presented herein, large-area flight-intercept or "window" traps of the type used in this study would seem to have considerable potential value as a simple and productive method for collecting and/or studying insects in temperate forests. Such traps are relatively easy to construct and can be set up and maintained in a variety of field locations. Moreover, with the use of a suitable killing/preserving fluid, they may be left unattended for a week or more at a time, a situation which allows them to be used even in fairly remote locations. In addition, the materials used in their construction are inexpensive and readily available, since the small-mesh (mosquito or "no-see-um") netting can be obtained from virtually any camping supplier and a series of shallow pans or other suitable containers can be used as a collecting trough. As such, we would certainly suggest that other ecologists working in the field with flying insects might wish to consider using these traps in their own research.

Acknowledgment

This research was supported in part by funds provided by a research grant from the Virginia Academy of Science.

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Botany Section

Seasonal Variations in the Foliar Mineral Nutrient Concentrations of Two Apple and Peach Cultivars*

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Abstract

This study was undertaken to compare mineral 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 cultivars Red Delicious and York Imperial, and peach cultivars Redhaven and Loring. 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 Imperial. Seasonal nutrient trends in the two peach cultivars were generally similar, but unlike apples, nutrient differences between them were usually 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. The leaf sampling period from mid-July to mid-August is satisfactory for fruit trees under West Virginia growing conditions.

Introduction

The mineral nutrient status of fruit trees has a direct bearing on tree vigor and productivity, fruit quality and storage behavior, and susceptibility to winter injury (6). Foliar nutrient analysis is recognized as the most accurate technique for determining the nutritional status of fruit trees (5,7). The primary fruit crops in West Virginia are apples and peaches. Recent surveys of apple and peach orchards in West Virginia (1,12) revealed that in many instances excessive fertilizer applications

*Approved for publication by the Director, West Virginia Agricultural and Forestry Experiment Station as Scientific Article No. 1965.

were being made. This information should assist growers in modifying their fertilization practices and thereby improve production efficiency. The objectives of the present study were to explain the nutritional differences previously observed in these cultivars (1,12) and to determine whether the recommended leaf sampling period of mid-July to mid-August is satisfactory for both apples and peaches under West Virginia growing conditions.

Materials and Methods

The apple cultivars Red Delicious (Bisbee strain) and York Imperial were selected for this study. Red Delicious is grown primarily for fresh marketing channels whereas York Imperial is mostly produced for processing. Both peach cultivars, Redhaven and Loring, are grown for the fresh market and account for a significant portion of the total peach crop in the state.

Foliar samples from both apple and peach trees were collected during the 1982 growing season, at weekly intervals from Julian 153 (June 2) to Julian 244 (September 1). The apple trees were growing at Jefferson Orchards, Inc., Kearneysville, WV and the peach trees at Lewis Brothers Orchards, Arden, WV. All trees were on seedling rootstocks.

Three replicate samples were collected at each date from each cultivar. Samples consisted of 100 leaves obtained from the mid-shoot region of the current season's shoot growth from tagged limbs on each of 10 trees. Leaf samples were washed with detergent, rinsed in distilled water, dried at 45°C in a forced air oven and ground in a Wiley Mill equipped with a 20-mesh stainless steel sieve. Nitrogen was extracted with perchloric and sulfuric acid and determined with an ammonia specific electrode. For the other nutrients (K, Ca, Mg, B, Mn, Fe and Zn) samples were dry ashed at 450°C, digested with nitric acid and the nutrients analyzed with an inductively coupled argon plasma spectrograph.

Results and Discussion

Apple cultivars: Foliar nutrient concentrations in the two apple cultivars showed similar trends during the growing season (Figure 1,2). These seasonal trends are in general agreement with the report of Rogers et al (9). With the exception of Ca, macronutrient levels were higher in Red Delicious than in York. The differences in Ca levels were minimal during the initial sampling period, but became evident after Julian 210. York Imperial is very susceptible to disorders like cork spot and bitter-pit, which are induced by low levels of fruit calcium. Because most of the Ca accumulation in fruits occurs within the first six weeks after bloom (13), foliar applications of $CaCl_2$ are conducted, in association with routine pesticide sprays, to enhance fruit Ca levels. The higher Ca levels in York Imperial are partially a reflection of foliar applications. Micronutrient levels (Figure 2) were generally higher in York Imperial than in Red Delicious. Variations in foliar nutrient composition of different cultivars have been reported by various workers (2,4,10,11,15). These

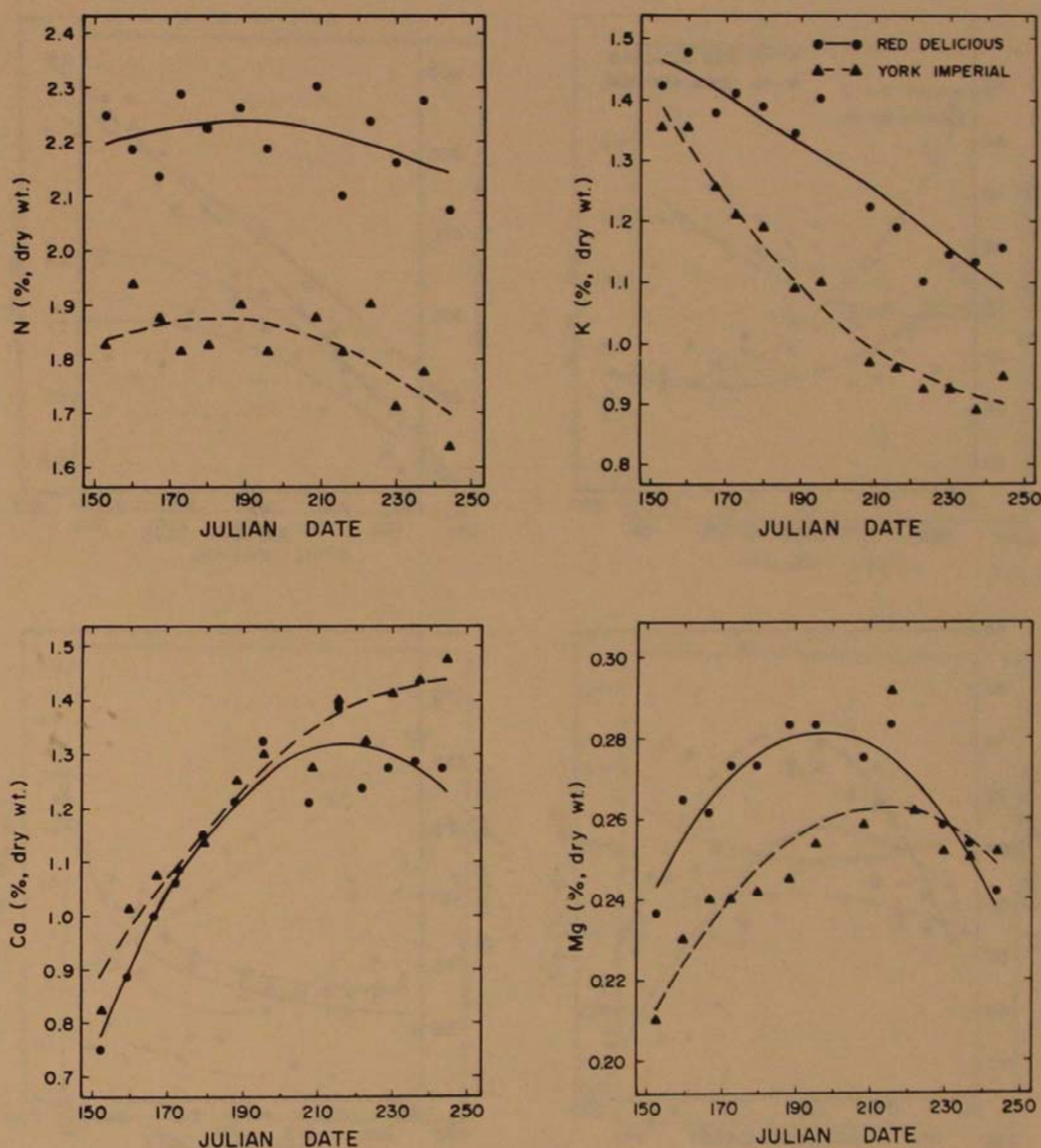

FIGURE 1. Seasonal changes in macronutrient concentrations in apple leaves.

variations may be due to inherent differences in these cultivars regarding their nutrient uptake. However, they are more likely attributable to differences in cultural/management practices based on market intentions of Red Delicious and York Imperial for fresh market and processing, respectively.

Although nutrient levels in leaves are never quite static, the period from mid-July to mid-August (Julian 196-Julian 227) is an acceptable period for collecting leaf samples for determining the nutritional status of fruit trees. When considering these two cultivars, the levels of most of the nutrients (Figures 1 and 2) are relatively stable during this period.

Peach cultivars: The seasonal changes in the two peach cultivars were generally similar (Figures 3 and 4). These trends are in agreement with

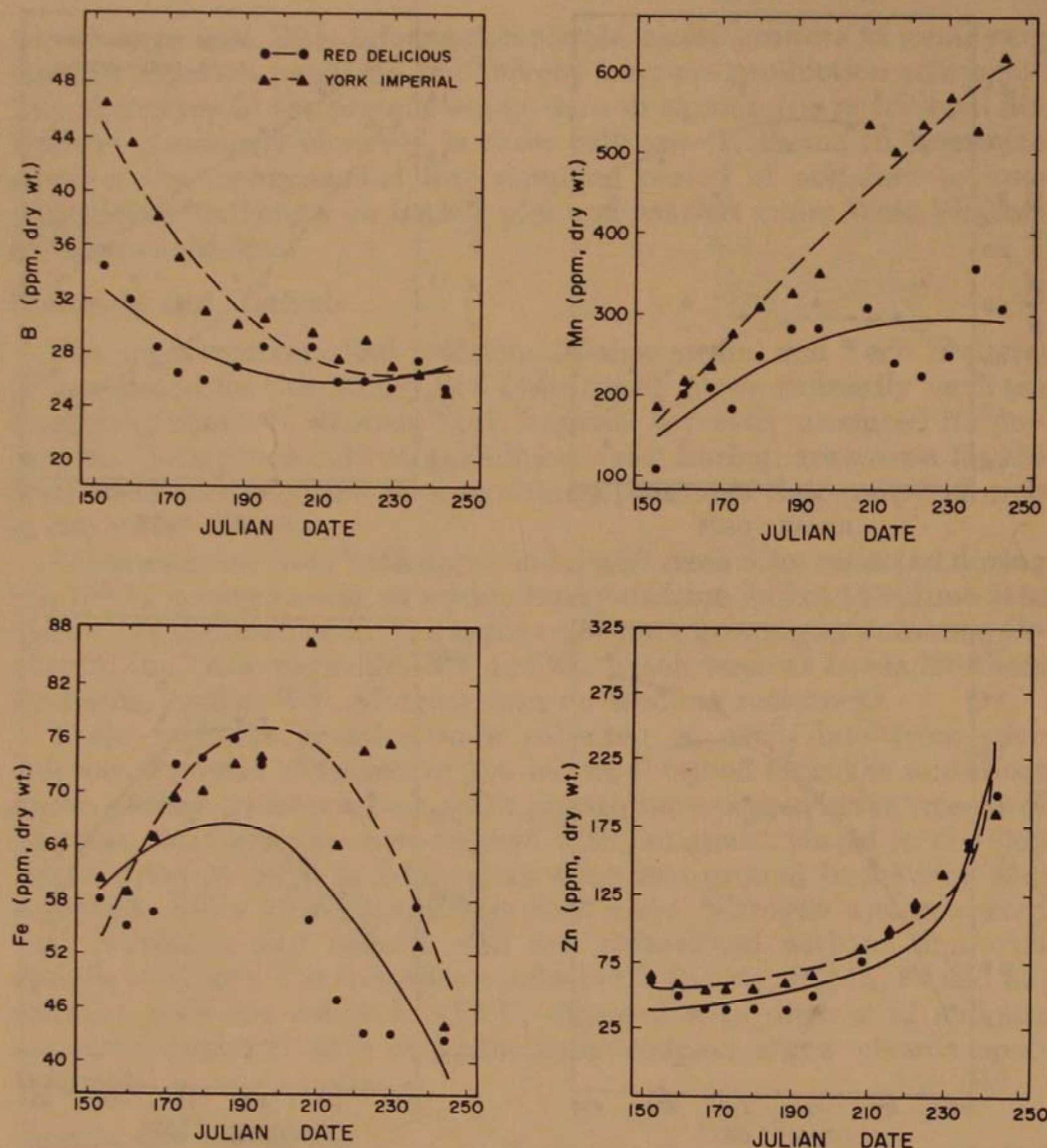

FIGURE 2. Seasonal changes in micronutrient concentrations in apple leaves.

earlier reports for the cultivars Elberta (14) and Hiley (8). Variations between these cultivars in the two key nutrients, N and K, were not as large as those between apples (Figures 1 and 3). As previously determined (12), Ca levels in Loring were higher than in Redhaven. The seasonal differences in micronutrients were very limited (Figure 4). In view of the relationship between leaf nutrient composition and the growth stage of the fruit (3), the nutrient variations between these cultivars, both of which are targeted for the fresh market, may be a function of variations in maturity. Fruit maturity in Redhaven occurs approximately 2 weeks prior to Loring.

As with apples, there is no period when leaf nutrient levels are stationary. The currently recommended sampling period of mid-July to mid-August for peaches is generally satisfactory. However, even during this period the nutrient changes can be quite large, depending on cultivar.

