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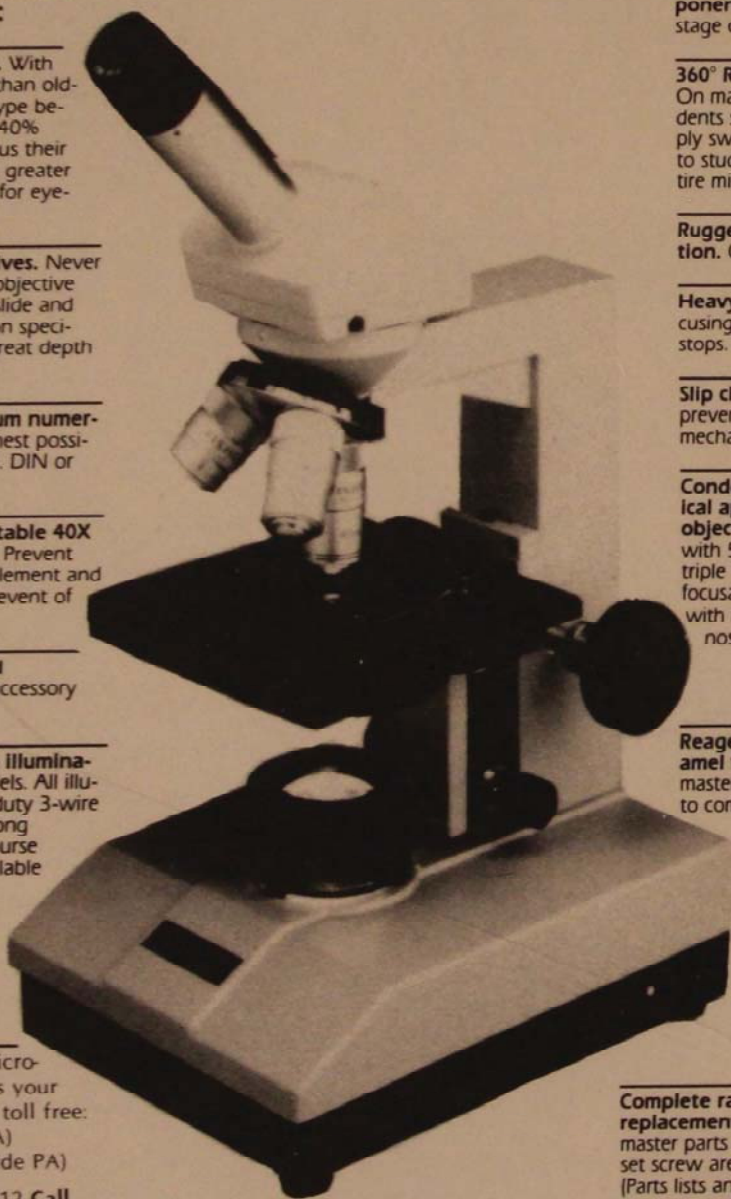
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# Biology Section

## West Virginia County Trends for Cancer Mortality: 1959-1982

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### Abstract

Trends were determined for resident deaths due to general cancer mortality and three major cancer sub-groups viz., respiratory, digestive/peritoneum, and urogenital cancers, by sex, for each West Virginia county. All three sub-groups of cancers were categorized as having increasing, decreasing, or no trends for each of the counties.

In general, there were few trends in female digestive/peritoneal cancers. There were seven counties with increasing trends and four with decreasing trends. The same generalization held for female urogenital cancers, with three counties having increasing trends and one with a decreasing trend. There were no counties with decreasing trends for female respiratory cancer, but 38 percent of the counties were found to have increasing trends. The main clustering of those counties having increasing respiratory cancer trends occurred in the southern coal mining region.

One county had an increasing trend and four had decreasing trends for male digestive/peritoneal cancers. Fifteen percent of the counties showed increasing urogenital cancer trends in male. Only one county had a decreasing trend. Most of the counties with increasing male urogenital cancer trends (8 counties) were found along the eastern banks of the Ohio River. Male respiratory cancer mortality showed increasing trends in 82 percent of the counties. Generally, the counties which showed no trends in male respiratory cancer mortality were in the eastern panhandle and central part of the State. No decreasing trends were observed for male respiratory cancer.

### Introduction

Cancer mortality trends vary according to sex, type of cancer, and the age group of affected individuals. Recently, the age-adjusted mortality rate for all types of cancer in the United States rose from 162.2 to 170.7

per 100,000 individuals, however the mortality rates for non-lung cancers has remained stable (Bailar 1987). Some cancers have shown a decreasing trend. For example, cancers of the digestive system have declined (IARC 1976) especially in persons under the age of 45 (Devesa et al. 1987). In contrast, brain and lung cancers have increased by at least 50% from 1968 to 1978 for persons aged 75 to 84 (Davis et al. 1986; Devesa et al. 1987). An EPA report (Riggan et al. 1983) indicated that total cancer mortality for white males has increased 16 percent between 1950 and 1979 in the U.S. Conversely, the same report revealed that there was a 7 percent total cancer mortality decrease in white females over the same time period. A study by Devesa and Silverman (1976) reported that for white males there was a 39 percent increase in total cancer mortality in the United States from 1933 to 1974. In the same study, a 19.5 percent decrease in total cancer mortality was observed for white females. In contrast to these two reports, Pollack and Horm (1980), reported a 6.3 percent increase in cancer mortality in the U.S. for males and a 0.4 percent increase for females over the ten year period (1969-1979).

With regard to respiratory cancers, Devesa and Silverman (1976) concluded that in the U.S. the incidence of lung cancer mortality had a large increase between 1933 and 1974. They showed that in white females there had been an increase in deaths due to lung cancer since the mid 1950's, up to and including 1974. Pollack and Horm (1980) reported an 18.2 percent increase for white males and a 49.7 percent increase in white female lung cancer mortality for the period 1969 and 1976.

For digestive/peritoneal cancers, Devesa and Silverman (1976), for the years 1935 through 1974 reported that intestinal cancer was the third most frequent site of cancer, with white males having increased mortality rates and white females having no change in rate over that interval. For stomach cancers, Devesa and Silverman (1976) reported decreased mortality in both males and females. Further, they reported that while the rates of morbidity have increased for esophageal cancer, the rate of mortality has been stable for each sex. In support of this study, Pollack and Horm (1980) reported that both morbidity and mortality rates showed a considerable decrease in stomach cancer mortality for each sex over an eight year period (1969-1976). They also reported decreasing trends for both white females and males for intestinal and esophageal cancer.

Concerning urogenital cancer, for the years 1935 through 1974, Devesa and Silverman (1976) reported a decrease in uterine cervical cancer mortality for white females. However, among white males, they reported increases in cancer mortality of the bladder and kidneys.

In West Virginia, total cancer deaths for white males has increased 38 percent during the period 1950 through 1979. Over that same period of time, there was a 3 percent decrease in total cancer mortality for white females (Riggan et al. 1983).

The objectives of this paper are to examine recent West Virginia county mortality cancer trends and to search for geographical clustering. The



results of this study might enable us to identify areas of the state having high cancer rates. Further investigations can then be carried out to determine what unique environmental or other factors might be associated with these areas of high cancer rate mortality.

### Methods

Individual death records were obtained from the West Virginia Department of Health for the years 1959-1982, excluding 1966.<sup>1</sup> From these records, computer plots were generated which showed the number of deaths across the 23-year period for the three major types of cancer across West Virginia counties, by sex. Only the death records of West Virginia residents were used in the study. Evaluations were completed for total cancer mortality and for each of the major cancer subgroups (respiratory, digestive/peritoneal, and urogenital). These major mortality sub-groups are those used in The Manual of the International Statistical Classification of Diseases, Injuries, and Cause of Death (1957, 1967, 1977). Because of the small portion of non-white resident death records in the study, they were included in the study.

Computer-generated plots were examined and each county and sex category was visually classified as having an increasing trend, a decreasing trend, or no trend. Upon checking those counties classified as having good visual trends from 1959 to 1982 it was determined that the change was approximately 30 percent, or greater. Any percentage change equal to or greater than a 30 percent change (coupled with a monotonic increase or decrease of the trend) was then considered to have an increasing or decreasing trend. Plots with less than 30 percent changes (either negative or positive) were considered to have no trend.

After determining the trends for each county, sex, and major category of cancer, the type of trend (positive, negative, or no trend) was plotted by county on West Virginia maps. The maps were then examined for geographical clustering.

Although we recognize that the etiology of the three sub-groups are somewhat dissimilar in certain of these sub-categories, we have chosen to group the data according to the conventions used by the West Virginia Department of Health and the Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death (WHO, 1957, 1967, 1977).

### Results

There was about a 50% increase in total cancer mortality between 1959 and 1982 in West Virginia. A 45.8 percent increase for male cancers (Figure 1) and a 55.3 percent increase for female cancers (Figure 2) was determined.

<sup>1</sup>The 1966 data tape had marriage and divorce data intermixed with the mortality data at the time of data acquisition and could not be used.

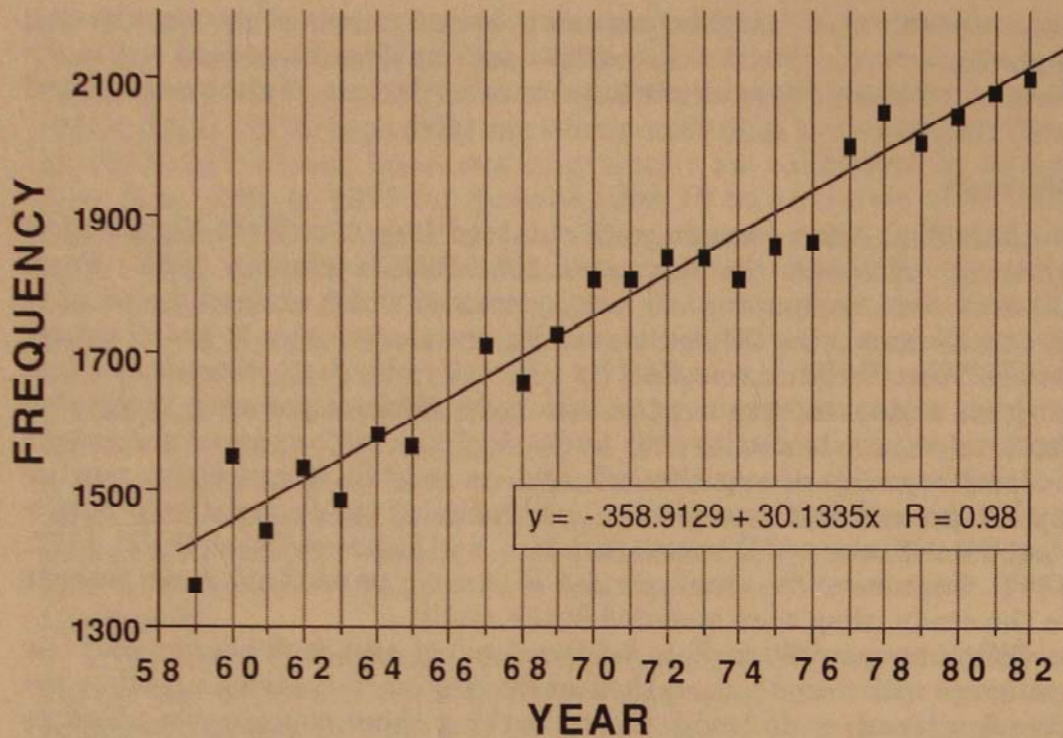


FIGURE 1. Trend of Male Total Cancer Mortality in West Virginia, 1959 through 1982.