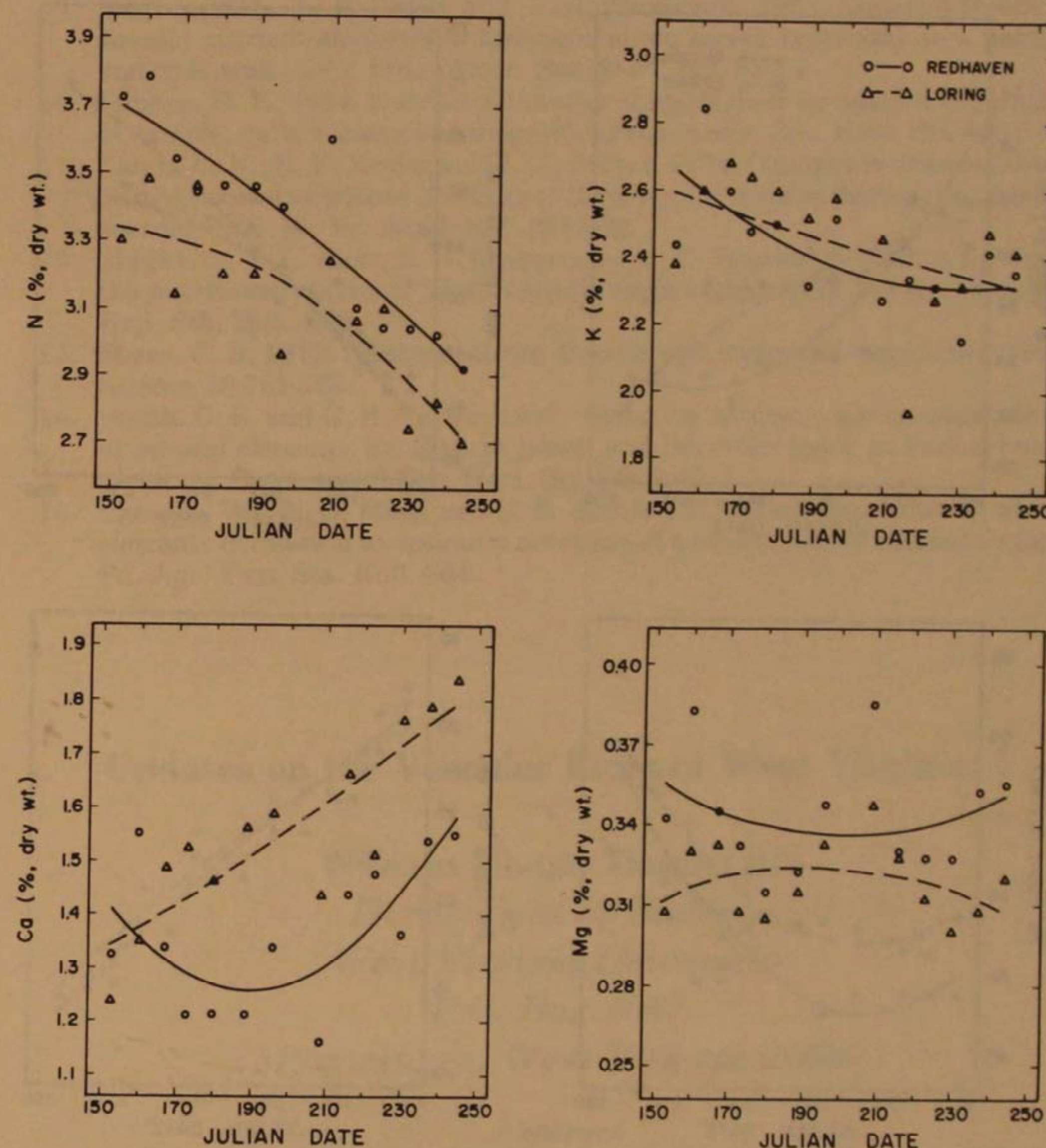

FIGURE 3. Seasonal changes in macronutrient concentrations in peach leaves.

Thus it would be desirable to collect samples at a more delineated time during this period.

Acknowledgment

The authors would like to thank Jefferson Orchards, Inc. and Lewis Brothers Orchards for their cooperation in this study. The assistance of Dr. Steven H. Blizzard is gratefully acknowledged.

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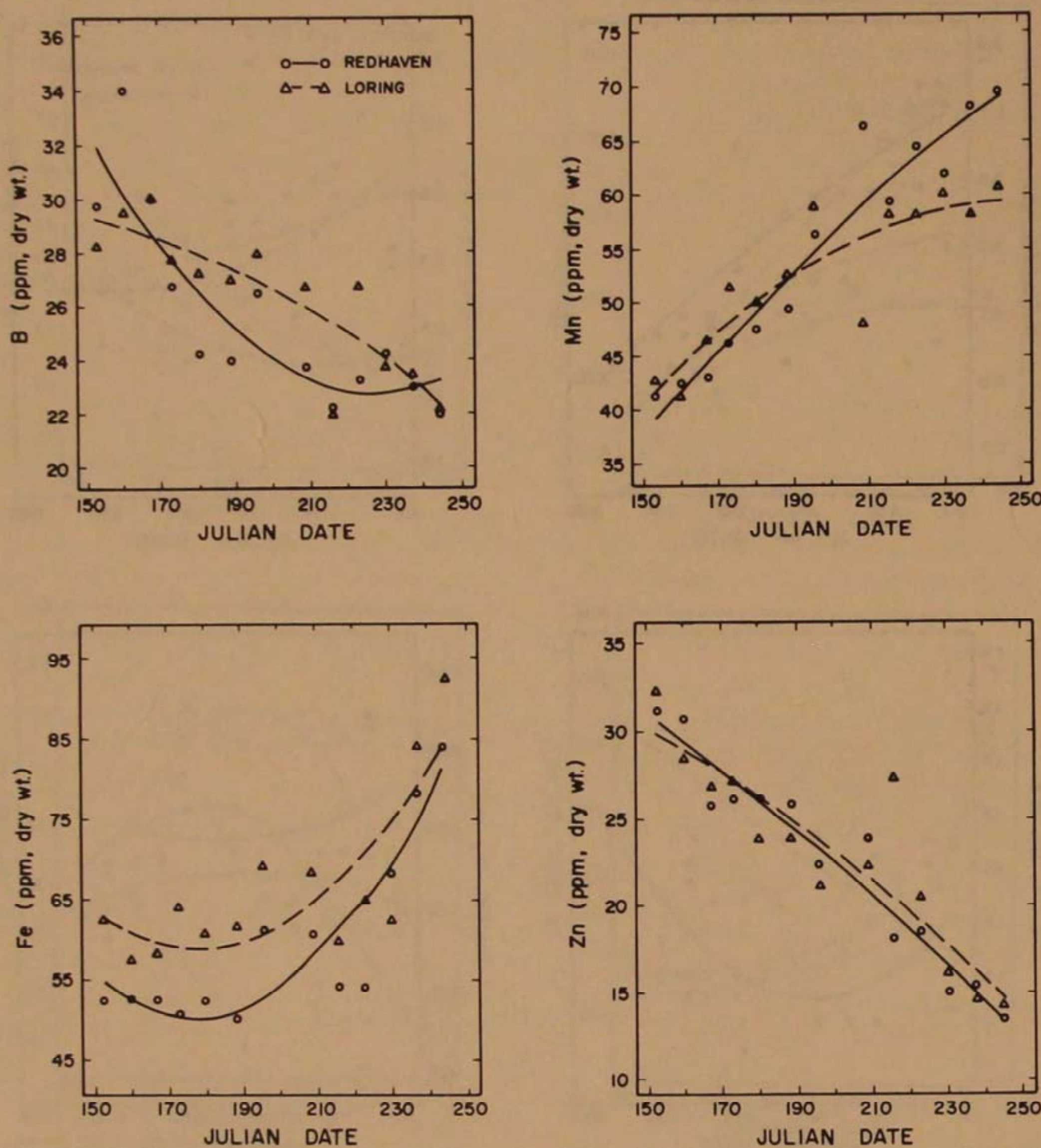

FIGURE 4. Seasonal changes in micronutrient concentrations in peach leaves.

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Updates on the Vascular Flora of West Virginia: I

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Abstract

During the past year, 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.

The new species here reported are:

Hosta ventricosa (Salisb.) Stearn, Fayette County (*Rodney Bartgis* s.n.) July 21, 1984. (Often cultivated. Naturalized from eastern Asia and spreading in rich, moist soil.)

Kochia scoparia (L.) Roth, Hampshire County (*Wilbert Frye* s.n.) June 20, 1947; Kanawha County (*Margaret E. Denison* s.n.) September 28, 1969; Hampshire County (*Wm. Homer Duppstadt* s.n.) September 26, 1979. (Cultivated and spreading. Naturalized from Eurasia.)

Hedera helix L., Monongalia County (*Gene M. Silberhorn* 1330)

April 23, 1965; Fayette County (*William N. Grafton* and *Claude McGraw* s.n.) August 27, 1972; Fayette County (*William N. Grafton* and *Claude McGraw* s.n.) September 23, 1973 and Fayette County (*Rodney Bartgis* and *Emily W. Grafton* s.n.) July 21, 1984. (Introduced and naturalized from Europe. Commonly cultivated.)

Onopordum acanthium L., Mason County (*Charles Sperow* s.n.) June 14, 1984. (Naturalized from Europe. Established on roadsides and waste places.)

Hieracium umbellatum L., Pendleton County (*Eugene E. Hutton*, et al. s.n.) September 14, 1984. (Native to the northern tier of states and Canada. To be expected at higher altitudes in our area.)

Radial Response of Wind-Exposed Red Spruce[1]

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Abstract

Radial growth and the formation of compression wood were 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 the basal branch swell did not account for the increased radial growth.

[1]Published with the approval of the Director, West Virginia Agriculture and Forestry Experiment Station as Scientific Paper No. 1894.

Introduction

Winds, especially strong winds, influence trees in many ways including bole and crown form, wood character, and height growth. Strong winds cause trees to lean and for conifers faster growth on the lee side and slower growth on the windward side has been noted (Bannon and Bindra 1970, Büsgen and Münch 1929, Jacobs 1939, and Larson 1963). Compression wood is often formed on the lower side of leaning coniferous stems but may occur in upright trees as a result of wind sway (Tsoumis 1968). Compression wood differs from normal wood in that tracheids are rounded in cross section, and have thicker walls which are higher in lignin, annual rings have a greater percentage of latewood with less well defined distinction between late and early wood, the wood is also denser and compressive strength is lower (Panshin and de Zeeuw 1980). These characteristics make compression wood inferior to normal wood for many uses.

Where winds are strong trees have a flagged appearance. Branches originating on the windward side develop toward the lee side, and desiccating effects of the wind may keep windward branches small. In addition, strong winds may contribute to lowering site quality resulting in trees short in stature (Toumey and Korstian 1947).

The reasons for abnormal stem development are not fully understood although several hypotheses have been proposed. Of these, the hormonal model is most widely supported. It has been suggested that wind sway stimulates growth in some way by inducing a steeper downward gradient of auxin (Larson 1962, 1963, 1965). A less widely held hypothesis is a mechanistic one in which a tree is considered as a tapered cantilever beam of uniform resisting moment. This hypothesis has been reviewed by Larson (1963).

Because branches are larger and appear to be concentrated on the lee side of trees and because there is a basal swell at the point of origin of the branch, it occurred to the authors that eccentric stem form may result, at least in part, from branch location and size.

The objectives of this study were to: (1) determine if stem eccentricity is a function of branch location and size, and (2) to determine the extent of compression wood formation in wind exposed trees.

Study Area and Methods

The study required an area which was subjected to strong winds and had exposed individual trees. Such an area was selected on a west-facing slope near the top of Spruce Knob, the highest mountain in West Virginia having an elevation of 1842 m.

The area has a heavy shrub cover, mostly not over 1 m tall. The dominant species are mountain laurel (*Kalmia latifolia* L.), rhododendron (*Rhododendron maximum* L.), and blueberries (*Vaccinium* spp.). Trees also occur growing isolated as individuals and not close enough to compete with each other. By far the most abundant tree species is red spruce. Others are red maple (*Acer rubrum* L.) and American mountain-ash (*Sorbus americana* Marsh.) (Figure 1).

FIGURE 1. Red spruce on the study area, a west-facing slope near the summit of Spruce Knob mountain.

An accurate description of the climate is not possible because climatological data have not been taken at the summit. However, precipitation data were taken at a nearby location approximately 100 m lower for the period 1931 through 1952. Here the mean annual precipitation was 115.5 cm (U. S. Department of Commerce 1931-52). The distribution of precipitation is favorable for plant growth, being quite evenly distributed throughout the year, but with the highest amounts occurring in July and August.

Actual temperature data are not available, but estimates from a model suggested the following for Spruce Knob summit (Leffler and Foster 1979). Mean annual temperature was 5.7°C; mean minimum annual temperature (average of lowest temperature reached each day) was 1.3°C; and the mean maximum annual temperature was 10.1°C. The authors estimate the length of growing season to be approximately 125 days.

Unfortunately wind velocity data are non-existent for Spruce Knob summit or for a similar mountain top. However, prevailing winds are westerly, but at times may come from any direction. These winds are generally strong but may be calm or gale-like.

The rock type of the area is of the Pottsville Group of the Pennsylvanian System, with sandstone predominating. Soils are medium-textured, of medium depth and are extremely rocky throughout the general area.

Six red spruce were selected for study. They ranged in age from 14 to

60 years and from 2 to 4 m in height. All six trees were free-growing, and exposed to the prevailing winds with resulting flagged clowns (Figure 1). The stem of each tree was determined to be straight and without lean except for the tips which were displaced to the leeward. The direction of the prevailing wind was marked along the tree boles, and the trees cut immediately above the basal swell.

In the laboratory the branches were removed leaving only a short stub beyond the basal swell. The bole was marked into approximately 15.3 cm sections starting at the base, but allowing slight adjustments in section length to avoid including branch stubs in the end surfaces.

The top of each section was divided into four 90° segments subsequently referred to as positions. The first was centered in the direction of the prevailing wind and was designated the windward side. The remaining positions, in a clockwise direction were normal 1 side, leeward side, and normal 2 side. Within each position, 5 radii, equally spaced by degrees and extending from pith to cambium, were measured and averaged to give the radius length of that position.

The diameter of each branch was measured and the distance of each branch from the lower cut of the section was recorded. The effect of branches on bole eccentricity was examined using the ratio of branch diameter to branch height above the next lower cross section assuming the influence of branches on radial bole growth at any given level is directly proportional to branch diameter and inversely proportional to branch distance above the section. The angle of the branch from the windward direction was measured in degrees as an azimuth, and assigned to the appropriate bole position. Compression wood was located by transmitted light, a method used successfully by many investigators and described by Panshin and de Zeeuw (1980).

The experimental design was a split plot with Tree-Section combinations comprising the whole plots and Positions the split plots. The effect of branches was examined using the ratio of branch diameter to branch height (D/H) as a covariate.

Results

Radial Growth

Radial growth rate differed significantly between the four positions around the bole (Table 1). The values in this table represent the means of the six trees. The greatest growth, 25.7 mm, was on the leeward side. Real differences existed among all positions except the two normal ones with the highest level of significance occurring between the windward and lee positions. The same relative growth rate occurred among positions throughout the length of the bole.

Branch Effect

Examination of the location of branches revealed that although branches originated on all four positions, more branches originated on the leeward side than either of the other positions (Table 1). Figure 1 indicates that the branches on the windward side were shorter than others

Table 1. Mean radii length and number of branches for position around tree bole

Position	Radius (mm)	Number of branches
Windward side	20.6	52
Normal 1 side	23.4	53
Leeward side	25.7	74
Normal 2 side	24.6	66

or developed toward the lee side. There was not, however, any significant effect of branches on stem eccentricity.

Compression Wood

Compression wood occurred in all six sample trees. It was variable with respect to abundance among trees and in different parts of the bole, especially throughout its length.

Compression wood was most common on the lee side of the bole. This abnormal wood often extended into the two normal positions, and only rarely was it found in the windward position. Commonly, this denser wood was found confined within individual annual rings with normal rings on either side. In only one tree, the one with the greatest amount of compression wood, were there areas of compression wood encompassing several annual rings and this situation gradually changed to an involvement of only individual rings in the normal areas of the cross section.

This wood was most common in the wider annual rings. Where the compression wood was well developed within a portion of a ring or rings, such as in the lee position, it often extended vertically throughout the length of that ring as it occurs in the bole. Rarely, compression wood was observed in a cross section completely encircling the bole within the annual ring.

Tree Height

The effect of site conditions on tree height was examined in terms of site index. Based on the height and age of sample trees, the site index was 3.6, height in meters at 50 years. The average site index for red spruce in the Northeast is 11.9 (Hampf 1965). Thus, there appears to be a dramatic effect of exposure on height growth.

Summary and Conclusions

At the summit of Spruce Knob, where the study trees were located, strong winds had a profound effect on tree development. Branches originated in all four positions around the stem. However, the branches originating on the windward side were either short, presumably from the dessicating effect of the wind, or developed toward the lee side resulting in a flagged appearance.