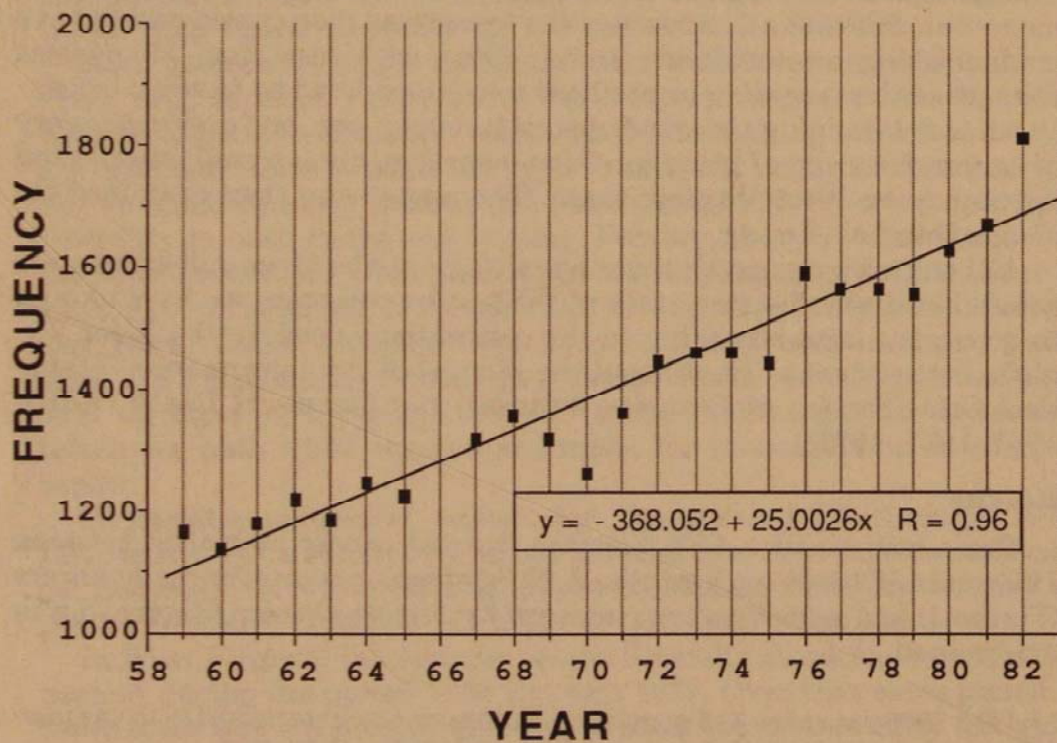


FIGURE 2. Trend of Female Total Cancer Mortality in West Virginia, 1969 through 1982.

### Total Cancer Mortality

Fifty-six percent of the counties had no observable trends and were generally clustered in the southern and central portion of the state for total male cancer mortality (Figure 3). Forty-four percent of the counties had increasing trends which were clustered mostly in the south/central part of the state and in the eastern panhandle. There were no counties with decreasing trends.

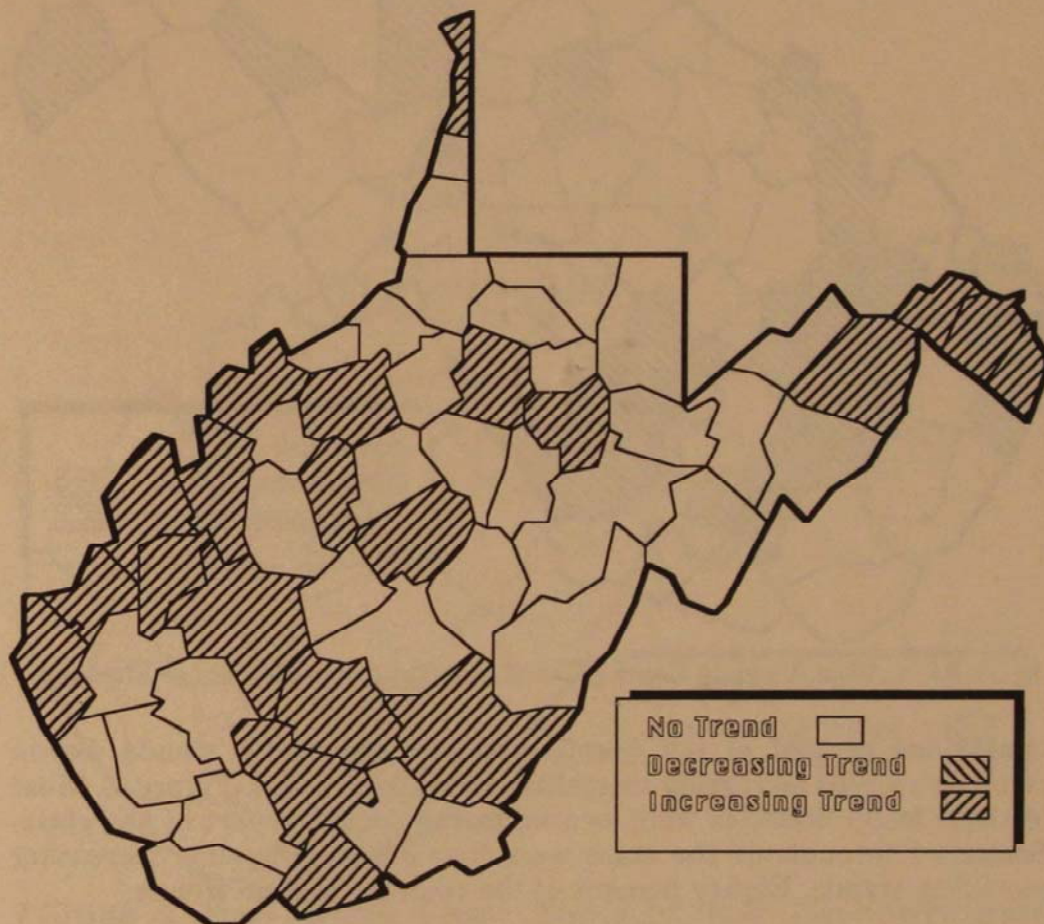


FIGURE 3. West Virginia County Trends for Total Male Cancer Mortality.

For females, no trends were observed in 73 percent of the counties (Figure 4). Those counties without trends were clustered in the central and northern part of the state. Twenty-seven percent of the counties had increasing trends. There were no counties with decreasing trends.

### Digestive/Peritoneal Cancers

Only Jackson County, located on the central western border of the state, had an increasing trend for digestive/peritoneal mortality in males (Figure 5). Four counties with decreasing trends were observed—three in the northern panhandle and one in the eastern panhandle.

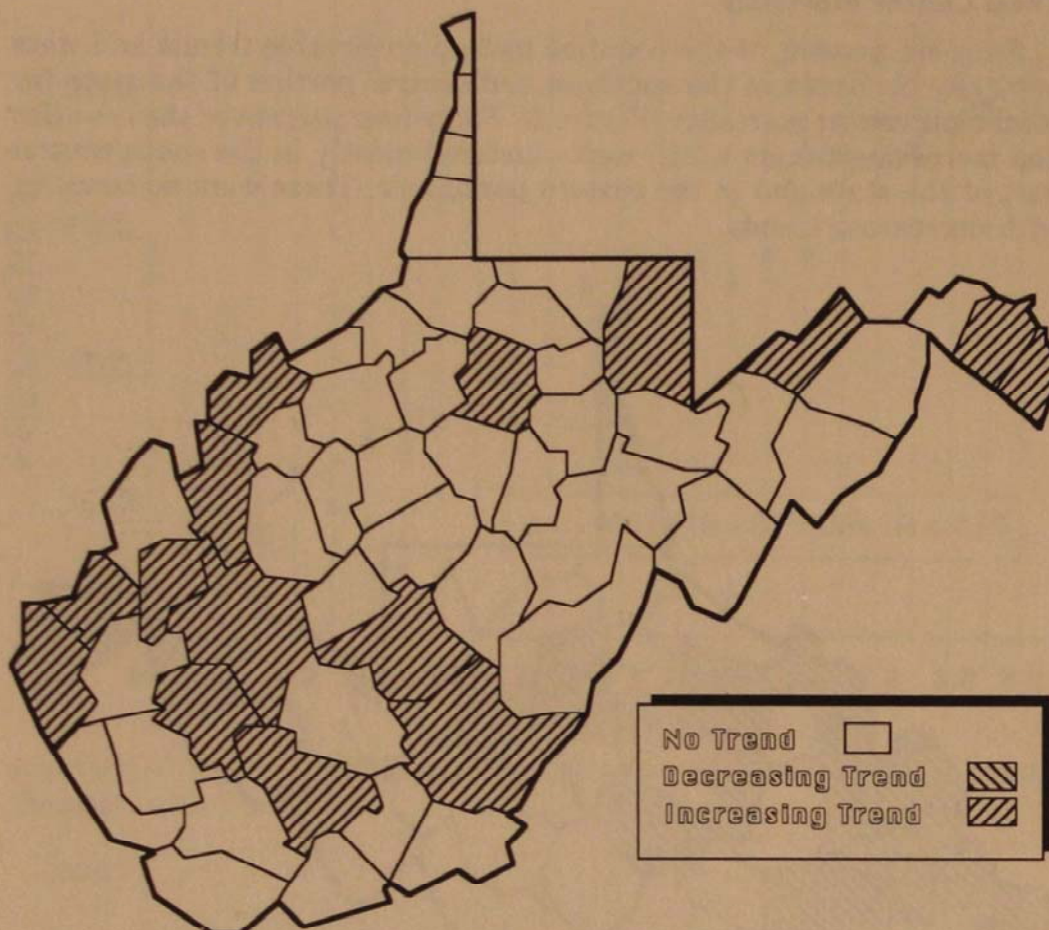


FIGURE 4. West Virginia County Trends for Total Female Cancer Mortality.

Ninety-one percent of the counties had no observable trends. Seven counties showed increasing mortality trends for females (Figure 6). Most of these latter counties were located in the southern part of the state. Scattered throughout the state were four counties having decreasing mortality trends. Eighty percent of the counties had no trends.

#### Urogenital Cancers

Eighty-four percent of the counties had no observable trends in male urogenital cancer mortality (Figure 7). Eight counties had increasing trends. These counties were primarily located along the western border of the State. Ohio County in the northern panhandle had the only decreasing trend in the state. For females, ninety-three percent of the counties had no observable trends (Figure 8). Grant, Hancock, and Kanawha counties had the only increasing trends in the state. Ohio County had the only decreasing trend.

#### Respiratory Cancers

Eighty-two percent of the counties had increasing trends for male respiratory cancer mortality (Figure 9). Those counties with no observ-

able trends are scattered throughout the central and eastern part of the state. There were no counties with decreasing trends. For females, thirty-eight percent of the counties had increasing trends (Figure 10). These counties were clustered mainly in the southern part of the state. No trends were observed for 62 percent of the counties. Those counties without trends were generally clustered in the central and eastern portions of the state.

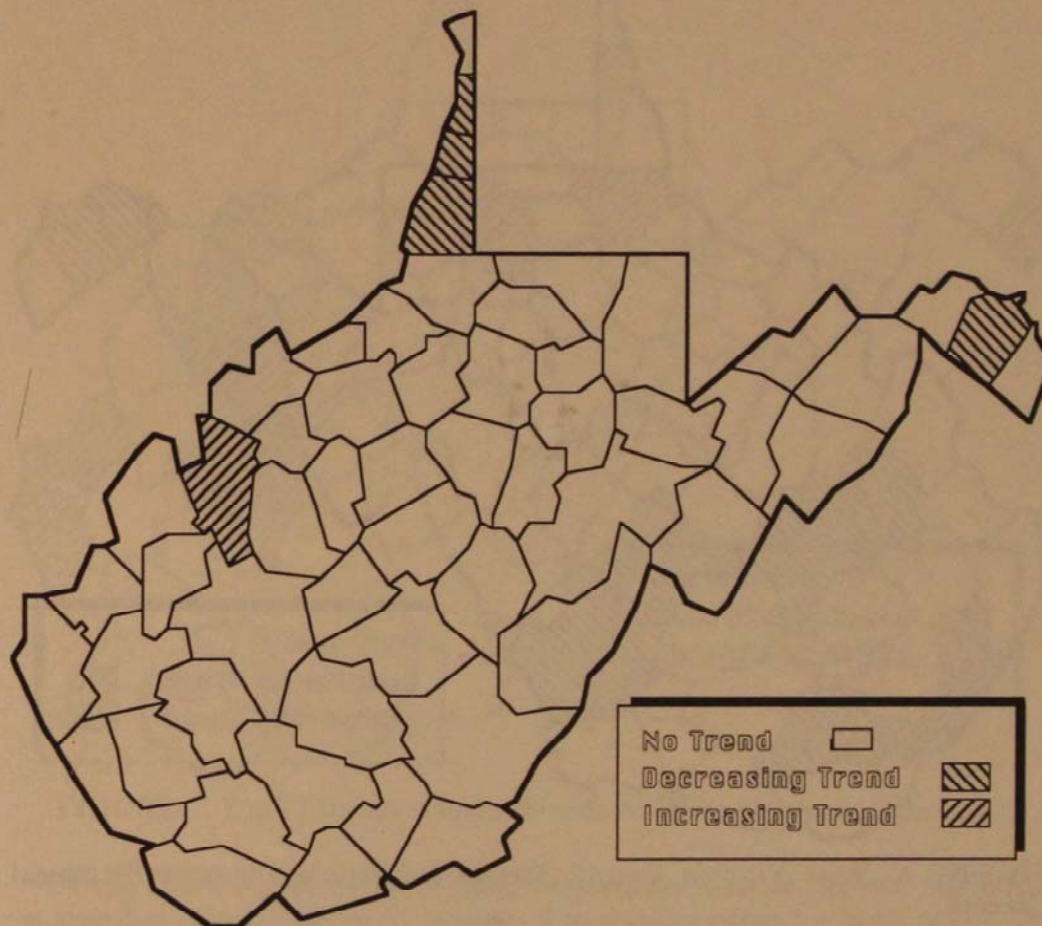


FIGURE 5. West Virginia County Trends for Male Digestive/Peritoneal Cancers.

### Discussion

The increasing rates of total cancer mortality for West Virginia are generally higher than those for the U.S. population (Riggan et al. 1983; Devesa and Silverman 1976). Both of the above studies support the findings of the present report that in recent years there has been a rather large increase in total cancer mortality in the state. Both Riggan et al. (1983) and Devesa and Silverman (1976) indicate that there has been a small decrease in total female cancer mortality until about 1979 in the U.S. population as a whole. The data of Pollack and Horm (1980), on the other hand, reports that there has been an increase in both male and female cancers in the recent past in the U.S. population. While the

Riggan study covers 29 years and Devesa and Silverman's study covers 34 years, it is quite possible that the 1969 to 1976 Pollack and Horm study did show an increasing rate of total female cancer mortality in that shorter time period.

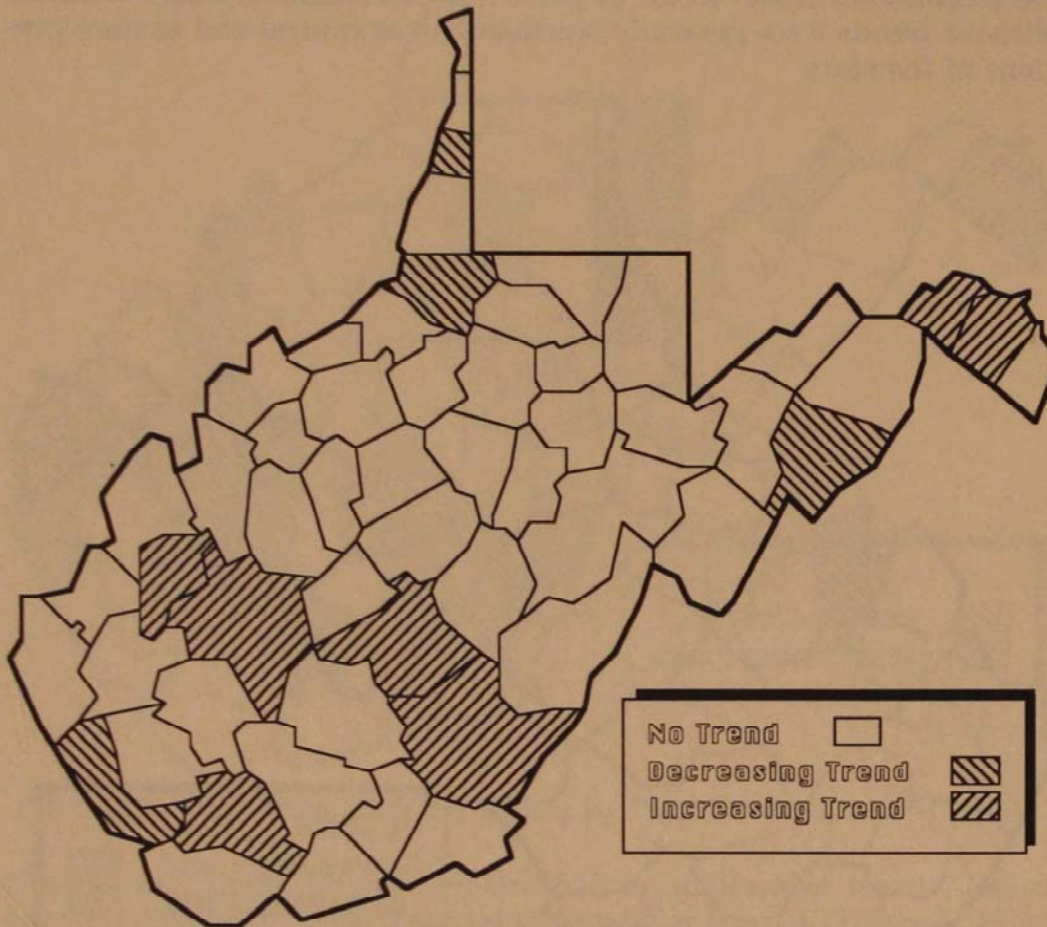


FIGURE 6. West Virginia County Trends for Female Digestive/Peritoneal Cancers.

The area of increased total cancer mortality for both males and females was quite prevalent in the southern part of the State. This part of the state is unique to other areas of the state in two major aspects: type of manufacturing industry predominating and socio-economic status. The Kanawha River Valley in the vicinity of Charleston has a large number of chemical plants. South of the Kanawha River Valley is one of the poorest regions of the state, which has relied on a single type of industry for its economic base. With the decline of the coal industry, many residents of the region suffered a substantial decline in their standard of living with the resulting unemployment and increased incidence of poverty. With the exception of male digestive/peritoneal cancer, either the Kanawha River Valley region or the southern counties showed a high number of counties with increasing cancer mortality trends. This may

indicate a possible relationship between higher cancer rates and the type of manufacturing industry that prevails in the Kanawha River Valley and/or the depressed economic area south of it.

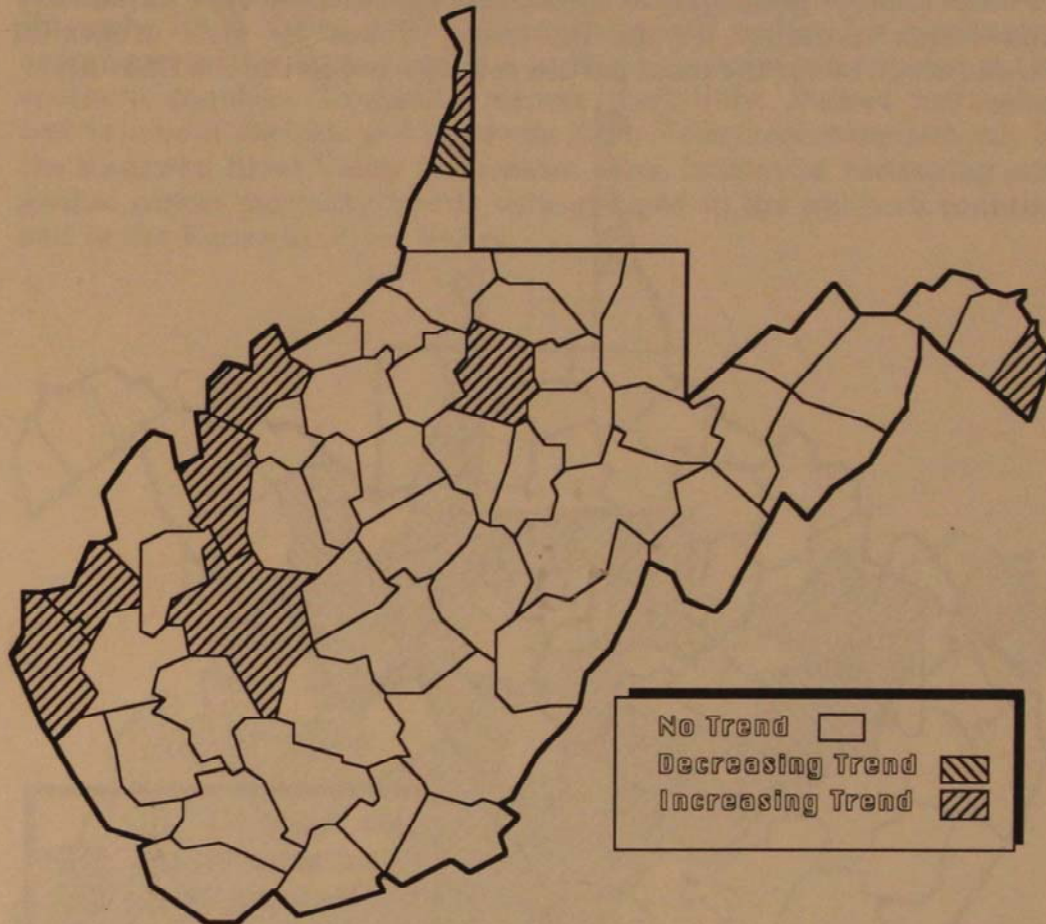


FIGURE 7. West Virginia County Trends for Male Urogenital Cancers.