Greatest radial growth was observed on the lee side and least was observed on the windward side. Prior to the study the reason for this phenomenon was considered to be a result of either strong prevailing winds, tree lean, or branch origin around the bole. The last idea was based simply on observation of the flagged tree crowns.

The results strongly suggest that location of branches did not influence differences in radial growth of the four positions around the bole. Although the stems stood upright without lean except at the tips which were displaced in a leeward direction others have shown that even brief periods of motion and displaced leaders can affect stem form (Kellogg and Steucek 1976, Mergen 1958). Therefore, wind was considered to be the major factor causing growth differences around the bole, with the possibility that a slight lean or a sway which may occur in times of strong westerly winds also influenced growth.

Formation of compression wood has been indicated as erratic and commonly found within tree rings, mainly on the lee side of the bole, but also on other sides or positions. The findings are consistent with reports by Tsoumis (1968) who stated that composition wood could be formed in upright stems as a result of sway. Stem displacement of only two degrees for a period of 24 hours or less have been observed to produce abnormal tissues in coniferous seedlings (Kennedy and Farrar 1965) and movement of leaders has been associated with the formation of compression wood in hemlock (Mergen 1958). In addition, compression wood streaks have been observed by Kellogg and Warren (1979) in western hemlock tree boles below the point of origin of branches.

The reduction in tree height may very well reflect the site quality of the area. The site was judged to be of low quality because of the harsh climate even though soil and moisture characteristics appear to be favorable. The effect of wind on tree height growth cannot be discounted, however. Kellogg and Steucek (1976) and Larson (1965) have observed a reduction in height growth and a change in the pattern of xylem distribution in wind exposed conifers.

When conifers are grown where strong winds are a factor that tends to adversely affect their development and growth, it is suggested that they be managed so that wind effects are lessened. This should reduce the amount of compression wood formed and thus improve wood quality in contrast to a situation where the wind has maximum effects. In general, an even-aged method of growing the stand, where this is a satisfactory method from other considerations such as site protection, should give the best results. The individual trees of similar age growing side-by-side will be somewhat protected from the wind except at the edge of the stand and should not only develop less compression wood, but should also have a more uniform crown development, a more cylindric bole and probably better growth as a result of reduced transpirational loss. The single tree selection method would be less desirable and it would produce more free-standing trees subject to direct wind action resulting in poorer quality wood.

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Geology Section

Sedimentology and Paleohydrology of the Fluviodeltaic Conemaugh Group (Late Pennsylvanian) along the Big Sandy River, Kentucky-West Virginia-Ohio

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Abstract

The Conemaugh Group of West Virginia has been interpreted by previous workers as consisting of a lower delta plain assemblage of facies—the Glenshaw Formation—succeeded by upper delta plain deposits of the Casselman Formation. Extensive new exposures of the Glenshaw and Lower Casselman Formations along the Kentucky Rt. 23 bypass south of Catlettsburg complement existing localities near and along the Big Sandy and Ohio Rivers providing an unusually complete 3-dimensional perspective of the local depositional history and paleogeography. Three transgressive-regressive cycles are present within the Glenshaw Formation. 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 paleochannel sandstones with epsilon cross-strata provide width and depth values for fluviodeltaic channels of the Grafton sandstone. The width/depth ratio (channelform index) is used to estimate paleohydraulic and paleogeomorphic characteristics of the Grafton River system which are then compared with previous estimates for the Grafton sandstone 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.

Introduction

During the Pennsylvanian, much of the interior of North America was covered by a shallow cratonic sea. A northeast-trending arm of this sea extended through the tri-state area as far as western Pennsylvania. During the Late Pennsylvanian as the Conemaugh Group accumulated, this seaway filled in largely as the result of northwestward prograding deltas which carried large volumes of sediment from the tectonically uplifted Appalachians (Donaldson and Schumaker, 1979).

The Conemaugh Group is divided into the Glenshaw and Casselman Formations. In the study area the Glenshaw Formation is about 73m (240 ft) thick whereas the overlying Casselman Formation is about 88m (290 ft) thick (Fonner and Chappell, 1985). Both formations consist of gray, green and red mudstones, light gray sandstones, and thin coals and limestones.

Previous workers have interpreted the Conemaugh Group in northern West Virginia, eastern Ohio, and southwestern Pennsylvania to consist mainly of lower delta plain to nearshore marine deposits (Glenshaw Formation) overlain by upper delta plain deposits (Casselman Formation; Donaldson, 1979, p. 124). South of our study area in the Adams, Blaine, Richardson, and Sitka 7½′ quadrangles of W. Va.-Ky., the basal Glenshaw up to the Brush Creek Coal bed has been interpreted as alluvial, whereas the rest of the superadjacent Conemaugh Group has been interpreted as lower delta plain (Hayes and Connor, 1982, p. 14, 19-20). The lithostratigraphy, paleoecology, and syndepositional tectonics of the Conemaugh Group in the study area have been studied by Merrill (1981, p. 509) who identified 3 marine zones including in ascending order the Brush Creek, Cambridge, and Ames.

New Conemaugh exposures were created in northeast Kentucky south of Catlettsburg during construction of the Rt. 23 bypass (Fig. 1). These new road cuts complement existing exposures along Rt. 23 (KY), Rt. 52 (OH), and I-64 (KY-WV) providing an unusually complete picture of sedimentary facies present in the lower and middle Conemaugh Group. The objectives of this study are: 1) to describe the new sections along the Rt. 23 bypass, 2) to correlate these sections with nearby sections along the Big Sandy and Ohio Rivers, and 3) to compare the sedimentary facies, transgressive-regressive cycles, and paleohydraulic and morphologic characteristics of the paleochannel systems with the findings of previous workers.

Results

Stratigraphic sections at 12 locations (Fig. 1) were measured with Jacobs staff and Brunton compass. Each section was divided into sedimentary facies based on lithology, sedimentary structures, fossils, paleocurrent pattern, and facies geometry. Lithostratigraphic correlation of the sections (Fig. 2) is based on their elevation with respect to structural contours drawn on marker beds including the top of the Princess No. 7 Coal and the Ames Limestone. A composite section is shown in Fig. 3 which summarizes the stratigraphy, paleontology, and sedimentary facies along with our paleoenvironmental interpretations.

Discussion

Stratigraphic Correlation

In southern West Virginia, the base of the Conemaugh is identified by the first occurrence of red beds or variegated strata above the Allegheny

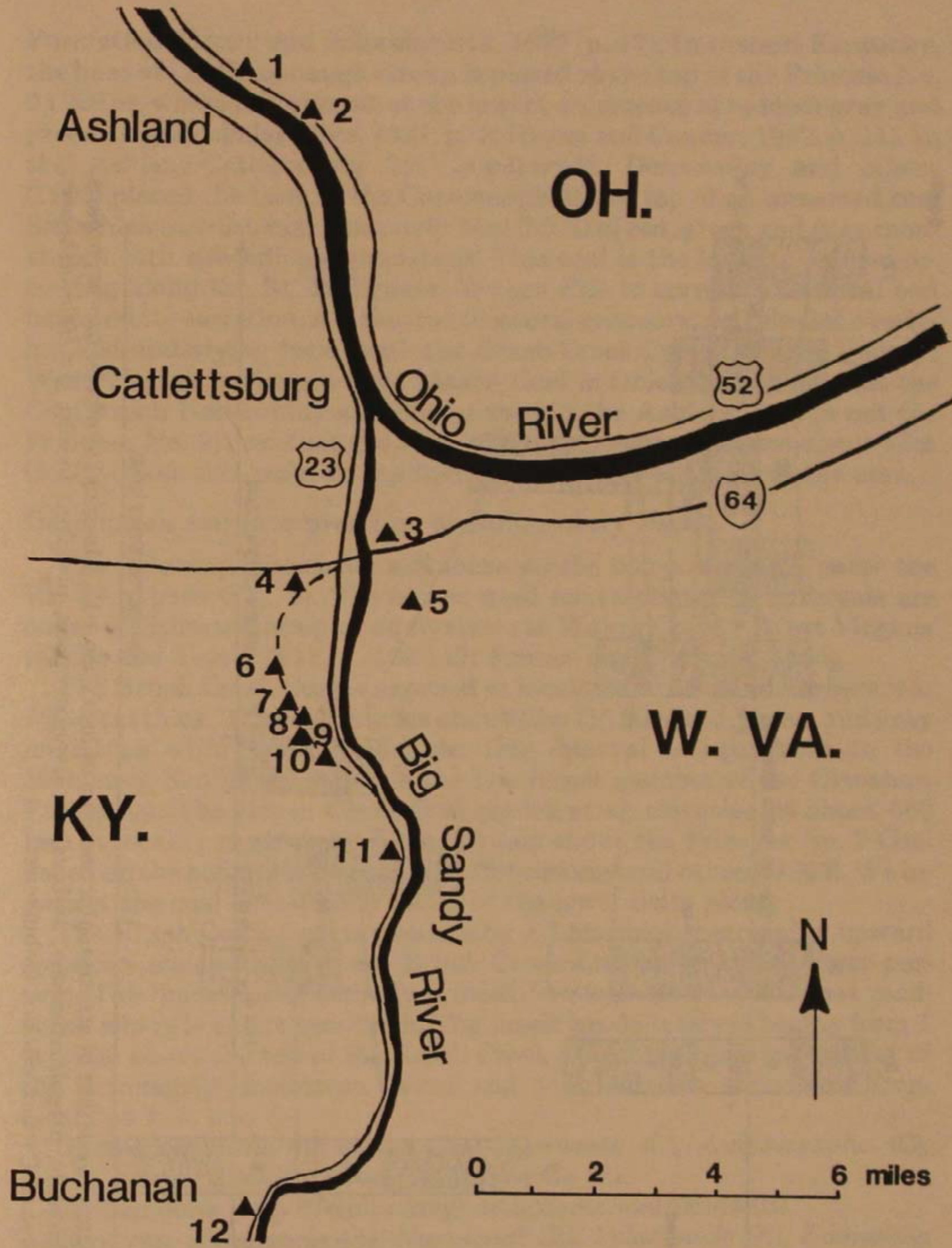


FIGURE 1. Location map showing study area and the 12 outcrop localities used in this study. Coordinates for each locality are:

Locality 1: 38°28′48″N, 82°37′14″W; 2: 38°28′17″N, 82°36′19″W; 3: 38°23′1″N, 82°35′22″W; 4: 38°22′30″N, 82°36′38″W; 5: 38°22′30″N, 82°34′50″W; 6: 38°21′00″N, 82°36′41″W; 7: 38°21′23″N, 82°35′52″W; 8: 38°20′35″N, 82°36′33″W; 9: 38°20′31″N, 82°36′04″W; 10: 38°20′52″N, 82°36′00″W; 11: 38°19′3″N, 82°34′41″W; 12: 38°14′14″N, 82°36′50″W

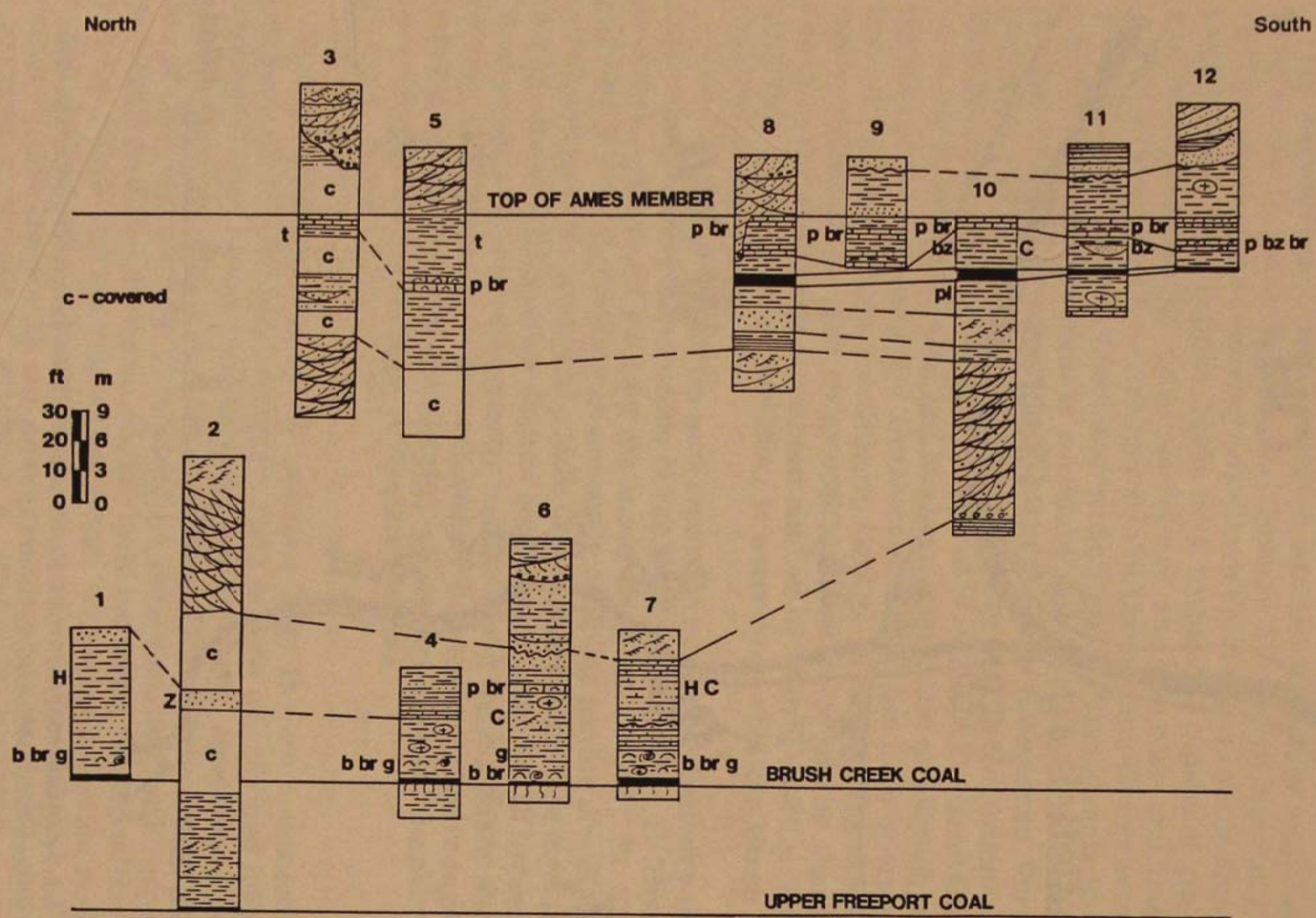


FIGURE 2. Correlation of stratigraphic sections of localities 1-12. Marginal symbols: bz=bryozoans, br=brachiopods, p=pelmatozoans, b=bivalves, g=gastropods, pl=plant fossils, H=*Helminthopsis*, Z=*Zoophycos*, C=*Curvolithus*, t=burrowed.