Of the three major cancer types, respiratory cancer showed the largest number of counties with increased mortality rates for both sexes. In contrast, a number of counties had decreasing digestive/peritoneal cancer mortality rates in both sexes. No geographic clustering appeared for male respiratory cancer, with increased trends occurring throughout the state. Although increasing trends for female respiratory cancer predominated in the southern counties, there were also increasing trends in many other counties scattered throughout the state. Respiratory cancer mortality, especially in males, does not seem to be related to any geographic area of the state.

For the other types of cancers, geographical clustering of trends were apparent. For example, there was a general clustering of counties with decreasing trends for digestive/peritoneal cancer mortality in the northern panhandle. Increased trends for female digestive/peritoneal cancer mortality rates were concentrated in the southern part of the state.

Counties with increased male urogenital cancer mortality clustered geographically along the central western border of the state which might indicate another geographical association between the type of industry and cancer mortality trends. Increasing trends for male urogenital cancer occurred for the most part in counties bordering the Ohio River.

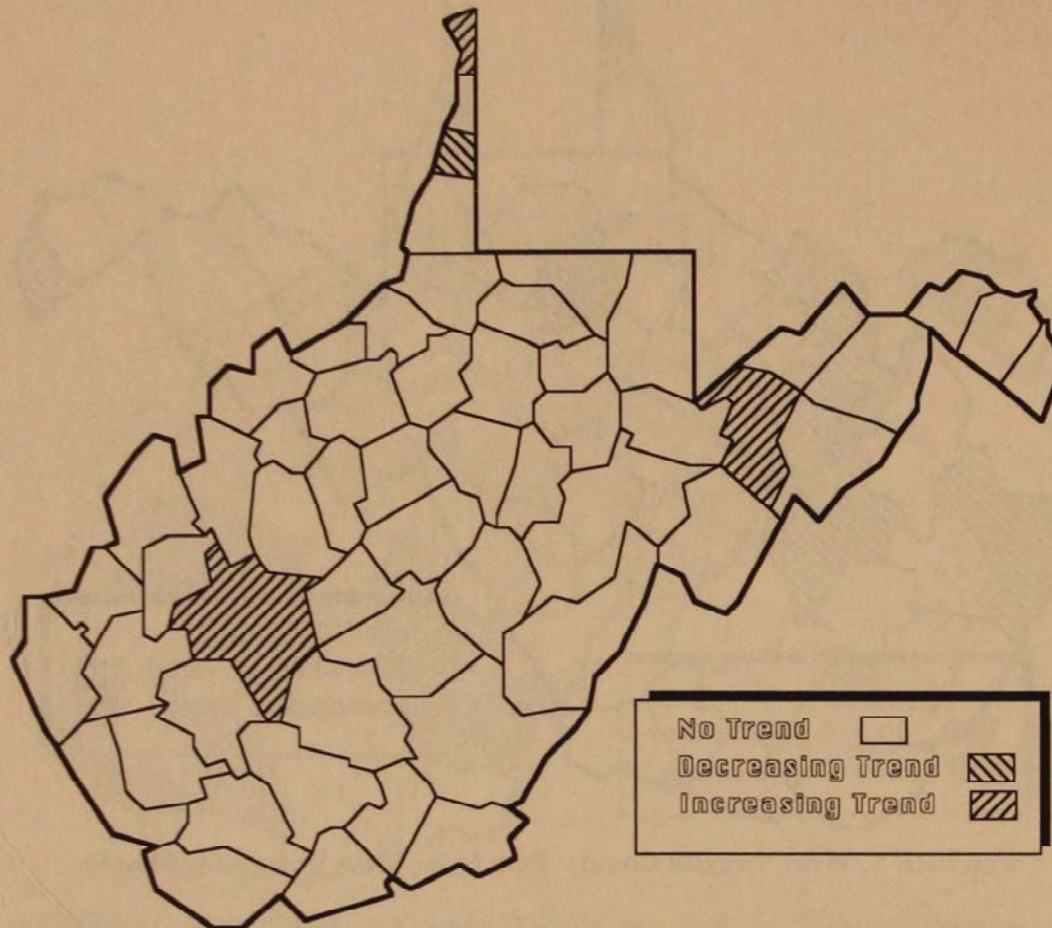


FIGURE 8. West Virginia County Trends for Female Urogenital Cancers.

The Ohio River region also has a heavy concentration of manufacturing industries, although the chemical industry does not predominate as much there as in the Kanawha River Valley. The additional presence of coal processing plants and steel mills provides more industrial variety to the Ohio River region. The apparent absence of any increasing urogenital cancer mortality trends for females in this region (with the exception of Hancock County) might be due to the traditionally low number of females working in these industries. This may indicate an occupational relationship to urogenital cancer in the Ohio River region, whereas some of the cancer types previously discussed may not be restricted to an occupational environment relationship. However, Kanawha County has a predominant chemical industry and showed an increasing cancer mortality trend for women.



## Conclusions

With regard to geographical clustering, most types of cancer mortality (except male digestive/peritoneal cancer) showed increases in the Kanawha River Valley and/or the southern coal region. For respiratory cancer mortalities there may be a regional clustering in females in the southern counties. Urogenital cancer mortalities showed increasing trends in both the Ohio and Kanawha River Valleys for males but only in the Kanawha River Valley for females. Also, in females, increasing urogenital cancer mortality trends were grouped in the southern counties and in the Kanawha River Valley.

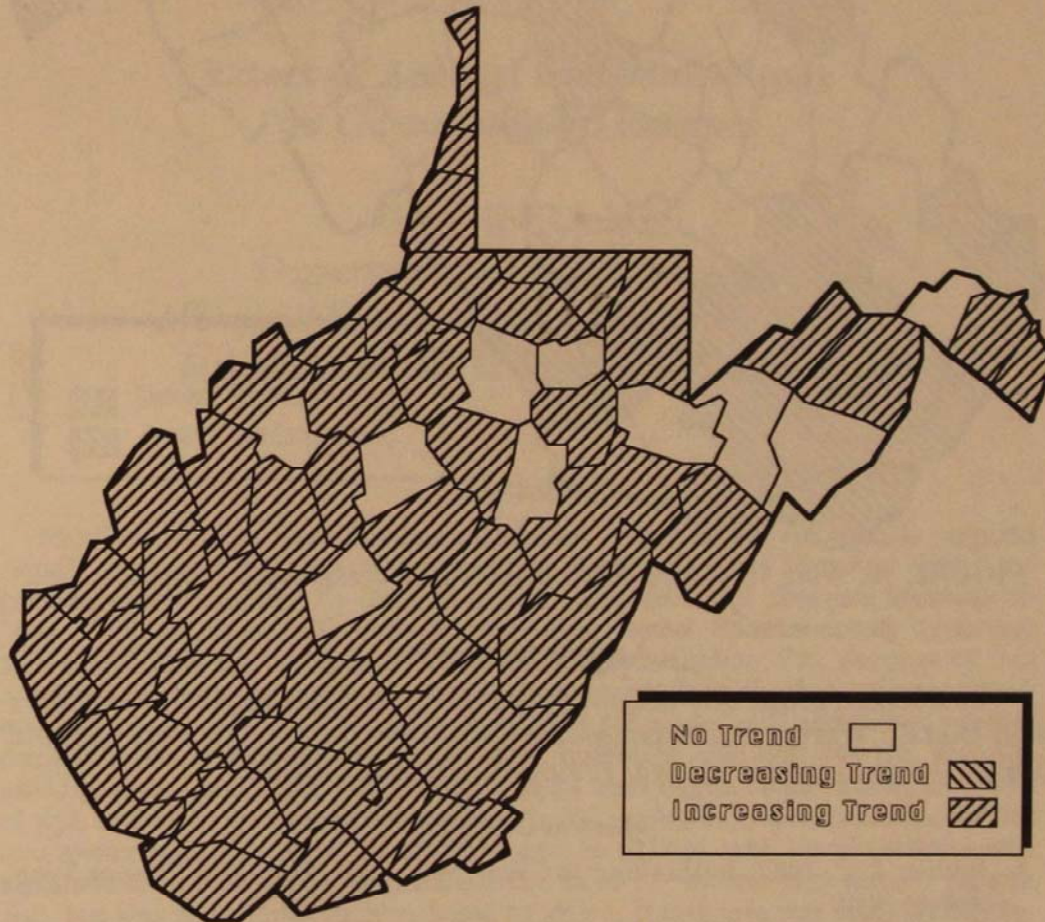


FIGURE 9. West Virginia County Trends for Male Respiratory Cancers.

Few counties showed increasing trends in digestive/peritoneal cancer mortality in both sexes and several counties showed decreasing trends. Only a few counties showed increasing male or female urogenital cancer mortality trends. Respiratory cancers showed a large number of counties with increasing trends for both males and females. About half of the counties showed increasing trends for total cancer mortality.

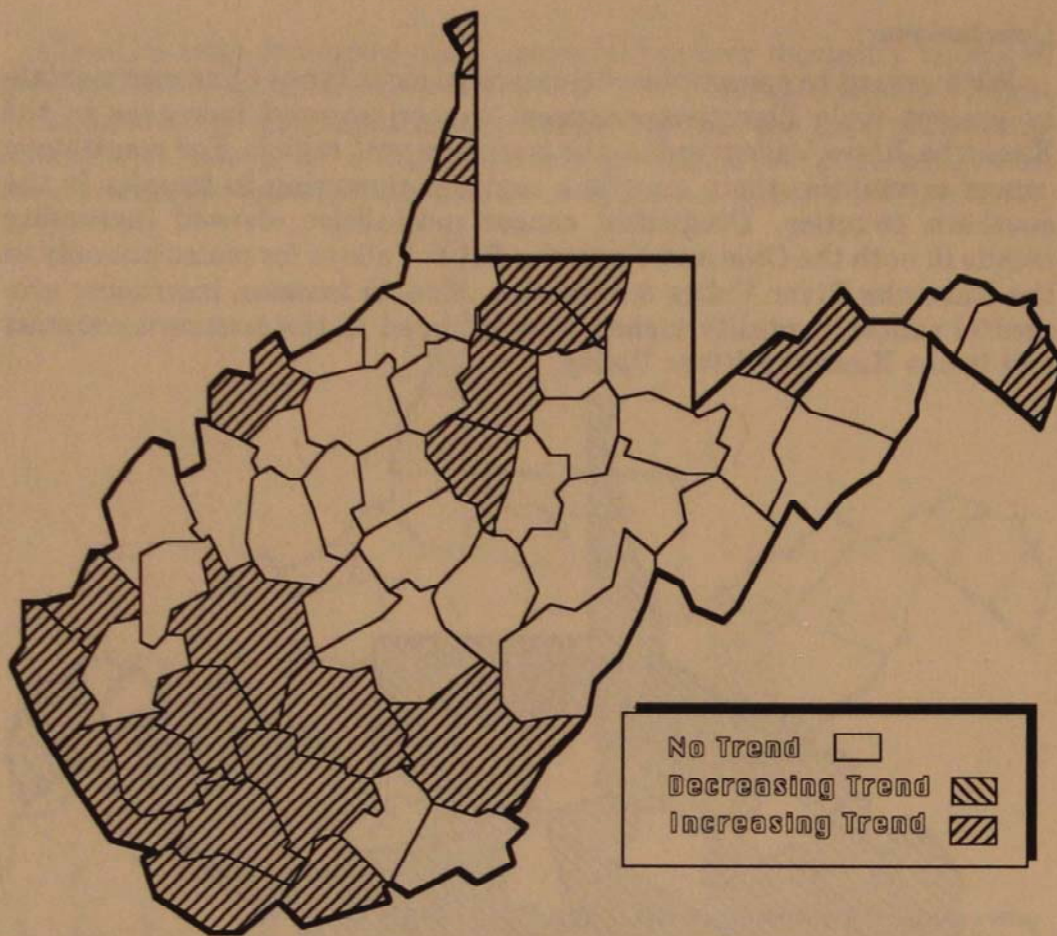


FIGURE 10. West Virginia County Trends for Female Respiratory Cancers.

#### Acknowledgment

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## Effect of Adrenal Demedullectomy on Guanethidine Tolerance

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### Abstract

Previous studies have demonstrated that hypertensive rat models respond rapidly to the antihypertensive properties of guanethidine. However, many hypertensive animals rapidly develop tolerance to the blood pressure lowering effects of guanethidine with daily guanethidine dosing. Spontaneously hypertensive rats (SHR) are particularly resistant to guanethidine. The purpose of this study was to determine the role of the adrenal medulla in the development of tolerance to guanethidine. Groups of male SHR (10 weeks old) underwent adrenal demedullectomy (SHAD; N=7) or sham operation (SHAM; N=10). Systolic blood pressure and heart rate measurements were begun on all rats at 16 weeks of age, and daily guanethidine treatments (50 mg/kg/day, intraperitoneally) for two weeks were started at 19 weeks of age. In SHAM rats, blood pressure was significantly decreased by guanethidine on days 1 (-33 mm Hg) and 3 (-35 mm Hg), but was not significantly reduced by day 5. Heart rate was significantly reduced on all treatment days. In SHAD rats, blood pressure remained lowered on treatment day 5 (-32 mm Hg) and was significantly lower than SHAM rats on treatment days 13 and 14. Although heart rate was significantly lowered on all treatment days, heart rate was decreased less in SHAD rats than SHAM rats after treatment day 5. These results suggest that the adrenal medulla plays an important role in the development of tolerance to guanethidine. The ability of adrenal demedullectomy to suppress late rather than early development of tolerance also suggests that adrenal catecholamines are more responsible for maintaining tolerance than initiating tolerance development to guanethidine.

Guanethidine has been used as an antihypertensive drug for over 20 years and is still useful in treating severe or resistant hypertension [1].

In man, tolerance can develop to guanethidine's antihypertensive properties within a few days or weeks of beginning therapy [1,2]. The mechanism(s) of tolerance development to guanethidine is not fully understood but fluid retention [1] and increased vascular sensitivity to endogenous catecholamines [2] have been suggested as possible explanations.

Previous studies in our laboratory have described the development of tolerance to guanethidine's blood pressure lowering properties in male and female spontaneously hypertensive rats (SHR) and two renovascular models of hypertension (one-kidney, one clip and two-kidney, one clip) [3]. We also observed that the renin-angiotensin-aldosterone system was an important physiological compensatory system for attenuating guanethidine effects on blood pressure in SHR [4]. The purpose of this study was to examine the effect of adrenal demedullectomy on the development of tolerance to guanethidine to determine the role on catecholamines released from the adrenal glands in tolerance development.

### Materials and Methods

Male SHR (10 weeks of age) were anesthetized with an intraperitoneal (i.p.) injection of sodium pentobarbital (40 mg/kg), and bilateral adrenal demedullectomy (SHAD; N=7) or sham operation (SHAM; N=10) performed. Adrenal demedullectomy was performed by exposing the adrenal glands via retroperitoneal incisions, followed by puncturing each cortex and forcing the medullas from the glands with forceps. In SHAM, adrenals were replaced untouched following exposure. At 16 wk of age, systolic blood pressure and heart rate measurements were started twice weekly in conscious rats using the tail artery occlusion technique [5]. Values recorded were the mean of at least three consecutive determinations. At 19 wk of age, rats received daily guanethidine (50 mg/kg/day, i.p.) injections for 2 wk. Guanethidine was a gift from Ciba-Giegy Corporation (Summit, New Jersey). Systolic blood pressure and heart rate determinations were recorded on day 1 and on alternate treatment days at least 16 hr after the previous day's injection. Data were analyzed using one-way analysis of variance and Student *t*-tests. Differences were considered significant if  $\alpha P < 0.05$ .

### Results

In SHAM, systolic blood pressure was significantly decreased from the preguanethidine value of  $199 \pm 4$  mmHg on only treatment days 1 and 3 (Figure 1). Although blood pressure tended to be decreased on days 5, 7 and 9, these decreases were not significant. By contrast, daily guanethidine dosing in SHAM produced a marked and sustained decrease in heart rate (Figure 2) from the preguanethidine value of  $436 \pm 10$  beats/min. This bradycardia was maintained throughout the 2 wk treatment period. In SHAD, systolic blood pressure was significantly decreased on treatment days 1, 3 and 5 from the preguanethidine value of  $213 \pm 8$  mmHg (Figure 1). Although heart rate was decreased by guanethidine on all measurement days from the control value of  $363 \pm 13$  beats/min, heart rate was not decreased as much in SHAD as in SHAM after 1 wk of guanethidine dosing (Figure 2).

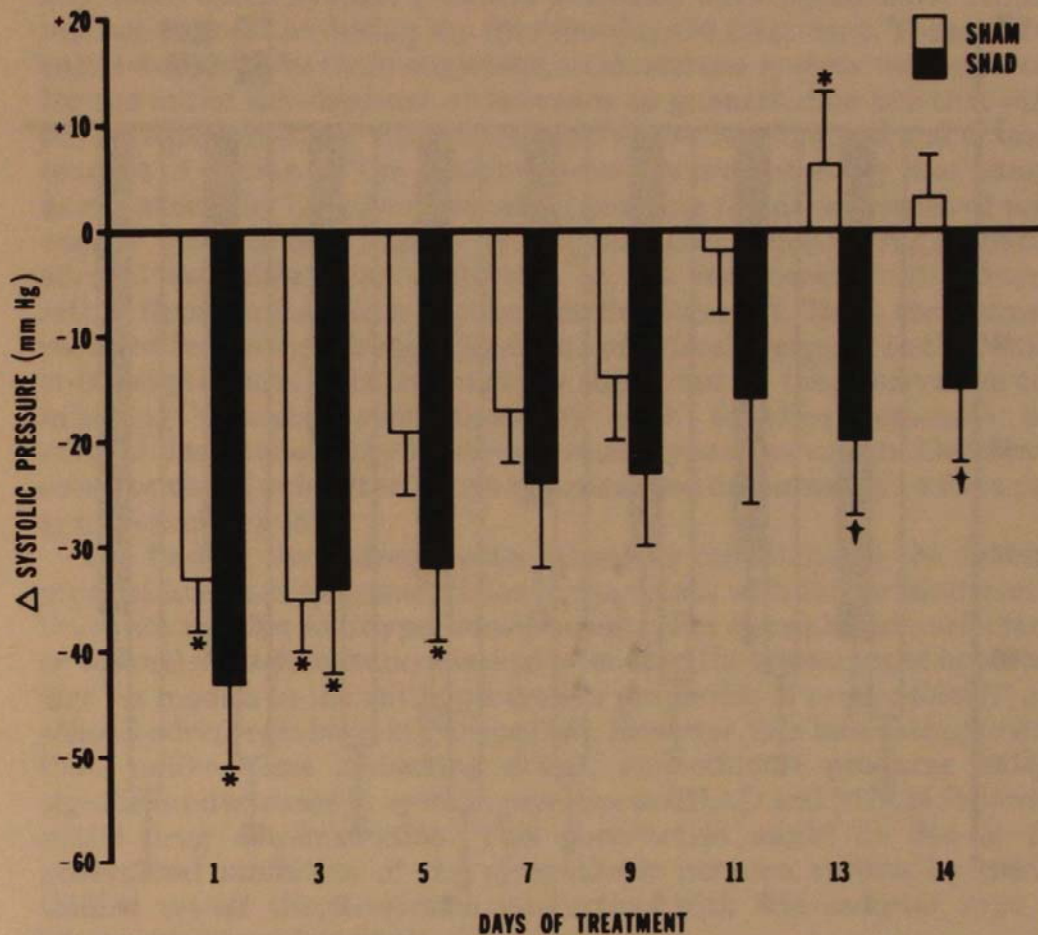


FIGURE 1. The effect of daily guanethidine (50 mg/kg/day, i.p.) administration on systolic blood pressure in adrenal demedullectomized (SHAD; N=7) or sham-operated (SHAM; N=10) male SHR. Values are the means  $\pm$  S.E. of the change ( $\Delta$ ) from control systolic blood pressures (SHAD,  $213 \pm 8$  mmHg; SHAM,  $199 \pm 4$  mmHg) within a group. \*Value is significantly different from the control day value ( $\alpha P < 0.05$ ). †Change ( $\Delta$ ) in blood pressure is significantly different from the corresponding change in blood pressure observed in the SHAM group for that day ( $\alpha P < 0.05$ ).

### Discussion

The results of this study indicate that SHAM animals respond to guanethidine as we previously observed for SHR which have not been sham operated [3]. However, in our previous study systolic pressure in intact SHR was still significantly reduced on treatment day 5 [3]. Also both sham and non-sham operated groups of rats exhibited sustained decreases in heart rate of 100-120 beats/min. Therefore, sham operation of SHR for adrenal demedullectomy does not appear to alter their response to guanethidine.