Formation (Henry and Schweinfurth, 1977, p. 17). In eastern Kentucky, the base of the Conemaugh Group is placed at the top of the Princess No. 9 Coal or, where it is absent, at the lowest occurrence of reddish-gray and greenish-gray shales (Rice, 1981, p. 2; Hayes and Connor, 1982, p. 11). In the Ashland-Catlettsburg 7½′ quadrangle, Dobrovolny and others (1963) placed the base of the Conemaugh at the top of an unnamed coal bed which overlies approximately 15m (50 ft) of red, green and gray mudstones with subordinate sandstone. This coal is the lowest coal bed occurring along the Rt. 23 bypass. We are able to correlate this coal bed based on its elevation, relation to structural contours, and similar overlying and underlying facies with the Brush Creek Coal of Wayne County, West Virginia and equivalent Mason Coal in Ohio. We believe that the Coal which Dobrovolny and others used in the Ashland area is not the Princess No. 9, and that the base of the Conemaugh occurs about 15m (50 ft) below this seam at the first occurrence of red beds in the area.

Description and Interpretation of Sedimentary Facies

The following discussion will focus on the composite section for the Rt. 23 bypass (Fig. 3). The names used for stratigraphic intervals are based on lithostratigraphic equivalents in Wayne County, West Virginia (Krebs and Teets, 1913, p. 129-142; Fonner and Chappell, 1985).

The Brush Creek Coal is exposed at localities 1, 4, 6, and 7 where it is 10-45 cm thick. The coal overlies about 15m (50 ft) of red, green, and gray mudstone with minor sandstone; this interval is equivalent to the Mahoning Sandstone which is the lowermost member of the Glenshaw Formation. The Brush Creek Coal occurs at an elevation of about 660 feet at locality 4 which is about 120 feet above the Princess No. 7 Coal based on the structural contours of Dobrovolny and others (1963). We interpret the coal as a swamp facies of the lower delta plain.

The Brush Creek Coal is overlain by a 7-8m thick, coarsening upward sequence which includes the Brush Creek Limestone in the lower portion. The limestone is actually a fossiliferous shale to calcareous mudstone which is about ½m thick. The fossiliferous interval begins from 1 to 2½m above the top of the Brush Creek Coal. The following is a list of the dominantly molluscan fauna and their relative abundance from localities 1, 4, and 7:

Gastropods: *Pharkidonotus* (A), *Worthenia* (C), *Amphiscapha* (C), *Schizostoma* (C), *Mourlonia* (R).

Cephalopods: tiny (7-8mm long) orthoconic nautiloids (R)

Bivalves: *Nuculopsis* (A), *Nuculana*? (R), *Palaeoneilo* (R), *Edmondia* (R)

Brachiopods: *Chonetes* (R)

The assemblage is indicative of restricted marine conditions which reflect transgression of lower delta plain swamps by waters of an interdistributary bay. The coarsening upward sequence reflects bayfilling and resultant local regression and is very similar to the generalized bay-fill sequence described by Chesnut (1981, p. 61) for Pennsylvanian strata of eastern Kentucky. Continued marine influence during bayfilling is indi-

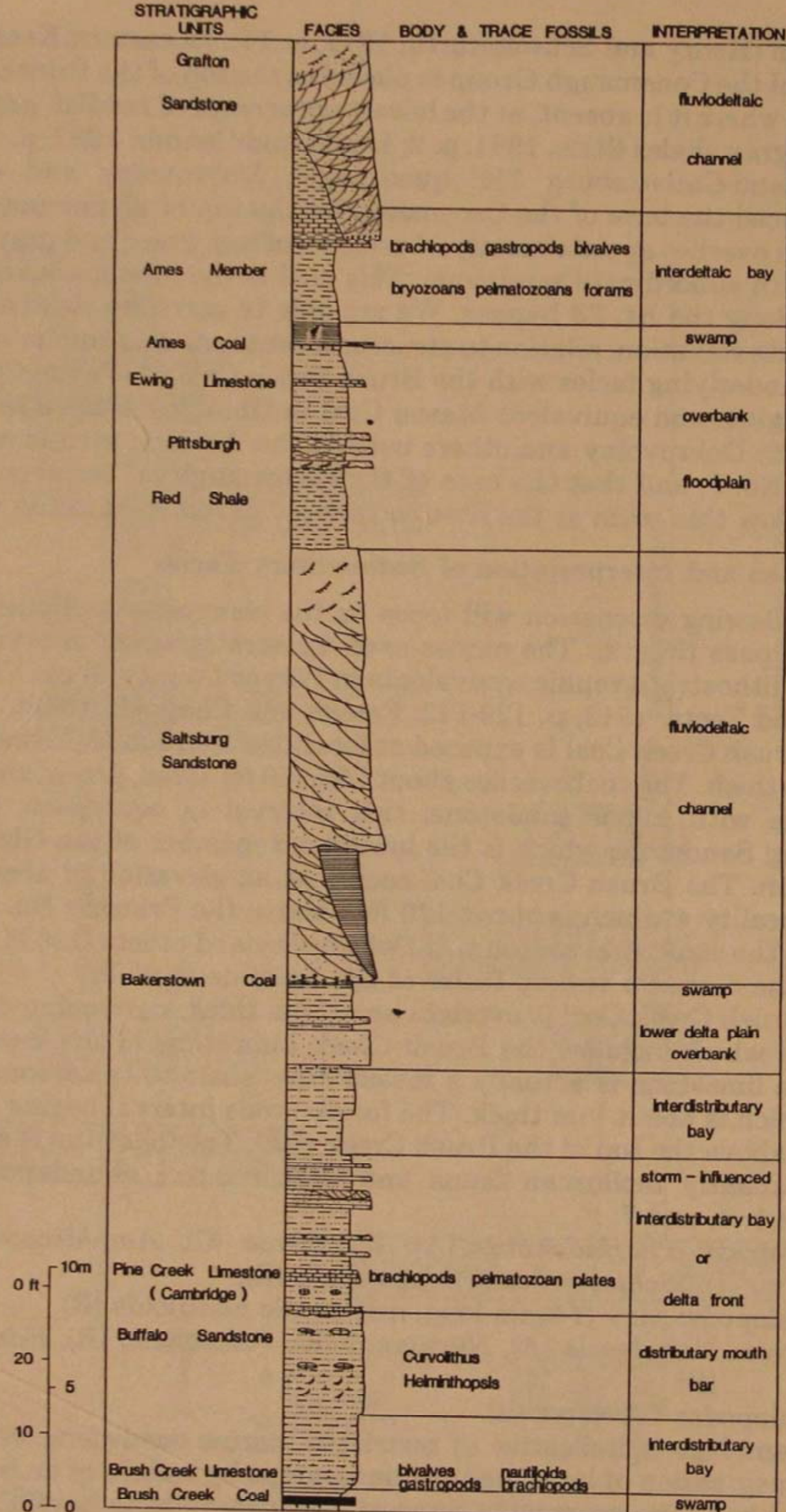


FIGURE 3. Composite section summarizing the stratigraphy, paleontology, and paleoenvironmental interpretations of outcrops along the Rt. 23 bypass. Stratigraphic terminology is after Krebs and Teets, 1913.

cated by the occurrence of the trace fossils *Curvolithus* and *Helminthopsis* (locality 7). The coarsening upward interval is capped by thin-medium bedded sandstones with local scour-fill features interpreted as distributary mouth bars. This interval is laterally equivalent to the Buffalo Sandstone of Wayne County, W. Va.

Above the Buffalo Sandstone equivalent is a 7m thick interval which consists mainly of gray mudstone and siltstone with subordinate thin, very fine, calcareous, graded sandstones and sandy limestones which typically have sharp locally erosional bases. One sandy limestone in particular which occurs 9.3m above the Brush Creek Coal is up to 40 cm thick, contains pelmatozoan plates and articulate brachiopods, and correlates with Pine Creek Limestone of Wayne County, West Virginia and the Cambridge Limestone of Ohio. The scoured base, occurrence of intraclasts, sparse marine fauna, and burrow mottled top of this bed are consistent with deposition as a storm sand in an interdistributary bay or delta front environment. Other graded beds in this interval may be of similar origin, although flood events may also be represented.

At locality 2, the Pine Creek marine interval is poorly exposed but partially represented by a 2.5 m thick micaceous fine-medium sandstone containing the feeding trace *Zoophycos.* The top of this bed occurs about 8m below the base of the Saltsburg Sandstone.

Following the Pine Creek transgression, bay filling or delta progradation occurred. The occurrence of an underclay, overlain by a root (?)-mottled splay sandstone indicates a return to lower delta plain overbank conditions. The splay sandstone is overlain by gray sandy mudstone and thin carbonaceous shale-bone coal which correlates with the Bakerstown Coal of Wayne County. The Bakerstown horizon occurs immediately below a thick channel sandstone (Saltsburg Sandstone) which has locally removed it. These deposits probably accumulated in poorly oxygenated lakes and swamps of the lower delta plain.

Above the Bakerstown Coal horizon, a 14-17m thick, multistoried channel sandstone with local shale plugs occurs which correlates with the Saltsburg Sandstone described by Krebs and Teets, (1913). The sandstone is light gray, and fine to medium grained with pebble lags at the base. Internal structures include large scale epsilon cross-strata which enclose small to medium scale sets of trough and tabular planar cross-stratification. Paleocurrent pattern based on cross-stratification was unimodal and ranged from northwest at locality 10 to northeast at locality 3. The Saltsburg Sandstone represents both active and abandoned fluviodeltaic channel deposition in the upper delta plain.

Between the top of the Saltsburg Sandstone and the Ames Limestone occurs about 13m of overbank deposits including 1) the Pittsburgh Red Shales with crevasse splay sandstones, 2) the Ewing Limestone, a nodular pelmicrite, slightly arenaceous and dolomitic, with calcite-filled syneresis cracks and rare fossils of bivalves(?) or ostracods(?) of probable lacustrine origin, and 3) carbonaceous shale and thin coal representing the Ames coal(?) horizon, interpreted as a lower delta plain swamp deposit.

The Ames marine interval reaches a maximum thickness of 8m at locality 11. Within this interval 5 facies are present: 1) brachiopodal green shales, 2) nodular to thinbedded poorly washed biosparites, 3) thickbedded, cross-stratified to thoroughly bioturbated, arenaceous biosparite to calcareous siltstone-very fine sandstone (crinoidal), 4) dark gray burrowed mudstones, and 5) variegated mudstones. The following is a list of the fauna recovered: branching and lacy bryozoans, pelmatozoan plates, productid and spiriferid brachiopods, gastropods, and the bivalves *Pecten*, *Edmondia*, and *Parallelodon*. The bulk of these was collected from locality 12. Ames localities along the bypass were dominated by chonetid brachiopods and pelmatozoan plates. The lower delta plain swamp environment in which the Harlem Coal accumulated became inundated during the Ames transgression and evolved into a shallow marine embayment. Donaldson and Schumaker (1979, p. 32) represent this embayment as a narrow, interdeltaic, southward extension of the Ames Sea along which is now the Big Sandy River Valley. Merrill (1981, personal communication) has suggested that thickness variations and facies patterns in the Ames interval were controlled by syndepositional downwarping along the Parkersburg Syncline, and that lagoonal, tidal flat, and barrier island environments are represented. While it is clear that more work remains to be completed on sedimentary facies within the Ames interval, we believe that specific environmental interpretations may be suggested: The crinoidal sandstone-siltstone facies may represent offshore bar or shoal deposits. The thinbedded to nodular, poorly washed biosparites accumulated as storm deposits. The burrowed mudstones and brachiopodal shales may have accumulated in sheltered or deeper portions of embayment below wave base. Faunal diversity is highly variable both vertically and laterally within the Ames interval and was probably controlled to a great extent by variations in salinity within the embayment as a whole or more local salinity and substrate variations along the margins of this embayment.

The Grafton Sandstone is a multistoried, shoestring channel sandstone which is as much as 18.4m thick (locality 12). The Grafton is quite similar to the Saltsburg Sandstone except that it is more localized in its occurrence. Paleocurrent data from crossbedding indicates an average flow direction of S69W at locality 8 and N25W at locality 12. The Grafton and laterally equivalent mudrocks are interpreted as upper delta plain deposits associated with a fine-grained meanderbelt river system. Paleohydraulic and geomorphic estimates for the Grafton River in the study area are discussed later in this paper. Morton and Donaldson (1978) interpreted the Grafton Sandstone as a fluviodeltaic deposit in northern West Virginia.

Transgressive-Regressive Cycles

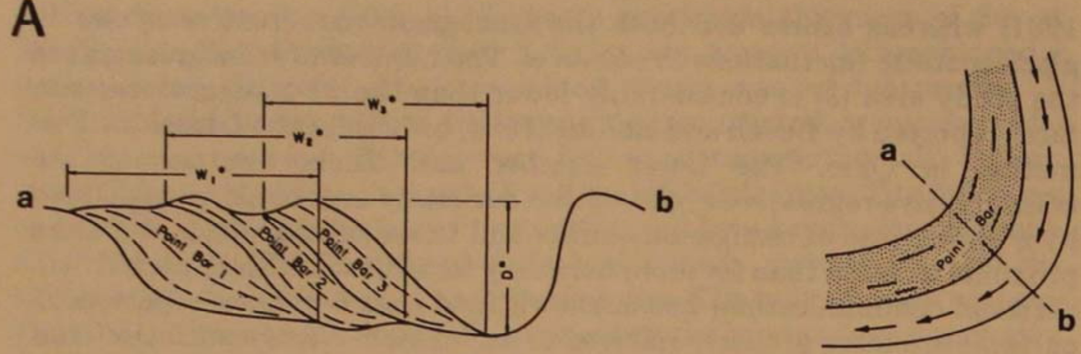
Within the Glenshaw Formation in the study area, 3 transgressive intervals are present: 1) the Brush Creek, 2) the Pine Creek (Cambridge), and 3) the Ames. Some workers have considered avulsion and delta switching to have been the controlling factor (Donaldson, 1979; Merrill,

1981) whereas others attribute the transgressive-regressive cycles to glacioeustatic fluctuations in sea level. The number of transgressions in the study area (3) is considerably fewer than the 11 transgressive surfaces reported by Busch and Rollins (1984, p. 472) for the Glenshaw Formation in Ohio. The fewer number and thicker nature of the transgressive-regressive cycles within our study area could be explained by a higher rate of terrigenous influx and basin subsidence, and a more proximal location than for more northerly localities in Ohio. Busch (1985, personal communication) has acknowledged that 6 of their reported 11 surfaces are more properly referred to as "climate change surfaces" and correspond to coals and/or lacustrine limestones rather than true marine zones. They maintain that 11 glacioeustatic sea level cycles are represented. Although such a mechanism could account for the observed cycles in the Dunkard Basin, the synchroneity of these surfaces within the basin or on a worldwide scale has not yet been clearly demonstrated.

Paleohydraulic Analysis

Studies of modern meandering rivers by Schumm (1972) concluded that the morphology and hydrology of modern rivers are related to and the mud content of the channel perimeter and to the channelform index (width/depth). Schumm developed a set of empirical relationships which has been used by many workers to semiquantitatively characterize ancient rivers based on their channel dimensions (Schumm, 1972; Ethridge and Schumm, 1978, p. 706-707; Fig. 4A). The channel depth "D" is determined by taking the height of the epsilon cross-strata (d*) and multiplying it by 0.585/0.9. This correction takes into account the up to 10% compaction of the sand during burial and the fact that rivers are about 1.7 times deeper in the meanderbends than in straight reaches which is what Schumm used in his study of modern rivers. Channel width "W" equal 1.5 times the width of the epsilon cross-strata bundles (w*) measured normal to flow (Ethridge and Schumm, 1978, p. 709; Fig. 4B).

A Grafton paleochannel cross-section at locality 12 was used to obtain channel width and depth values (Fig. 5A). Although offset stacking of 2 channelfills was evident, complete epsilon cross-strata in the upper channelfill were distinguishable. The mean azimuth of cross-bedding within the epsilon cross-strata indicated a paleoflow direction of N25°W. Since the face of the outcrop had a strike of N30°E, the apparent width of the epsilon cross-strata (40.1m) was corrected trigonometrically to obtain their width normal to flow (w*, 32.9m). This value was then multiplied by 1.5 to obtain the bankfull channel with (W, 49.2m). The 8.5m height of the epsilon cross-strata was multiplied by 0.585/0.9 to obtain a channel depth of 5.5m in the straight reaches of the Grafton River. These values were used to determine a channelform index of 8.5 which was then used in Schumm's empirical formulas (Fig. 4A). The resulting mean value estimates were compared with those of Morton and Donaldson (1978) for the Grafton River of northern West Virginia and their interpreted modern analogue, the Guadalupe River of Texas (Fig. 5B). Our estimates suggest that the paleochannel at locality 12 was of comparable depth,



B

Parameter	Formula	Units	Se	r	Sd
width-depth ratio (F)	$F = \frac{w}{d}$	---	--	--	--
sinuosity (P)	$P = 3.5F^{-0.27}$	---	0.06	0.89	0.13
mean annual discharge (Q_m)	$Q_m = \frac{w^{2.43}}{18F^{1.13}}$	cfs	0.20	0.90	0.46
mean annual flood (Q_{ma})	$Q_{ma} = 16 \frac{w^{1.56}}{F^{0.66}}$	cfs	0.20	0.90	0.46
channel gradient (s)	$s = 30 \frac{F^{0.95}}{w^{0.98}}$	ft·mile^{-1}	0.16	0.84	0.29

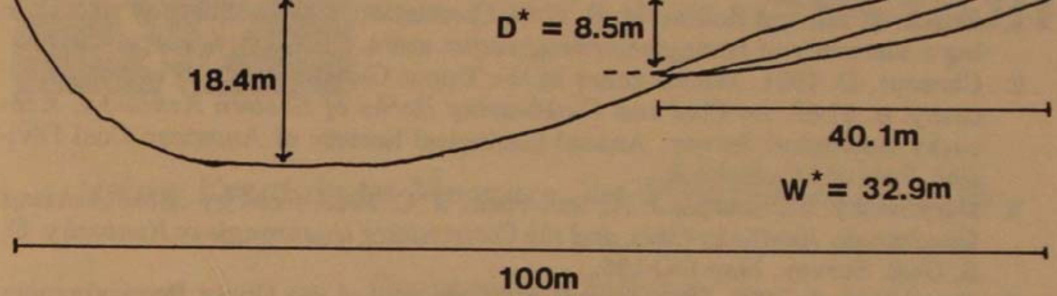
Se: standard error of the estimate in log units
r: correlation coefficient
Sd: standard deviation of estimate in log units

FIGURE 4. A: Meanderbend at left with cross-section showing epsilon cross-bedding and basis for determining paleochannel width and depth. The Bankfull channel width (W) = w* x 1.5. The Bankfull channel depth (D) = D* x 0.585/0.9. 4B. Paleohydraulic formulas developed by Schumm which were used to semi-quantitatively characterize the Grafton River system (modified from Ethridge and Schumm, 1978).

sinuosity, and gradient but somewhat narrower with correspondingly lower mean discharge and mean annual flood.

The mean values for channelform index (< 10), sinuosity (approximately 2), and gradient (gentle) suggest a suspended load river system was involved. However, values for channelform index and sinuosity are sufficiently close to the values of mixed load rivers (sinuosity 1.3-2, A

GRAFTON PALEOCHANNEL



B

PALEOHYDRAULIC ANALYSIS

	Grafton River W. Va. (Morton & Donaldson, 1978)	Grafton River eastern Ky. (this paper)	Modern Guadalupe River Texas (Morton & Donaldson, 1978)
Width	75m	49.2m	57m
Depth	6m	5.5m	7m
Width/Depth	12.5	8.9	8.1
Sinuosity	2.0	1.94	2.24
Gradient	0.35m/km	0.31m/km	0.33m/km
Mean Discharge	$58.8m^3$/sec	$30.6m^3$/sec	$45.8m^3$/sec
Mean Annual Flood	$364m^3$/sec	$296m^3$/sec	$389m^3$/sec

FIGURE 5. A: Schematic cross-section of the Grafton paleochannel at locality 12. D* (8.5m) is the height of the epsilon cross-strata in the upper channelfill, and w* (32.9m) is the corrected width of the epsilon bundles normal to flow. B: Hydraulic and morphologic estimates (mean values) for the Grafton River in eastern Kentucky compared to estimates by Morton and Donaldson (1978) for the Grafton River in northern West Virginia and to corresponding characteristics of the modern Guadalupe River of Texas.

channelform 10-40) that, considering the variation in our estimates at the 95 percent confidence limits, a mixed load river cannot be ruled out. The multistoried, shoestring geometry of the Grafton, abundance of overbank and absence of chute channel or chute bar deposits in the study area are consistent with a fine-grained meanderbelt river origin.

Acknowledgments

We would like to thank Glen Merrill, Richard Busch, and Alan Donaldson for helpful discussions during the course of this study.

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Mining and Engineering Section

Using Fractals to Measure the Progress of Erosion

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Abstract

Mountain front sinuosity is a method of measuring the progress of erosion by measuring the length of the mountain-pediment junction to the length of the mountain front. A higher ratio means a greater length of junction which implies more erosion. Measurements of the ratio 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.

Introduction

Bull and McFadden (1977) note that many workers have made general assessments of the degree of tectonic activity on mountain fronts using qualitative differences. They use what they term mountain front sinuosity to give a quantitative understanding of the balance of erosion and uplift during the Quaternary (last 1.8 million years) in the Basin and Range Province of eastern California. Mountain front sinuosity (S) is defined as the ratio of the mountain-pediment junction (Lmf) to the length of the mountain front (Ls):

$$S = \frac{Lmf}{Ls}$$

Mountain Front Sinuosity in West Virginia

Mountain front sinuosity was calculated for the Allegheny Front in eastern West Virginia using the method of Bull and McFadden (1977) by "walking" dividers along the 2000 foot contour line on published topographic maps at various scales. The maps used were: USGS Piedmont Folio (1:125000, 1891), USGS Elk Garden 15′ (1:62500, 1919), USGS Westernport 7½′ (1:24000, 1950), USGS Antioch 7½′ (1:24000, 1967), and USGS Mount Storm 7½′ (1:24000, 1949). The dividers were set at 1/4″, 1/8″, 1/16″ and a rotating wheel map measurer was also used. The value of S was found to vary depending both on the scale of the map and the method of measuring (table 1). These variations due to map scale and method of measurement are large enough that they may obscure the variation due to factors as progress of erosion or differential erosion due to different lithologies. This impairs the usefulness of the method.

Table 1. Values of S (mountain front sinuosity) for the Allegheny Front from Montgomery Run to the Right Fork of Linton Creek

Scale	1/4″	1/8″	1/16″	Wheel
1:125,000	1.16	1.47	1.55	2.11
1:62,500	2.18	2.36	2.73	2.77
1:24,000	2.55	2.69	2.80	2.79

Bull and McFadden (1977) discuss suitable sources of data and scales at which to make the measurements. They found small scale (1:250,000) geologic maps suitable (in fact, basing their study on a 1:250,000 geologic map). They deemed small scale topographic maps unsuitable, however. Large scale (1:62500) topographic maps and aerial photographs were judged satisfactory but were apparently not used in their study. Bull and McFadden do note that S is a function of the scale and detail of the map being measured. The example which they give is that aerial photographs and small scale topographic maps may give S values 20 to 30% larger than those obtained from a small scale geologic map. They take this observation no further. Since the S values are scale dependent this leaves two alternatives: using a standard scale or finding the function that relates S to scale. Choosing a conventional scale for measuring mountain front sinuosity would be an easy solution but an inelegant one. The most widely used map scales are different in different areas of the world. The preferred map scale also seems to change through time. Without a common basis given values of S are not really comparable and quantitative estimates of the progress of erosion using S cannot meaningfully be compared.

Self-Similarity and Fractals

Finding the function that relates S and scale provides a better solution. Coastlines are known to possess the property of statistical self-similarity (Gardner, 1976; Mandelbrot, 1967, 1982). That is to say that the length of a coastline or other geographical curve can become infinite as measurement is carried out at larger and larger scales. A mountain-pediment junction or a contour line along a mountain front is similar to a coastline in this respect. Mandelbrot (1982) has developed the mathematical theory behind determining the length of coastlines. Coastlines can be characterized by a number which has certain fractional properties.

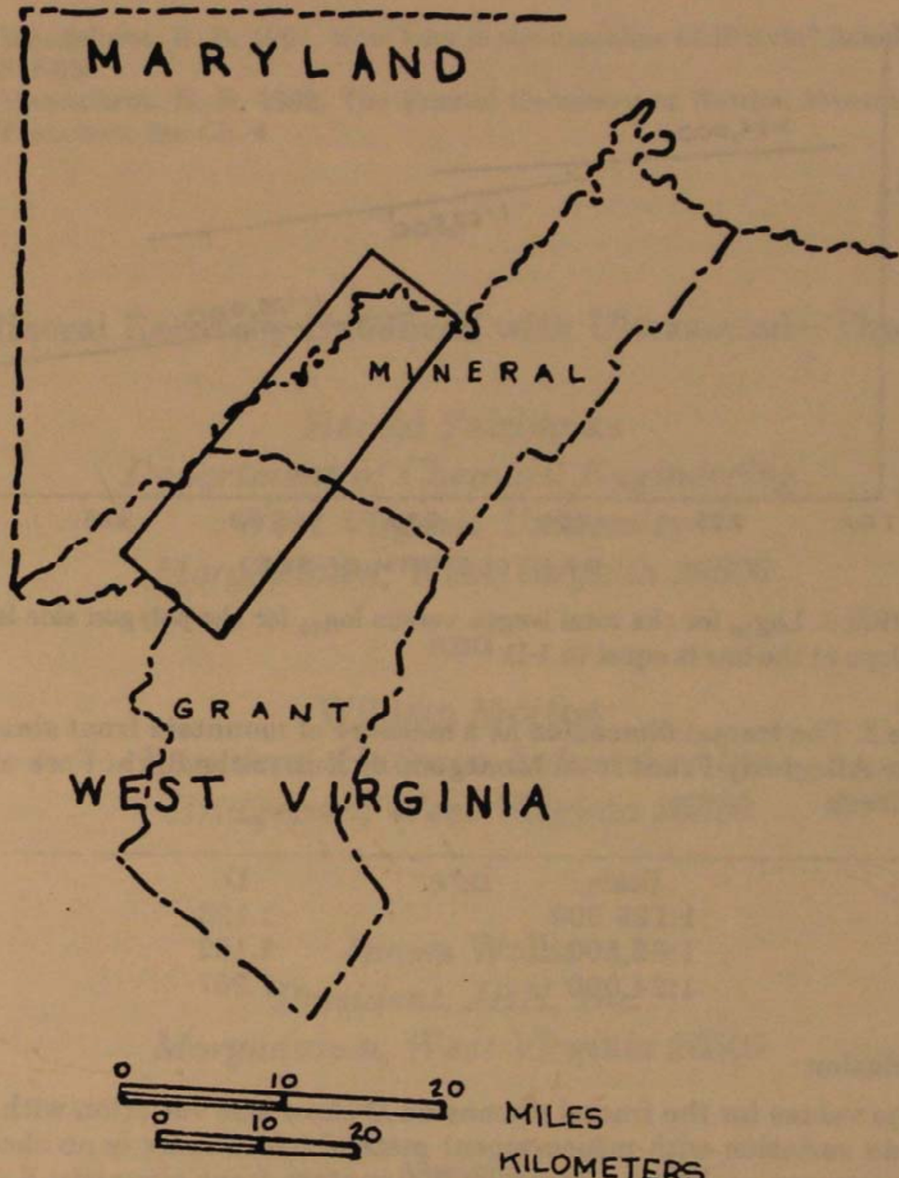

FIGURE 1. Location map. The study area is outlined.

He has coined the term "fractal" to describe such a number. Richardson developed but never really explored a promising practical application of fractals for this purpose (Mandelbrot, 1967). The length of a coastline, frontier, or any similar, non-rectifiable curve is stepped off using dividers set at several settings. This is the equivalent of the mathematical technique of replacing the coastline by a sequence of polygons. The divider represents a side of the polygon. The common logarithm of the total length is plotted versus the common logarithm of the polygon side length. This plot is a straight line of negative slope (Figure 2). Mandelbrot (1982) interprets the slope of this line as an approximation of 1-D where D is the fractal dimension. Values of D for the Allegheny Front are shown in Table 2.

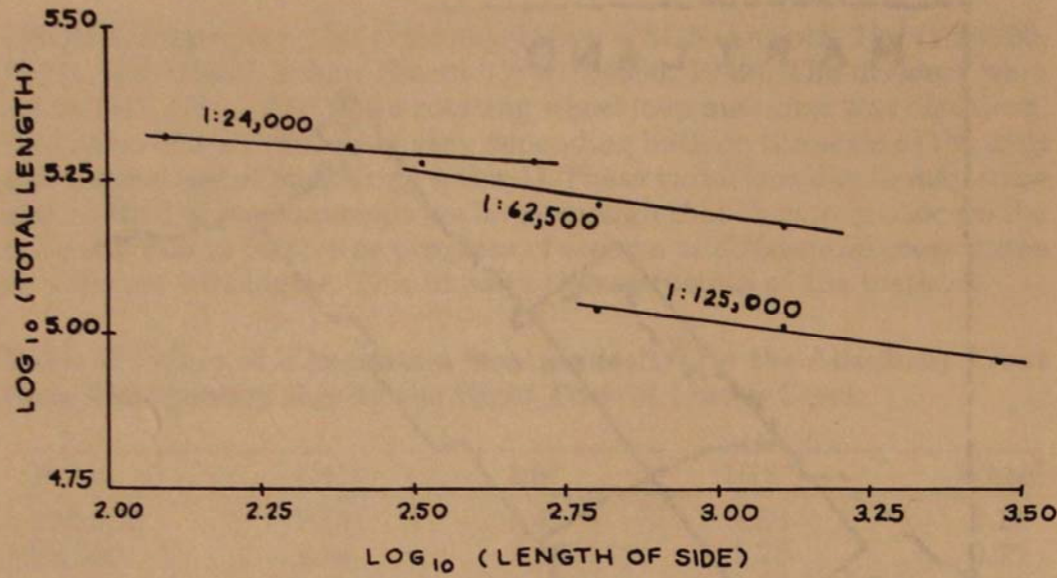

FIGURE 2. $\log_{10}$ for the total length versus $\log_{10}$ for the polygon side length. The slope of the line is equal to 1-D.