The bradycardia observed in SHAM and SHAD was different after 7 days of guanethidine therapy. The reason for this difference might be related to the fact that SHAD had lower control heart rates due to the absence of adrenal catecholamines. This conclusion is supported by the

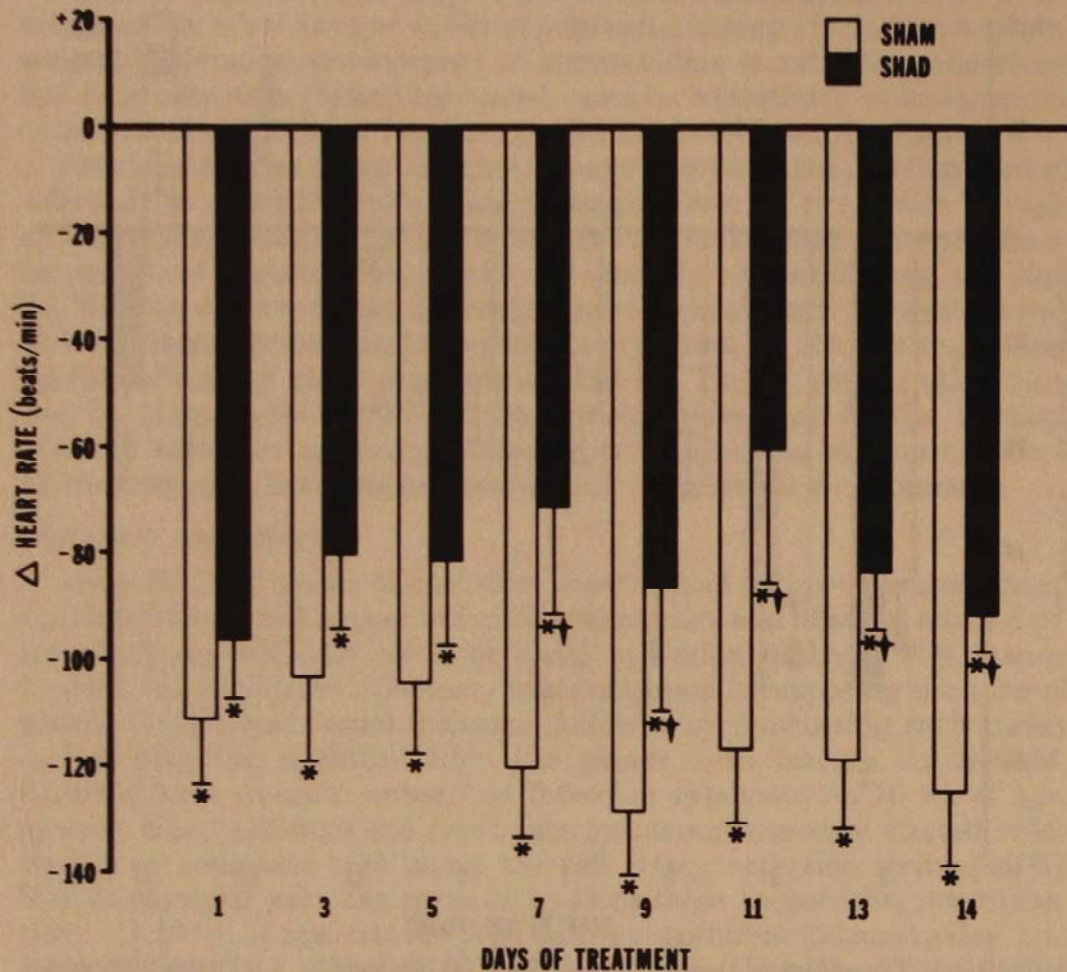


FIGURE 2. The effect of daily guanethidine (50 mg/kg/day, i.p.) administration on heart rate in adrenal demedullectomized (SHAD; N=7) or sham-operated (SHAM; N=10) male SHR. Values are the means  $\pm$  S.E. of the change ( $\Delta$ ) from control heart rates (SHAD,  $363 \pm 13$  beats/min; SHAM,  $436 \pm 10$  beats/min) within a group. \*Value is significantly different from the control day value ( $\alpha P < 0.05$ ). †Change ( $\Delta$ ) in heart rate is significantly different from the corresponding change in heart rate observed in the SHAM group for that day ( $\alpha P < 0.05$ ).

observation that heart rate was reduced in both SHAD and SHAM to a value near 300 beats/min. Therefore, although the degree of bradycardia was different, both groups reached a similar final heart rate which would be maintained by physiological mechanisms other than those inhibited by guanethidine and/or adrenal demedullectomy.

The results of a previous study from our laboratory demonstrated that concurrent captopril administration was capable of markedly attenuating guanethidine tolerance in SHR [4]. This attenuation occurred at a dose of captopril (30 mg/kg/day, orally) which did not result in decreased systolic blood pressure but increased plasma renin activity. Attenuation was greatest during the first few days of guanethidine ther-

apy, after which systolic pressure decreases were significantly reduced but not as great as during the first few days of treatment. These results suggested that the renin-angiotensin-aldosterone system was important for the initial development of tolerance to guanethidine but that other physiological systems also contributed to the development and/or maintenance of tolerance. The observation in the present study that adrenal demedullectomy had the effect of attenuating the development of tolerance to guanethidine after 1 wk of guanethidine dosing suggests that adrenal catecholamines contribute to the maintenance of tolerance rather than the initiation of tolerance development. Thus, some time is required before the adrenal glands can effectively respond to the change in blood pressure. This conclusion is supported by the observation that following chemical sympathectomy with 6-hydroxydopamine and adrenal demedullectomy in chronic renal hypertensive rats blood pressure decreased only after 7 days but remained decreased at 14 days post sympathectomy [6].

The finding that adrenal catecholamines contribute to the development of tolerance to guanethidine is consistent with the development of tolerance to other antihypertensive agents. For example, adrenalectomy or adrenal demedullectomy markedly reduced the resistance of hypertensive rat models to the antihypertensive properties of propranolol [7] and other  $\beta$ -adrenergic blocking drugs [7,8]. However, it is interesting to note that, unlike some  $\beta$ -blocking drugs, guanethidine produces similar significant decreases in systolic pressure in SHAD and SHAM following initial drug administration. This observation might be due to the generalized inhibition of the sympathetic nervous system by guanethidine rather than selective interaction with one receptor type at adrenergic nerve terminals.

#### Acknowledgments

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# Botany

## Section

### Distribution and Status of *Arabis serotina* Steele Populations in West Virginia

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#### Abstract

*Arabis serotina* Steele is an endemic of the mid-Appalachian shale barrens in West Virginia and Virginia. In West Virginia, it is known from only thirteen populations in the South Fork and Anthony Creek drainages of Hardy, Pendleton and Greenbrier counties. Only about seven hundred individuals are known in the state. A species of south to southwest facing Brallier shales at mid-elevations, its localized distribution appears to be due to past or present biogeographic events and not due to land-use changes or an absence of suitable environments elsewhere. Deer predation destroys a significant portion of the inflorescences at most populations, but drought stress may play a more important role as a population regulator.

#### Introduction

*Arabis serotina* Steele is a biannual endemic of the mid-Appalachian shale barrens and is restricted to a small number of counties in the Ridge-and-Valley Physiographic Province of western Virginia and eastern West Virginia (Keener 1983). Strausbaugh and Core (1977) reported the species from seven West Virginia counties, including three west of the Ridge-and-Valley. However, they had confused *A. serotina* with *A. laevigata* var. *burkii* Porter and narrow-leaf forms of *A. laevigata* var. *laevigata* (Muhl.) Poir. Wieboldt (1986) has clarified the characteristics that separate *A. serotina* from *A. laevigata burkii*. Notable among these is the difference in flowering times. In 1985, West Virginia populations of *A. laevigata burkii* were observed in bloom from 20 April through

19 May and fruits were fully formed by 10 June. In contrast, the first flowering of *Arabis serotina* was observed 21 June and continued through 8 August, with fully formed fruits first noted 16 August (Bartgis, pers. obs.).

This species is a candidate under review for possible federal listing as an Endangered or Threatened Species. Therefore, I undertook a study in 1985 to fully document its West Virginia range, population size, environment, and threats to individual populations. At that time, only about seventy individuals in three populations in Greenbrier County and an historical population from Pendleton County were known. About one hundred shale barrens have been surveyed. Numbers of reproductive individuals (i.e., rosettes excluded), percent successfully reproducing, geologic substrate, aspect, elevation, predation and associated species were recorded. Additional observations were made in 1987.

## Results and Discussion

### *Distribution and Environment:*

*Arabis serotina* was found to be restricted in West Virginia to two valleys in three counties (Figure 1). It occurs on seven shale barrens in the drainage of Anthony Creek, a tributary of the Greenbrier River in Greenbrier County. Here, it occupies a range of about 75 square kilometers. *Arabis serotina* was not found in the adjacent Greenbrier River drainage of Howard's Creek, which supports many large and well-developed barrens. *Arabis serotina* occurs on six shale barrens in the valley of the South Fork of the South Branch of the Potomac River in Pendleton and Hardy counties. Here, it occupies a range of about 70 square kilometers from the town of Brandywine north. Clench and Opler (1983) reported that larvae of the butterfly *Euchloe olympia* fed upon *Arabis serotina* at their study area farther south in the South Fork Valley. I could locate only populations of *Arabis laevigata burkii* there.

No known unsurveyed barrens remain in the drainage of Anthony Creek, but at least two unsurveyed barrens occur in the drainage of the South Fork.

The Anthony Creek populations are separated from Virginia populations in the Jackson River drainage by a small headwater divide. The North Fork populations are divided from Virginia populations in the Cowpasture River drainage by another small headwater divide. The Jackson and Cowpasture meet and form the James River, providing a continuous dispersal corridor for *Arabis serotina* between the Anthony Creek and South Fork drainages (Figure 1). *Arabis serotina* is one of three shale barren endemics (i.e., also *Eriogonum alleni* and *Clematis albicoma*) in West Virginia that have a predominantly southern range in the Greenbrier and James drainages, but have penetrated northward into the South Branch drainage via the South Fork Valley (Bartgis, unpubl. data).