Table 2. The fractal dimension as a measure of mountain front sinuosity on the Allegheny Front from Montgomery Run to the Right Fork of Linton Creek

Scale	D
1:125,000	1.123
1:62,500	1.162
1:24,000	1.067

Conclusion

The values for the fractal dimension D show less variation with scale and no variation with measurement method (since there is no choice of measurement scale) than measuring mountain front sinuosity S in the manner of Bull and McFadden. A useful quantitative method of measuring the progress of erosion can thus be made more precise and can be meaningfully compared with measurements made on maps of a different scale.

Fractals offer a means of characterizing the length of non-rectifiable curves such as a coastline, river length or contour line; they eliminate the scale dependence of direct measurements. Richardson's method offers a simple, inexpensive if tedious way of finding the fractional dimension.

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Mineral Recovery Enhanced with Ultrasound—Theory

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Abstract

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 used 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, 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.

Theory

With sufficient intensity of ultrasound a liquid can be made to cavitate.[1] Dissolved air in the liquid may act as cavitation nuclei as can the vapor of the liquid itself. Surfaces of solids submerged in the liquid cause attenuation of the sound energy at the liquid-solid interfaces, thereby promoting cavitation at the surface of the solid. Imperfections and crevices on the surface can promote cavitation. Also solid particles stuck together can promote cavitation near the point of contact.

Cavitation is the production of very small, low pressure vapor bubbles in liquid caused by the expansion cycle of the sound-wave passing through the liquid. During the compression cycle of the sound-wave, the small bubbles collapse expending great force.[2]

The collapse of the small bubbles flushes the solid surface with the surrounding liquid. This attempts to separate particles from each other and cleans out material from crevices and surfaces. Millions of bubbles are produced and collapsed during each frequency cycle of the sound-wave passing through the liquid. The frequency generally used for ultrasonic cleaning is between 20,000 and 60,000 cycles per second. Because of this, the deagglomeration and cleaning of solid interfacial surfaces can be very rapid.

To go into more detail, particles may have a thin film on their surfaces. This type of surface can absorb a relatively large amount of water which may form a gel with the surface film material. This water gel encasement produces a slippery surface. Hence, the particles can slide over each other more easily than normal, preventing good compaction.

When the particles have been ultrasonically treated, the film on the particle surface is removed and a thinner layer of water adheres to the cleaned particle surface. This water layer tends to follow more closely the outline of the particle's shape as shown in Figure 1. The irregularities of the particle's shape will tend to interlock more easily with adjacent particles; thereby, increasing the compaction strength of the material.

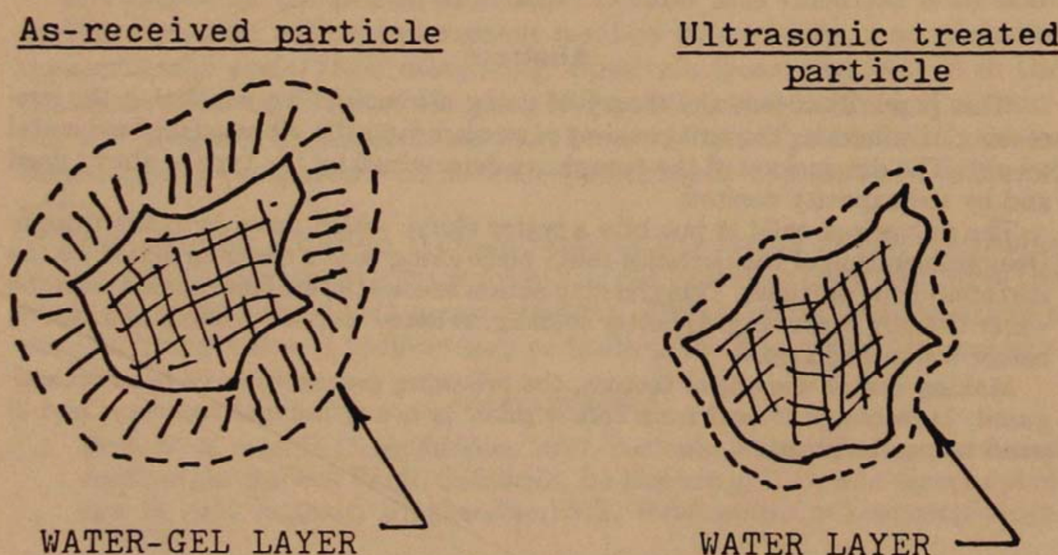

FIGURE 1.

Also the ultrasonically treated particles will be nearer their own true density and will settle in calm water at a rate which follows Stoke's law.

Applications

Settling and Compaction:

The technique for making use of the ultrasonic processor for enhancing the settling and compaction of fine materials may be outlined as follows:

1. A water slurry of the fly ash, tailings, or other fine material is run over the ultrasonic processor.

2. From the ultrasonic processor the slurry is run into a pond, mine shaft, valley or other areas where needed.

It has been visually observed that the settling rate in ponds for ultrasonically treated materials increased five to ten times. Laboratory tests on compaction of the fines have shown that ultrasonic treatment of the slurries improved the densification and settling process for the slurried deposits.[3]

Coal Separation:

Coal washer refuse contains normally over 25% coal. The remaining material consists mainly of soft shale and clay with some sulphur as iron pyrite. The recovery process using the ultrasonic processor may be briefly outlined as follows:

1. The refuse material is either screened through 1/4" to 1/2", or first crushed and screened.

2. A water slurry is made with the crushed and screened material which is passed over the ultrasonic processing trough and into a separation tank.

3. The lighter coal floats and is recovered from the top while the heavier unwanted material sinks to the bottom and is removed.

4. The coal is then washed and passed over a dewatering screen into storage.

The use of the ultrasonic processor produces a much cleaner coal product than other systems. The BTU of the coal is increased and the retained water content is decreased when compared to other recovery systems used. Also the clay refuse which is removed from the coal settles much faster and forms a more compact mass in the settling pond.

Heavy Mineral Separations:

This process may be outlined as follows:

1. The raw ore is crushed to a fine enough size to make it physically possible to separate the wanted material from the unwanted material.

2. A water slurry of the fine ore is made which is run over the ultrasonic processor.

3. From the ultrasonic processor the slurry goes into a separation process for removal of the wanted minerals from the unwanted material. In this case the mineral is heavy and settles while the lighter clay and silicious material goes off with the water.

Again the ultrasonic processor cleans the particles, thereby increasing the settling rate of the wanted materials. Also, the fine clay and silicious material are found to settle in the pond faster which produces cleaner recycle water for the process.

Pond Water Clarification:

Stagnant ponds may contain gelatinous material which may stabilize the small inorganic particles as shown in Figure 1. Ultrasound will disintegrate and separate the water-gel layer from the inorganic particles, thereby aiding the water clarification by more rapid settling at particles.

The processing may be stated as follows:

1. The water is passed over the ultrasound processing trough into a settling pond. The ultrasound breaks up the slimes and gelatinous material, and also disintegrates the organic materials such as algae, bacteria, etc.

2. The water from the settling pond may be used as drinking water for livestock, irrigation, process water for mineral separation, and manufacturing processing or treated by standard procedures for other uses.

Figure 2 shows a general flow diagram for the application of the ultrasonic processor. Figure 3 shows a photograph of one type of ultrasonic processor.

Conclusion

The rapid ultrasonic cleaning of fine material in a slurry by an ultrasonic processor is capable of greatly enhancing the mineral recovery processes and pond water clarification.

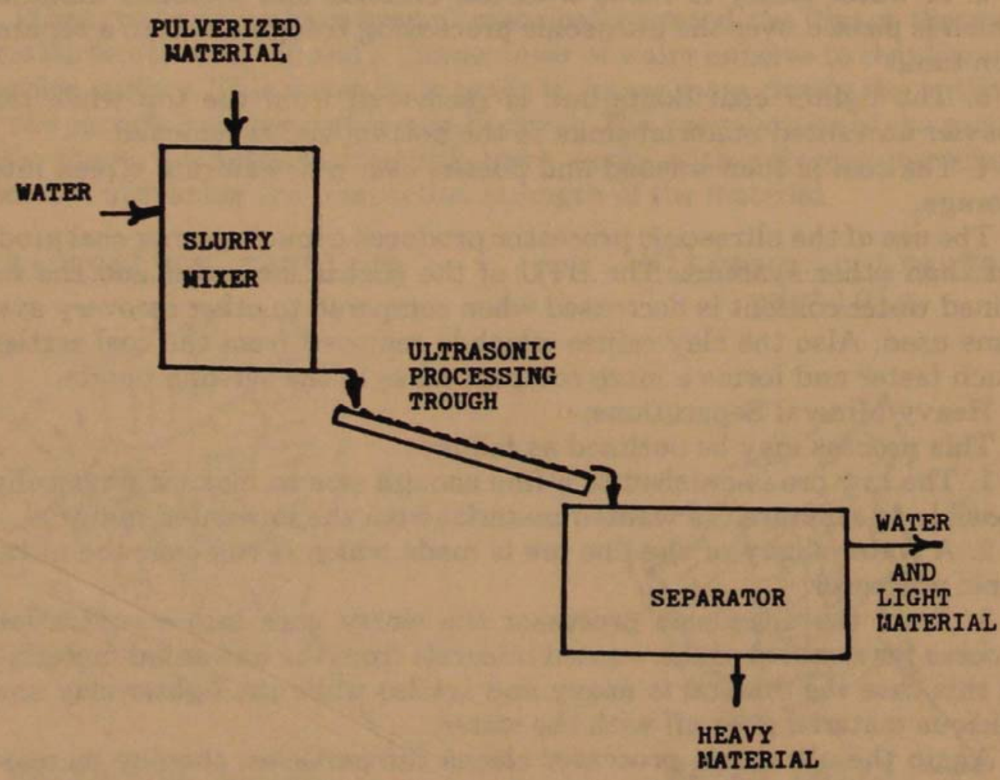

FIGURE 2.

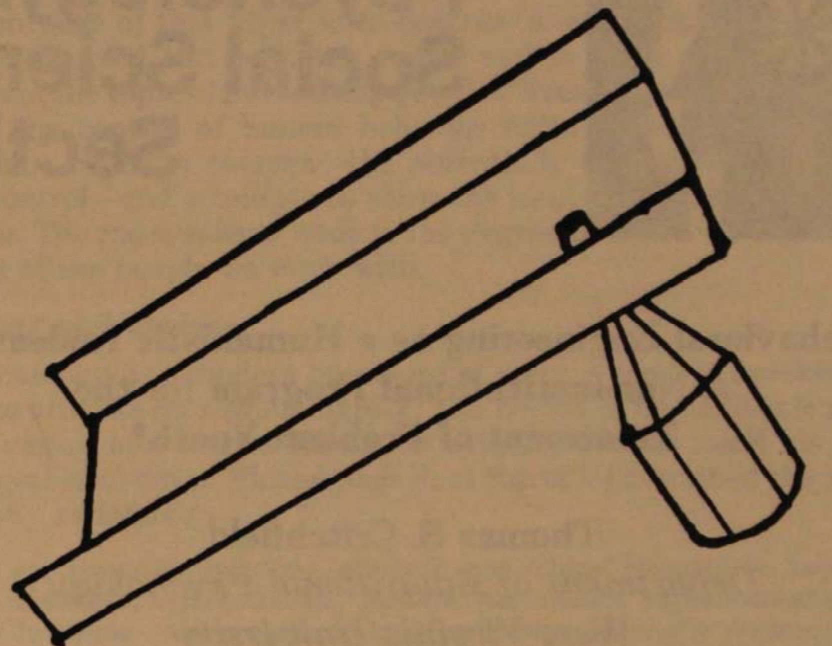

FIGURE 3.

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Psychology/ Social Science Section

Behavioral Engineering as a Humanistic Endeavor: A Non-institutional Program for the Treatment of Problem Youth*

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Abstract

Behavior control is often thought of as antithetical to Humanistic goals, but failing to harness known principles of behavior compromises human potential as much as does controlling punitively. An alternative is to control positively, as the youth treatment program described illustrates. The Pressley Ridge Youth Development Extension, or PRYDE, uses behavioral engineering techniques to produce success-oriented and independent behavior in troubled-youth. To the extent that it contributes to the happiness and autonomy of the individuals it serves, PRYDE is offered as an example of behavioral engineering as a Humanistic endeavor.

*This paper is dedicated to the PRYDE Treatment Parents who, by excelling in an impossible job, showed us Humanistic ideals in action. We also gratefully acknowledge the contributions to this paper of Pamela Meadowcroft, PRYDE Director; R. P. Hawkins, Consultant to PRYDE; W. C. Luster, Executive Director of Pressley Ridge School; and the PRYDE staff with whom we have been fortunate enough to work.

For more information about PRYDE contact Pamela Meadowcroft, PRYDE Director, Pressley Ridge School, 530 Marshall Ave., Pittsburgh, PA 15214.

Humanism and "Behavioral Engineering"

The purpose of this paper is to describe a successful treatment program for troubled and troubling youth, and to make a point along the way. When the topic of influencing peoples' lives arises, philosophical regarding the control of human behavior often follow. This paper addresses one common concern—the potentially damaging nature of behavior control—and attempts to show the issue of control to be an artificial one. The more salient issue is the degree to which we can enhance the lives of the people we work with.

Conflicting philosophies

"Humanism" is a modern buzzword of sorts, a concept invoked in response to affronts on human dignity. The notion of humanism is appealing but vague, and what a Humanist actually *does* to merit his title is not altogether obvious. Philosopher Paul Kurtz [8] described the general philosophy as follows:

> There are scientific, religious, atheistic and ethical Humanists. Indeed, many Marxists, existentialists, liberals, naturalists, experimentalists—even Christians—today claim to be Humanists. All loudly declare that they are *for man,* that they wish to actualize human potential, enhance human experience and contribute to happiness, social justice, democracy and a peaceful world. All say that they are opposed to authoritarian or totalitarian forces that dehumanize man. All profess compassion for human suffering and commitment to the unity of mankind (p. 6.)

To be a Humanist, then, by Kurtz' definition, is to be *for man.* A Humanist has at heart the best interests of the person as individual, and of society as a whole, and conceives those interests to be one and the same.

Behaviorism is often trotted out as the antithesis of Humanism. Behaviorism assumes that behavior, like all natural phenomena, is a function of past and ongoing environmental influences—that is, it is controlled from without. The study of behavior from this perspective has produced powerful strategies for arranging environmental influences to alter behavior—strategies which might be lumped together as efforts in *behavioral engineering* [5]. The effectiveness of such techniques arouses concern: Carl Rogers has compared modern human behavior control to the frightening world of George Orwell's *1984* [11]. Rogers warned that development of behavior-control technology was dangerous because of the potential for abuse it introduced into human affairs.

The inevitability of control

Concerns like Rogers' may be viewed as well-intentioned but naive. If objections to behavioral engineering aim to prevent abuses, they add nothing to the status quo. Tyranny has rarely been considered a virtue, yet even before a science of behavior control devious and enterprising people have found ways to swindle and persecute. If objections aim instead to entirely prevent behavior control, that goal conflicts with another Humanistic ideal, reason. A wealth of data from human and infrahuman research demonstrates that behavior changes systematically as a function of its environment context. Environment either accounts for most human behavior or acts in concert with cognitive and biological influences, but no third option, which denies behavior-environment functional relations, is currently plausible. One can't simply ignore controlling relations and expect them to go away.

The threat perceived by Rogers is not, as Rogers supposed, the unique byproduct of applying science to human behavior. Behavior control, either planful or haphazard, has existed as long as there has been behavior, and experimental psychologists did not invent behavior control any more than physicists invented radioactivity. Both the threat and potential of behavior control, like that of radioactivity, lie in how it is harnessed. Thus society is faced with choices. A decision to avoid influencing others would not eliminate the distasteful notion of control; it would simply abandon people to the whims of an uncaring and disorderly world [9]. A decision to control punitively—through intimidation and fear—is a second option and what Rogers perhaps feared most. This approach, as often employed by governments, controls for the benefit of the controller rather than the individual who is controlled. Neither option appears compatible with the Humanisitic ideal of being *for man,* for the best interests of the individual.

As a third and preferable alternative, then, one could decide to control, planfully and positively, to the limits of scientific knowledge about behavior. The field of Applied Behavior Analysis [1] has chosen this last approach and, as the following example will illustrate, accomplishes through it a broad range of Humanistic ideals. The program described below strives to actualize human potential and contribute to human happiness—with children who have little of either—by harnessing the built-in relations between behavior and environmental context. The program owes its roots to Behaviorism, but its outcome speaks to Humanistic ideals.

An Example of Behavioral Engineering

The PRYDE Program

The Pressley Ridge Youth Development Extension, or PRYDE, was designed in 1981 as an experimental program with the goal of providing institutional-intensity treatment in a nonrestrictive setting [2]. The program has offices in Pittsburgh and Sewickley, PA, and Clarksburg, WV. A fourth office opens in Southern West Virginia in 1987.

The youths PRYDE serves, most of them aged 8-17, exhibit a variety of behavioral and emotional problems. Most are aggressive toward others; some vandalize and break laws. Some are depressed or sexually deviant or have been physically or sexually abused. Most are unmanageable at home or in school and in the community. Figure 1 shows the percentage of PRYDE youth who are referred for some common problems.

Because of the severity and complexity of their problems, many PRYDE youths would traditionally be institutionalized, and many have been prior to entering the program. PRYDE places these children in the

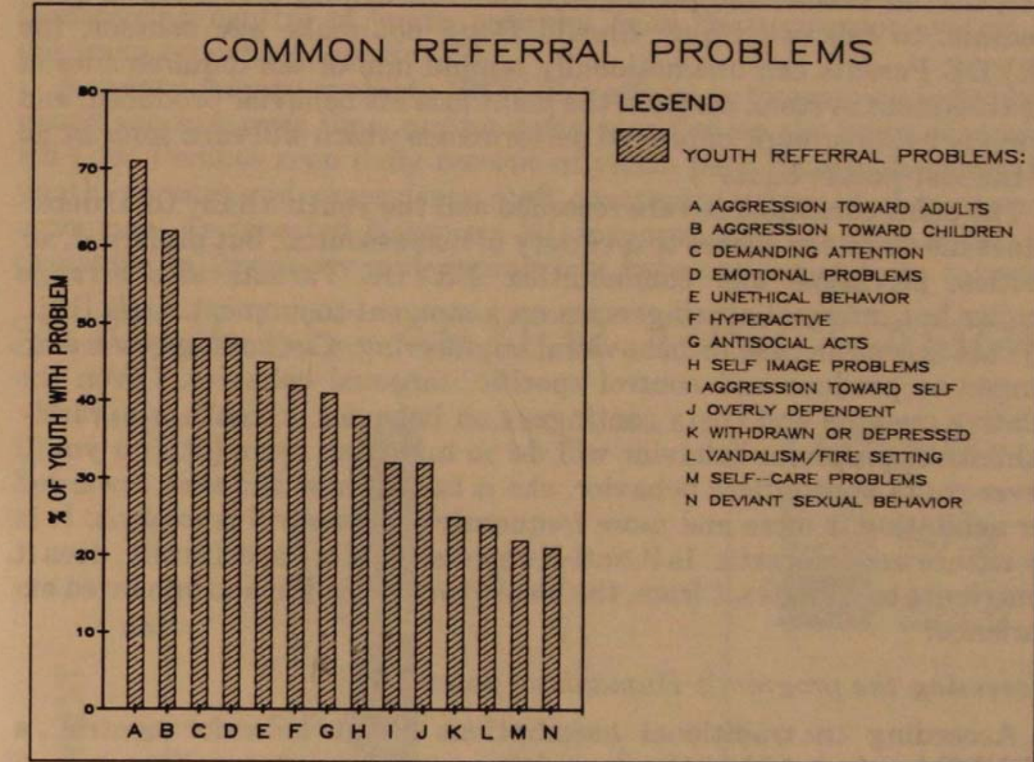

FIGURE 1. Common referral problems of PRYDE youth. Data adapted from Hawkins et al. (1985).

homes of private couples who have been recruited from the community and specially trained to take on the treatment challenge these children represent. PRYDE teaches these "treatment parents" skills in behavior management, basic counseling and communication. With the help of a masters-level supervisor, treatment parents implement a highly-structured treatment plan essentially during all waking hours. Thus, though the setting might be called "normal" or "minimally restrictive," the treatment is intensive and at times intrusive [3]. It is specifically designed to change youth-behavior toward pre-specified goals.

Behavioral engineering in PRYDE

An integral part of each youth treatment plan is an individualized point economy system. This incentive-based "motivation system" specifies 10 to 40 appropriate and inappropriate behaviors relevant to the youth's referral problems, and specifies their consequences in terms of points. The treatment parents (also called PRYDE Parents) reward or punish instances of youth behavior, as prescribed by the motivation system, with point losses and gains. For example, the system may specify that 12-year-old Doug, who is working on his interpersonal interactions, make eye contact when he converses with an adult. When Doug makes eye contact, his PRYDE Parents can carry on a normal conversation, with all its built-in social reinforcers for both parents and child, and add, almost as an afterthought, that Doug did a nice job making eye contact, that he earned 100 points, and that the eye contact made it quite pleasant to talk with him. Should Doug not make eye contact, the PRYDE Parents can unemotionally remind him of the requirements of his treatment system, mention the point loss his behavior produced, and in many cases prompt improved performance which will earn some or all of the lost points back.

The point consequences are recorded and the youth's daily total determines his degree of access to a variety of non-essential, but preferred, activities, privileges and commodities. PRYDE Parents also arrange similar but informal contingencies on a moment-to-moment basis [10].

This is a clear case of behavioral engineering. Circumstances are arranged to produce and control specific, targeted behavior. Given the relative rewards and costs contingent on behavior, a youth who rarely exhibits appropriate behavior will do so more and more [6]. If a youth never emits appropriate behavior, she is taught how and then rewarded for exhibiting it more and more frequently. The control is explicit. It is by nature undemocratic. Is it anti-Humanistic? More specifically, does it contribute to, or detract from, the ideal of actualization and enhanced experience?

Assessing the program's Humanistic potential

According to traditional assumptions about behavior control, a PRYDE home should be the most dehumanizing of places. Yet what occurs in a PRYDE home looks more like actualization than dehumanization. Four types of evidence support this conclusion.

First, the types of goals selected for the youth, and represented as target behavior on the point economy, are individually selected to make the youth successful rather than simply less disruptive to others—an important distinction [13]. In fact, all youths participate in the selection of their own goals. Table 1 lists a small sample of behaviors for which PRYDE youths have earned points. Clearly these goals have been selected for the person, and they have been carefully worded to emphasize the positive. In addition, as youths respond to treatment, the treat-

Table 1. Examples of Daily Point Economy Behaviors Selected "for the Youth" Rather Than for the Convenience of Authority Figures

1. Accepts praise politely.
2. Initiates negotiation to a problem.
3. Says something good about herself.
4. Initiates an activity with a member of the family.
5. Requests instruction.
6. Invites a friend to the house.
7. Has an "opinion talk": As someone's opinion on an issue, expresses his own, and discusses how and why the two may be different.
8. Expresses a feeling and discusses its causes or any necessary course of action to be taken.

ment program is adapted to teach independence and self-sufficiency—transferring control of youth behavior from the treatment system to naturally-occurring payoffs [12].

A second way to evaluate PRYDE's effects is to examine individual youth success, over time, on the goals specified on the point economy. PRYDE Parents keep daily records of youth performance, keeping the youth, parents and supervisory staff constantly informed of treatment outcomes. As reported elsewhere [4], inappropriate behavior generally decreases in frequency and appropriate behavior expands to take its

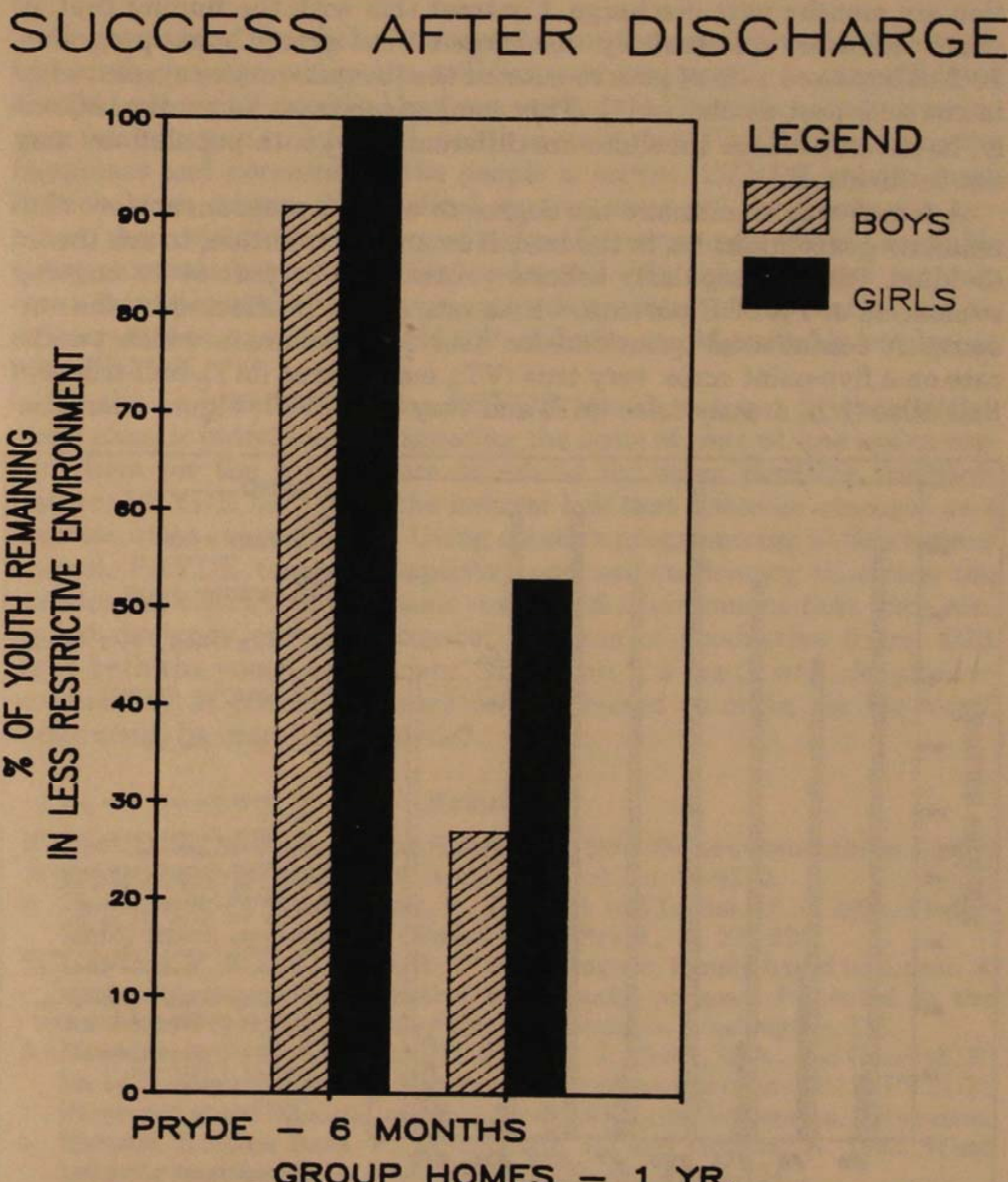

FIGURE 2. Percentage of youth who maintain success after discharge: PRYDE six-month follow-up vs. one-year follow-up of youths treated in group homes (latter data from Kirigin et al., 1982).

place. When the treatment is ineffective the data prompt swift revision of approach in search of better-defined goals or more effective motivating consequences. In any event, the length of a youth's stay in the program is greatly influenced by the success data: Once goals have been mastered the youth can be discharged to a more normal setting.

Thus a third way to evaluate PRYDE would be the extent to which it contributes to youth success upon discharge. In 1984, of 16 youths discharged from the program, 13, or 82%, returned to their biological families or to an independent living situation. Of 28 youths successfully discharged since 1982, only one had been placed into treatment or detention six months past discharge. Contrast this with the finding that, of youth offenders successfully discharged from group home programs, 73% of boys and 47% of girls re-entered the juvenile justice system within one year post-discharge [7]. (This comparison must be made cautiously, however, because timelines are different and youth populations may not be identical.)

A fourth way to measure the degree to which a program achieves humanistic goals might be, in the best Humanistic tradition, to ask the individual. PRYDE regularly solicits youth input as part of its ongoing evaluation of PRYDE parents, whose rate of pay is affected by the outcome. A confidential questionnaire lists 25 statements which youths rate on a five-point scale: very true (VT), mostly true (MT), half-true and half false (1/2), mostly false (MF) and very false (VF). Figure 3 summa-

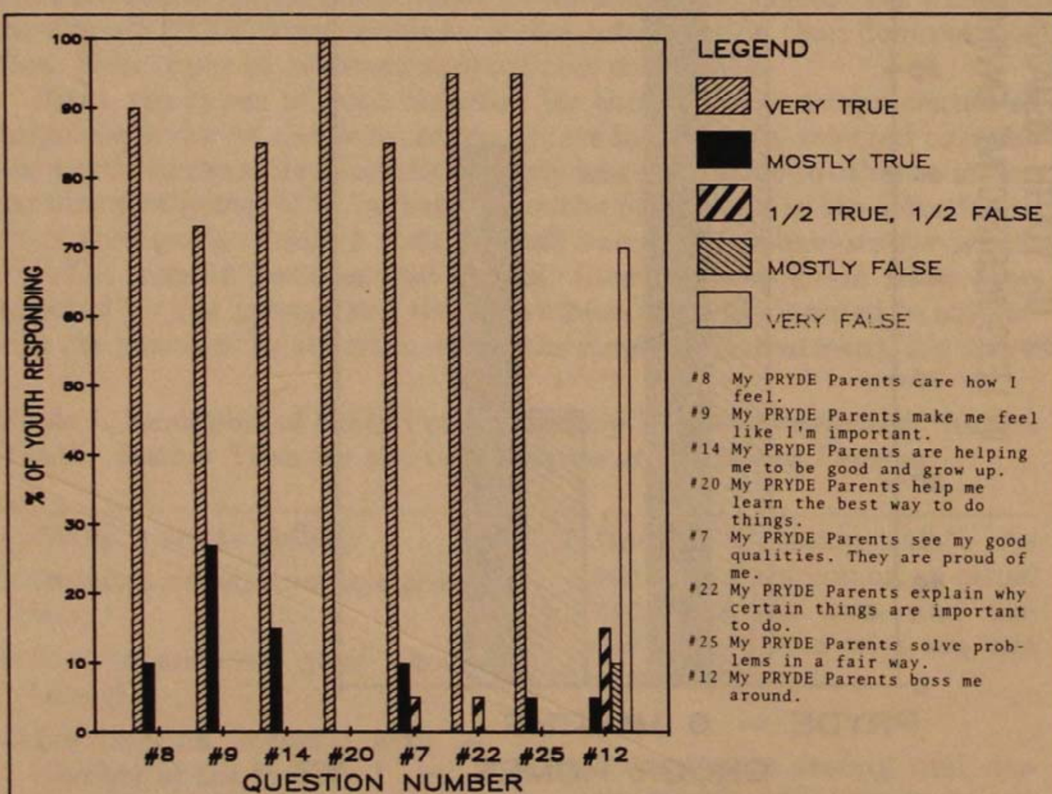

FIGURE 3. Responses to selected program evaluation items by the first 20 youths to participate in the evaluation.

rizes responses to some questions relevant to the current discussion. For the most part, PRYDE youths appear to believe that the goals they work on are in their best interest; that the people controlling the system do so in the interest of the youth rather than for adult convenience; and that the treatment is implemented in a caring fashion. These data may be all the more impressive given that PRYDE youths tend to enter the program showing little evidence of concern for socially-important goals or for quality interpersonal relations.