All populations of *Arabis serotina* found in West Virginia were on the

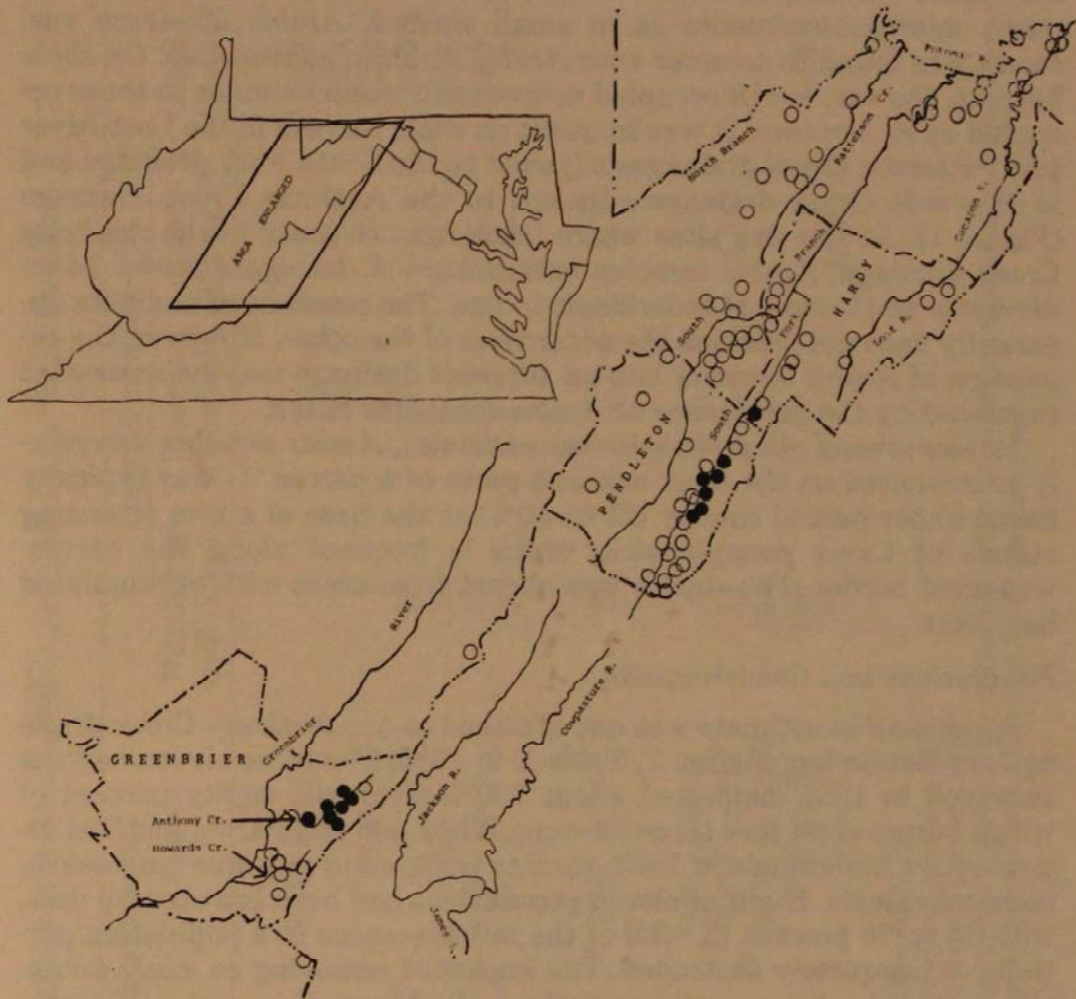


FIGURE 1. Distribution of *Arabis serotina* in West Virginia. Populations of *Arabis serotina* indicated by dots; shale barrens lacking *Arabis serotina* indicated by circles. Surveyed shale barrens also occur outside of area shown.

Braillier Formation (Table 1), a non-fossiliferous grey to dark marine Upper Devonian shale rich in siltstone (Cardwell et al. 1968). Forty percent of all shale barrens I surveyed were on Braillier (or the closely allied Harrel) shales. It is a common shale barren substrate in adjacent drainages and throughout the Ridge-and-Valley Province of West Virginia. Populations typically occur on south to south-west facing slopes, the orientation of nearly 90% of all barrens surveyed. In the South Fork drainage, *Arabis serotina* occupied barrens at elevations from 390 to 600 m; in the Anthony Creek drainage it occupied barrens at elevations from 610 to 745 m. These elevations are similar to the elevations of unoccupied shale barrens in adjacent drainages. Consequently, it appears that the small West Virginia range of *Arabis serotina* is a result of past or present biogeographic events restricting its range expansion and is not due to land-use changes or the lack of favorable environments elsewhere.

*Arabis laevigata* var. *laevigata* co-occurred with *Arabis serotina* on

four shale barrens. However, *A. laevigata laevigata* was restricted to mesic microenvironments as in small washes. *Arabis laevigata* var. *burkii* was found to co-occur with *Arabis serotina* at two sites. On shale barrens, the var. *burkii* occupied microenvironments similar to those occupied by *A. serotina*. It was frequent on shale barrens in the Lost River and Patterson Creek drainages adjacent to the South Fork drainage and in Howards Creek drainage adjacent to the Anthony Creek drainage (Figure 1). At the two sites where these taxa co-occur in the Anthony Creek drainage, *Arabis serotina* outnumbered *A. laevigata burkii* 34 individuals to 12 and 124 individuals to one. The presence of one taxa apparently does not preclude the occurrence of the other. However, the expansion of *Arabis serotina* into an adjacent drainage may be somewhat regulated by the occurrence of *Arabis laevigata burkii*.

Unlike several other shale barren endemics, *Arabis serotina* was rarely encountered on the most exposed parts of a barren. It was typically found under partial canopy (25 to 50%) at the base of a tree or among stands of *Carex pensylvanica*, which is frequent along the barren-woodland border. The *Arabis* was absent from areas with accumulated leaf litter.

#### *Populations and Conservation:*

A population estimate was not obtained at one Anthony Creek drainage population (population 7, Table 1) in 1985. The other eleven barrens surveyed in 1985 supported about 700 individuals, eighty percent of which occurred on just three barrens. While one population had 294 reproductive individuals in 1985, median population size was only seventeen individuals. Eight of eleven populations had been browsed by deer, with 15 to 70 percent ( $\bar{X}=30$ ) of the inflorescences in a population partially or completely destroyed. The impact of removing so many potential propagules from small populations of a biannual in such a stressful environment is unknown.

A potentially more significant population regulator than predation may be drought stress. 1987 was a severe drought year in the South Fork Valley, with shale barren vegetation showing a significant degree of drought stress and mortality (Bartgis, unpubl. data). Reproductive failure was significant for *Arabis serotina*. At one barren that had 136 reproductive individuals in 1985, only twelve plants set fruit successfully in August 1987. At a South Fork Valley population first found in 1987, eleven plants were found. Of these, only two plants set fruit successfully. For most individuals in these populations, the inflorescence withered before or during anthesis. At each population, one plant was found in mid-August producing new flower buds on lower branches after the remainder of the inflorescence had aborted.

Two small populations had been grazed in the past by goats or sheep (Table 1). These barrens had very little recovered vegetation, marked erosional features, and a higher number of individuals of exotic species than other barrens (Bartgis, pers. obs.). No known populations of *Arabis serotina* occur on actively grazed barrens. Six of the barrens have been partially cut by road construction and two barrens were partially de-

Table 1. Characteristics and status of *Arabis serotina* populations in West Virginia

County	Population Number	Environmental Characteristics			Population Status in 1985			Land Status**
		Geologic Strata	Elevation (m)	Aspect	Number of Individuals	Percent Browsed	Other Threats*	
<u>Greenbrier Co.</u>								
	1	Braillier	660 to 745	SSW to SSE	16	20	A	USFS
	2	Braillier	635 to 645	SW	3	0		SIA
	3	Braillier	655 to 670	SW	1	0		USFS
	4	Braillier	670 to 730	S	34	20		USFS
	5	Braillier	620 to 665	SW	124	70	B	SIA
	6	Braillier	610 to 640	SW to S	50	30	B	SIA
	7	Braillier	640 to 670	S	?	?	B	
<u>Hardy County</u>								
	8	Braillier	395 to 420	SSW to SW	11	15	C	
<u>Pendleton County</u>								
	9	Braillier	490 to 510	SW to SSW	6	0		
	10	Braillier	490 to 520	WSW to SW	17	40	A,B	
	11	Braillier	490 to 550	WSW to SSW	294	30	B	
	12	Braillier	530 to 595	SSW to S	136	30		USFS
	13***	Braillier	530 to 560	SW	?	?	B,C,	

\*A denotes a shale barren had been grazed by livestock in the past;

B denotes a shale barren had been partially destroyed when a road was built;

C denotes a shale barren had been partially destroyed when a dam was built.

\*\*USFS denotes a barren is partially or completely owned by the U.S. Forest Service but has no formal protection; SIA denotes a barren is owned by the Forest Service and set aside for protection as a Special Interest Area. Otherwise, land is privately owned.

\*\*\*First found 1987.

stroyed during construction of a flood-control dam (Table 1). It is not known how any of these activities directly impacted the *Arabis* populations on those barrens.

Three *Arabis serotina* populations on national forest lands have been designated as special areas for protection (U.S. Forest Service 1986). Seventy-five percent of the West Virginia sites for this highly restricted species have received no legally-binding long-term protection.

#### Acknowledgments

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### Updates on the Vascular Flora of West Virginia. III.

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#### Abstract

During the past year, fourteen species of vascular plants have been recorded at the West Virginia University Herbarium as additions to the flora of West Virginia (based on Strausbaugh and Core, 1978). Unless otherwise noted, nomenclature and distribution information follows Fernald, 1950.

The new species are as follows:

*Diplachne fascicularis* (Lam.) Beauv., [*Leptochloa fascicularis* (Lam.) Gray.] (Poaceae). Marshall County, *E. E. Hutton s.n.*, *Bill Tolin, Roger Stern*, July 28, 1986. Species occurs in our range and is to be expected, (Gleason and Cronquist, 1963).

*Sporobolus clandestinus* (Biehler) Hitchc. (Poaceae). Summers County, *William N. Grafton s.n.*, October 9, 1986. Plant occurs in our range and is to be expected, (Gleason and Cronquist, 1963).

*Paspalum fluitans* (Ell.) Kunth. (Poaceae). Mason County, *William N. Grafton s.n.*, October 19, 1985 and *E. E. Hutton s.n.*, October 19, 1985. Species occurs to our south and west and is to be expected in West Virginia.

*Carex albolutescens* Schwein. (Cyperaceae). Randolph County *Eugene E. Hutton s.n.*, July 15, 1972 and July 4, 1983. Plant is in our range and to be expected.

*Betula populifolia* Marsh. (Betulaceae). Marion County, *William N. Grafton s.n.*, August 16, 1983. Species occurs in our range and is to be expected. It is widely planted and occasionally escapes.

*Salsola collina* Pallas (Chenopodiaceae). Jackson County, *William N. Grafton s.n.*, September 22, 1983. A native of central Asia, this species is a rare advent, (Gleason, 1952).

*Cerastium semidecandrum* L. (Caryophyllaceae). Morgan County, *Homer Duppsstadt s.n.*, May 13, 1978. This plant is naturalized from Europe.

*Nelumbo nucifera* Gaertn. (Nymphaeaceae). Mason County, *E. E. Hutton s.n.*, July 28, 1984. An introduction from Asia, this species has become locally established.

*Astragalus neglectus* (T.&G.) Sheld. (Fabaceae). Grant County, *E. E. Hutton s.n.*, July 13, 1986. Species occurs to our north and is to be expected at higher elevations in West Virginia.

*Hypericum pyramidatum* Ait. (Hypericaceae). Pleasants County, *E. E. Hutton s.n.*, *William Tolin, Roger Stern*, July 31, 1986. Native in the area to our immediate north, this species is to be expected.

*Ludwigia polycarpa* Short & Peter (Onagraceae). Mason County, *William N. Grafton s.n.* and *Zettie Stewart*, October 19, 1985. Species occurs to our north and west and is to be expected.

*Acanthopanax sieboldianus* Makino (Araliaceae). Randolph County, *Eugene E. Hutton s.n.*, October 25, 1985. A native of Japan and China, this species is planted and occasionally escapes.