Conclusions

Though alarm over behavior control is understandable on a philosophical level, perhaps where the well-being of real people is concerned we should be less philosophical and more practical. This has been only a cursory introduction to PRYDE, yet it is clear that PRYDE increases the happiness and potential of the people it serves. PYRDE youths learn first to work within the artifical system arranged for treatment purposes, then within the system of naturally-occurring rewards available for appropriate behavior in the "real world." In this way they not only serve themselves, they may even, someday, contribute to "social justice, democracy and a peaceful world." Paul Kurtz would probably be pleased with PRYDE.

All this is possible because PRYDE has chosen not to abandon already chaotic individuals by ignoring the issue of control, and not to control them for the convenience of adults by using punitive methods. Rather, PRYDE harnesses the natural law that behavior changes as a function of its consequences. Using creative programming of this type of control, PRYDE teaches adaptivity and self-sufficiency to create the paradoxical effect that the same real-world environment that once controlled deviancy comes to control patterns of productive living that serve both the youth and society. The result is a youth who, despite the inevitability of control, appears self-motivated to make his life work. What could be more Humanistic?

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Youth Services: Ten Years of a Unique Academic Discipline at West Virginia Wesleyan College

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Abstract

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 the third triennial survey mailed to graduates in October, 1983.

Introduction

The Youth Services major was created in 1974 and 1975 in consultation with staff members of the Menninger Foundation in Topeka, KS, and the Merrill Palmer Institute in Detroit, MI. The program is designed to prepare students who wish to work with troubled children and youths. It is an interdisciplinary major requiring work in Sociology, Government, and Psychology. In the junior year students participate in an urban semester in Columbus, Ohio, and in the senior year they serve one semester in an internship in a youth serving agency.

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 (Whittaker, 1979). Perhaps the Youth Services major at West Virginia Wesleyan College is an important step in that direction.

Methods and Materials

A questionnaire was prepared and mailed to 67 (all for whom a current address was available) persons who graduated from West Virginia Wesleyan College with a major in Youth Services between the years 1976 and 1983. The questionnaires were mailed in October, 1983, and 25 were returned between November, 1983, and May, 1984. Questionnaires requested that graduates evaluate the contents of the youth services major, the classes, the urban semester, and the internship. They also asked the students why they chose the major, what kind of job they obtained upon graduation, their level of job satisfaction, salary, hours, and working conditions, whether they were currently attending graduate school or were planning to do so, and what changes they would recommend in the program.

Limitations of space forbid the publication of all data obtained by the survey, but major findings are reported below. Complete results are available from the authors.

Results

A. Entry into the program.

1. Did you come to WVWC because you knew about the YS major?
   - Yes (2)
   - No (20)
   - No reply (3)
2. Did you change your major from something else?
   - Yes (17)
   - No (3)
   - No reply (5)

3. Why did you change your major?
   It focused on youth (2). I wanted to work with troubled youth (2). Greater employment potential (2). It was better than sociology. I was better able to meet my goals. The quality of the program. Greater growth potential. It offered experience.
4. If there had not been a YS major at WVWC,
   I would have stayed at WVWC. (13)
   I would have gone elsewhere (3)
   No reply (9)

B. The Urban Semester

5. How do you evaluate the Urban Semester? (Selected responses.) I loved the whole experience. It helped me grow in so many ways—meeting people, getting along with different people, exploring possible jobs, seeing a different way of life. It was the most rewarding experience of the entire four years. Columbus was one of the best, practical, experiences that I ever encountered. It taught me so much about myself, my capabilities. Good experience! Very good professors. There needs to be better contact between the director and the placements. There should be an evaluation form for the employer of the student. I feel I learned more from this experience and my internship than any other classes. It was a time of personal growth and searching for career options and goals. A very worthwhile experience! It was a great and worthwhile experience. Necessary!

C. The Internship

6. Did the internship provide you with the kinds of experiences you needed as a YS major?
   Yes (18)
   No (2)
   No reply (5)
7. Did you receive enough guidance from your field supervisor?
   Yes (16)
   No (4)
   No reply (5)
8. Did you receive enough guidance from your faculty advisor?
   Yes (15)
   No (5)
   No reply (5)
9. Selected comments on internship:
   Excellent experience (3)! An educational experience and also cultural and personal growth. Counselors were "burned out"—affecting the quality of the experience. I got my first job through my internship! Needs to be more formalized as far as the supervisor goes. Great experience, but it didn't help me get a job. It could have been more restricted to youth. I would have liked to have had more of the "hands on" experiences. I found that your relationship with your supervisor can be a big influence on how much you get out of the internship. I would have appreciated more contact with my faculty advisor.

D. Career after Graduation

10. Did you have a job "lined up" before graduation?
    Yes (12)
    No (11)
    No reply (2)
    If "yes," was it a youth-serving job?
    Yes (10)
    No (2)
11. If you did not have a job lined up, how many months were you unemployed before you got a job?
    Average = 3.4 months (N = 9).
12. How long did you have to wait after graduation until you obtained a job in the youth services field?
    Average = 6.6 months (N = 6).
13. How long have you been employed in a youth-serving (or other human-serving) agency?
    Average = 3.5 years (N = 16).

E. Graduate School

14. Are you presently enrolled in graduate school?
    Yes (8)
    No (12)
    No reply (3)
15. Have you completed a graduate degree?
    Yes (1)
16. Do you think the YS major properly prepared you for graduate school (for those now or in the past in graduate school)?
    Yes (8)
    No (1)
17. Evaluate the preparation for graduate school which you received through your major in Youth Services. Rate on a scale of 1 (low) to 5 (high):
    Rating = 4.05 average (N = 9)
18. How could the YS major better prepare students for graduate school? (Selected reponses.)
    More statistical research courses. Help us to know what is available. It is a good preparation for graduate school. Write more major papers. The focus is a little narrow—needs to offer experiences with broad base of age groups. Should have had more written assignments on topics of specific subjects.
19. If you have been employed in a non-human services field, what types of employment have you had?
    Organist, fast food worker, bank worker, salesperson, receptionist, oil and gas industry, office manager.
20. Was the YS major helpful to other jobs? (Selected responses.)
    YS is useful with troubled as well as normal people. Counseling techniques are applicable to the elderly population. BA helped, it could have been in anything. Helpful in dealing with others. I applied for many interesting jobs and those within my reach. I only got the one

in the group home and problems ensued which did not allow me to continue. No employer was impressed with either my college background or internship qualifications even though I had very good recommendations.

21. Have you ever experienced "burn-out" in a youth-serving or human-serving job?
    Yes (13)
    No (7)
    No reply (5)
22. Comment on "burn-out."
    Long hours; understaffed; no help; caused by physical problems; worrying about fellow workers; lack of support; unprofessional atmosphere; staff afraid of the youth; agency was burned out; 24-hr coverage is too much; varying shift work; high expectations; job insecurity; no social life; no way to vent my frustrations; the program was new and had problems and it was too much for my first job.
23. Job title positions held since graduation (respondents listed all jobs held, yielding more jobs [54] than respondents [25]): child care counselor or worker (19); social worker (5); mental health worker (3); school teacher (5); substance abuse counselor (2); family counselor for Youth Services Bureau (1); housewife (1); unemployed (1); other human service job (3); other non-human service job (13).
24. Current Job Responsibilities (some respondents indicated more than one responsibility): direct service (13) supervision or administration (4); case work (8); other (6); not presently involved in youth services work (9).
25. Type of clients served and age group: emotionally disturbed boys; abused, neglected, dependent, court related children; status offenders and delinquents; court referrals, full care elderly; retarded adults; troubled teenage girls; court ordered juveniles with suspended sentences; troubled youth and families; probation and youth services center, mental health referrals.
26. Type of setting (current position): group home (1); child care center (2); residential treatment center (2); mental hospital (2); correctional facility (3); health care center (1); rehabilitation center for retarded adults (1); apartment-based program for troubled girls (1); workshop for handicapped (1); youth services bureau (1); specialized foster care program (1); adolescent day treatment program (1); detention center (1); other (4).
27. Selected additional comments on present job.
    A great job experience; I have learned to deal with agencies, schools, and caseworkers; it is a shame I could not find a job in my major field; I could not do this as a long term job; I can do youth services only as a part time job—I need a good full time job to support myself; I changed to banking because I could not find a youth services job in this area; much of my youth services work can easily be transferred to work with the elderly.
28. Average salary (n = 18).
    a. range = $6,900 (plus room and board) to $19,000
    (seven had salaries between $13,000 and $19,000)

b. mean = $11,725
c. median = $11,000

29. Number of hours worked per week:
    a. range = 15 (pt) to 96 (4 days live-in per week)
    b. mean = 45
30. Degree of satisfaction in your work:
    Very satisfied (10)
    Moderately satisfied (7)
    Dissatisfied: (1) (respondent could not find YS job)
    No reply (7)

E. Additional Suggestions

31. Comments on improving the Youth Services major: (of 19 specific suggestions, nine are listed here): a. Professors should have more clinical training; b. internship should be much more closely monitored; c. we need more of a business background; d. the most valuable experience was the urban semester; e. I believe the program is tops in our field; f. I would like to see a graduate program (in YS) at Wesleyan; g. we need a course on documentation (i.e., ways to write goals/plans, in the prescribed jargon of the "state"); h. writing skills in assessing problems and case studies; i. more preparation for upward mobility in system.

Discussion

The Youth Services major was created at West Virginia Wesleyan College to serve three purposes: a) to provide a more direct means than the traditional sociology major for entering a human service field; b) to provide a sound educational base for those working with troubled children; c) to provide an experiment in education for human services professions. The authors believe that the program has been successful in all three regards.

Alumni responding to the survey indicate a high degree of satisfaction with the program and with the jobs they have entered upon graduation. The program has not, however, had a significant impact upon enrollment at the college.

The directors (authors) of the Youth Services program have attempted to keep in touch with graduates to elicit their suggestions from the field. Because the program is unique in academia, there are no models to follow, and it is especially important to hear feedback from alums.

Several questions were answered which could not be treated here, particularly those regarding specific courses. Those responses have been considered in the continual development of the program.

It is hoped that this program may someday be a model for others who wish to provide better education for persons wishing to provide direct services to troubled children, and this paper is presented to that end.

Literature Cited

1. Whittaker, James. 1979. Caring for troubled children: residential treatment in a community context. San Francisco, CA. Jossey-Bass.

The Minutes of the Annual Business Meeting
West Virginia Academy of Science
60th Annual Meeting
Hunt-Haught Hall
Fairmont State College
Fairmont, West Virginia

April 13, 1985

The meeting was called to order by President Tom Pauley.

Dr. Wendell Hardway, President of Fairmont State College, welcomed the West Virginia Academy of Sciences to Fairmont State and reminded us that he was once a dues paying member.

President Pauley recognized the Fairmont hosts and hostess for the meetings and soon to be new president William Kuryla.

Minutes of the 1984 Business Meeting were distributed and on the motion of Dr. Swiger, as seconded, the minutes were approved.

The Treasurer's report was read by Dr. Clarkson and also distributed. Approved. Copy attached. Note: The Treasurer's report was audited by Drs. Guthrie, Blaydes, and Keller.

The nominating committee nominated Dr. Ralph Taylor of Marshall University to be President-Elect. There were no other nominations from floor. Dr. Taylor was elected unanimously.

A date for the 1986 meeting had not yet been set. The meeting will be held at Marshall University.

Dr. Swiger made note of members who died during the past year. A moment of silence was observed in memory of:
Elizabeth Ann Bartholomew (WVU Biology)
Earl L. Core (WVU Biology)
Robert Birch (WVU Biology)
A. H. VanLandingham (WVU Extension Service)
Walter Taylor (WVU Engineering)

A reminder was given that Newsletter items should be sent to Dr. Karl Fezer of Concord College.

WV Wesleyan would like to pass the Junior Academy of Sciences—Science Fair on to some other institution. Consideration will be given to a permanent home instead of moving from year to year.

Dr. Kuryla moved that the Academy send a letter of thanks and appreciation to Dr. Wolfe at Wesleyan who has directed the Science Fair for the past 16 years. Motion passed unanimously.

Katherine Gregg moved that the Academy consider the page charge for publications in the Proceedings. Motion passed unanimously.

Meeting adjourned.

WEST VIRGINIA ACADEMY OF SCIENCE
ANNUAL TREASURER'S REPORT
1984

April 13, 1985
WVAS Annual Meeting
Fairmont State College
Fairmont, West Virginia

January 1, 1984 to December 31, 1984

CASH RECEIPTS

Balance on hand January 1, 1984		$ 7,590.12
Dues	$2,410.00	
Institutional Memberships	1,400.00	
Proceedings (Libraries)	1,340.00	
Contributions (Talent Search)	243.00	
Annual Meeting	1,637.00	
Page Charges	301.00	
Interest on Savings	678.79	
Advertisements	75.00	
TOTAL RECEIPTS FOR YEAR	$8,084.79	
TOTAL RECEIPTS & BALANCE ON HAND		$15,674.91

CASH DISBURSEMENTS

Printing (McClain Printing)	$ 830.69	
Contributions (Jr. Acad. Sci.)	$ 750.00	
Annual Meeting	1,384.15	
Postage	184.94	
National Assoc. of Academy of Science (dues)	30.00	
Secretarial Help	23.45	
Miscellaneous	82.41	
Talent Search	34.00	
TOTAL DISBURSEMENTS	$3,319.64	
BALANCE December 31, 1984		$12,355.27*
(Savings—$387.68)		
(Checking—$3,210.99)		
(Certificate of Deposit—$4,000.00)		
(Certificate of Deposit—$4,756.60)		

Respectfully submitted,

Roy B. Clarkson, Treasurer, WVAS

*It must be noted that the printing of Vol. 55 of the Proceedings would ordinarily have been paid during 1984. This balance needs to be reduced by the amount ($4,000.00+) in order to reflect our true financial picture. The Financial Records of WVAS was audited on April 4, 1985, and found to be correct.

The treasurer's report was audited by:

Roland L. Guthrie,
David F. Blaydes, and
E. C. Keller, Jr.