*Lonicera maackii* (Rupr.) Maxim. (Caprifoliaceae). Monongalia County, *William N. Grafton s.n.*, September 26, 1981. This species is native to Asia. It is frequently planted and escapes (Gleason and Cronquist, 1963).

*Solidago rigida* L. (Asteraceae). Pendleton County, *E. E. Hutton s.n.*, *Esther Reichelderfer, Kyle Bush, Beth Smith*, September 12, 1986. Occurs in our range and is to be expected.)

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## The Role of Azygospores in the Transfer of VAM Colonization

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### Abstract

Root and soil analyses were utilized to determine the role of the azygospores of *Gigaspora margarita* in the transfer of vesicular-arbuscular mycorrhizal (VAM) colonization between Bahia grass roots. Following mycorrhizal establishment in Bahia grass inoculum plants, two experiments were conducted using these plant roots. In one experiment azygospores associated with the plant roots were removed, and in the other, azygospores were allowed to remain attached. Bahia grass seeds were sown and permitted to germinate and grow with the inoculum plants. At 3 and 6 months, microscopic examination of root segments from both experiments indicated VAM colonization in experimental plants. Root and soil analyses showed azygospores present only in that experiment where azygospores were not removed. We conclude that azygospores are not required for the transfer of *G. margarita* colonization between Bahia grass roots.

### Introduction

Vesicular-arbuscular mycorrhizae (VAM) are widespread in forest RYAN trees and shrubs as well as herbaceous and crop species (Gerde-mann, 1968; Clark, 1969; Mosse, 1973). VAM colonization occurs when the fungus penetrates the epidermal cells of the host plant and spreads within and between the cortical cells (Marx, 1975). Penetration may occur mechanically following appressorium formation on the root surface (Nicolson, 1967) or digestion of the host cell wall by cellulolytic enzymes secreted by the hyphae (Hacskeylo, 1972). Though mechanisms of hyphal penetration have been documented, mechanisms of the transfer of VAM colonization between plants have not been thoroughly investi-



gated. Carling and Brown (1982) reported that VAM colonizations could be initiated following contact of a hypha issuing from azygospores, vesicles, or remnants of hyphal systems in the soil. Supportive data, however, were not included in their report.

The studies of Bierman and Lindermann (1983) indicated that root segments colonized by *Gigaspora* spp., when used as inoculum, did not colonize geranium or subterranean clover plants. The azygospores of *Gigaspora*, however, were infective. Additional avenues by which the transfer of VAM colonization can occur requires clarification.

This study determined the role of azygospores in the transfer of colonization from inoculum plants to uninfected plants. A mycorrhizal association was established between Bahia grass and the VAM, *Gigaspora margarita* Becker and Hall (Becker and Hall, 1976). These inoculum plants served as the source of inoculum throughout this investigation. Azygospores associated with these inoculum plants were either removed or allowed to remain undisturbed. Bahia grass seeds germinated and grew with the inoculum plants. Following a period of 3 and 6 months, the roots and soil associated with the experimental plants were analyzed clarifying the role of azygospores in the transfer of VAM colonization between plant roots.

#### Materials and Methods

The soil mixture used for growing the inoculum plants consisted of 520 parts Dotham sandy loam, 520 parts masonry sand, 0.75 parts Ca(OH)<sub>2</sub> and 1.5 parts (W/W/W/W) powdered 10-10-10 commercial fertilizer. Ten 6 inch plastic pots of soil were prepared at a time. The contents were thoroughly mixed by hand stirring and dumping between two containers. The mixture was sieved through a 0.25 inch mesh screen to remove large particles. This mixture was pasteurized in an autoclave at 85°C for three hours, allowed to cool and rest for one day, then steamed again as before.

For initial plantings, five pot cultures were established for inoculum plants used throughout this investigation. These cultures were obtained by adding soil mixture to within one inch of the top of the pot. A layer of mixed inoculum (soil containing azygospores, hyphae, and infected root segments, provided by M. L. Linthicum, Univ. of Ga.) was evenly distributed over the soil surface, then covered with one-half inch of soil. Approximately 75 Bahia grass seeds were distributed over this soil layer and covered with a one-fourth inch soil layer. Pots were labeled and maintained in the greenhouse. Germination occurred in seven to eight days.

After three months, inoculum pot cultures were examined for mycorrhizal establishment. Cultures were removed intact from the pot and a #7 cork bore used to obtain a soil and root sample from each. The samples were collectively wet-sieved through a sieve series of 710  $\mu\text{m}$ , 500  $\mu\text{m}$ , and 212  $\mu\text{m}$ , respectively. Spores were retrieved from the 212  $\mu\text{m}$  fraction. Root segments were obtained from the 710  $\mu\text{m}$  sieve. These segments were placed in plastic tissue capsules, labeled, then submerged in

FAA (90 ml 50% ethyl alcohol, 5 ml glacial acetic acid, 5 ml formalin), and allowed to fix for two hours. Root segments were examined microscopically to determine fungal infection. A modified version of Kormanik, et al. (1980) root staining technique was used. Roots were washed three times in distilled water to remove the fixative. Ten percent KOH (V/V) was added in a quantity large enough to cover the capsules, which were then heated at 90°C for 15 minutes. The roots were rinsed three times with distilled water and covered with 1% HCL. After 3 minutes the HCL was decanted and acid fuschin-lactic acid stain added. The roots were heated to 90°C for 40 minutes. Several root segments were placed on a slide, overlaid with 85% lactic acid, and viewed through a compound light microscope. The presence of mycorrhizal colonization in the inoculum plant cultures was determined.

To transplant inoculum plants with grass seeds, ten plastic pots were filled with soil to within one inch of the top. Two experiments were conducted. Five pots were used for each experiment.

Experiment A. Fifteen to twenty inoculum plants with azygospores present, as ascertained by microscopic examination of the roots, were placed in each pot. Plant roots were spaced evenly over the soil surface. Bahia grass seeds were distributed liberally over the root-soil interface. Roots and seeds were covered with one-fourth inch soil, labeled, and maintained in the greenhouse.

Experiment B. Fifteen to twenty inoculum plants, their azygospores removed with the aid of a dissecting microscope and forceps, were placed in each pot and planted with grass seeds as described in Experiment A.

To determine colonization in inoculum plants for the remainder of transplantings, the clearing and staining procedure of Brundrett, et al. (1984) was used to assess mycorrhizal infection. We found that this procedure gave better differentiation of mycorrhizal colonization than that of Kormanik, et al. (1980). Several plants were removed from each pot culture, and their roots thoroughly rinsed with tap water. One cm segments were excised from the roots, placed in labeled plastic tissue capsules, and stored in FAA overnight. The capsules were then rinsed with several changes of tap water to remove the FAA, transferred to 10% KOH, and heated at 90°C for 1 hour. Samples were rinsed several times with distilled water, transferred to a solution containing equal volumes of 80% lactic acid, glycerol, and distilled water with 0.1% chlorazol black E, and heated at 90°C for 1 hour. The stained roots were placed on slides, overlaid with 85% lactic acid, and colonization was determined by examination of stained root segments using a compound light microscope.

Colonized inoculum plants, confirmed through clearing and staining with chlorazol black E, were transplanted according to the conditions previously described for the original transplantings. Thus, duplicate studies were conducted for each experiment.

All inoculum plants used in this investigation were tied with string to prevent confusion between these inoculum plants and the young plants grown from Bahia grass seeds.

For control experiments, each study consisted of five pot cultures,

containing soil to within one inch of the top, prepared as follows, then maintained in the greenhouse:

1. Bahia grass seeds were scattered over the soil surface and then covered with one-fourth inch soil.

2. Uninfected Bahia grass plants were placed on the soil surface. Grass seeds were evenly distributed over the root-soil interface. Roots and seeds were covered with one-fourth inch soil.

3. Inoculum plants with azygospores removed were placed in pots and covered with one-fourth inch soil.

Colonization in young plants was assessed. After a growing period of three months, young plants were examined microscopically for mycorrhizal colonization. Sets of plant cultures (5 plant cultures per set) were removed from their pots and individually analyzed. Young plants were separated from inoculum plants using a knife and dissecting probe. Approximately 10 plants from each pot (50 plants per set) were collected. Plant roots were washed in water, root segments were cut and placed in labeled capsules, fixed, cleared and stained, and viewed as previously described. Presence of arbuscules and external vesicles on coiled hyphae was determined.

For collection of soil for spore analysis, soil loosened and removed as young plants were separated from their pot cultures was collected and examined for the presence of azygospores. Approximately 100 g of soil per pot (500 g of soil per set of pots) was obtained. Soil from each set of pots was individually examined.

Three methods of soil analysis were employed.

1. Wet-sieving and decanting (Gerdemann and Nicolson, 1963). Each soil sample was mixed with 750 ml water. Heavier particles were allowed to settle for a few seconds. The liquid was then poured through a sieve series of 710  $\mu\text{m}$ , 500  $\mu\text{m}$ , and 212  $\mu\text{m}$ . The sieve series was washed in a stream of water. The remaining contents in the beaker were resuspended in water and the sieving procedure was repeated. The material retained on the 212  $\mu\text{m}$  sieve was washed with water. This material was then transferred to a petri dish and examined for azygospores.

2. Sucrose centrifugation (adapted from Mertz, et al., 1979). Material collected in the petri dish was suspended in water, transferred to 50 ml centrifuge tubes, and centrifuged for 1 minute at 850 x g. The supernatant was carefully decanted and the pellet resuspended in 20 ml of distilled water. This solution was then layered by pipette on 20 ml of 20% sucrose contained in 50 ml centrifuge tubes. These tubes were centrifuged for 3 minutes (850 x g). The sucrose-water interface was extracted by pipette and examined under a dissecting microscope for the presence of azygospores.

3. Examination of young plant roots. Young plants, which had been separated from their pot cultures, were examined. Approximately 10-15 plants per pot (50-75 plants per set of pots) were placed singly under a dissecting microscope, and their roots examined for the presence of azygospores.

## Results

Within 3 months of seed germination, VAM colonization was observed in experimental plants. Mycorrhizal colonization in young plant roots was confirmed through microscopic observations in arbuscules and external vesicles on coiled hypha. These structures, characteristic of *Gigaspora margarita*, were observed in young plants grown with inoculum plants as prepared in experiments A and B (azygospores present and azygospores removed, respectively). Thus, inoculum plants with azygospores, as well as those without azygospores, appear to be able to spread the mycorrhizal colonization.

*Soil analysis.*—Wet-sieving and decanting soil samples through a sieve series, and layering and centrifuging the sievings of 20% sucrose, indicated azygospores were present only in cultures where the inoculum plants were transplanted with their azygospores intact. No azygospores were found in soil where inoculum plants had their azygospores removed. Dissecting microscopic examination of young plant roots indicated that no azygospores were attached to their roots, although the young plants had roots with arbuscules and external vesicles on coiled hypha.

*Controls.*—One control contained soil and seeds. No inoculum was added. After a 3-month growing period, no evidence of infection by *G. margarita* was found in the roots, nor were azygospores found in the soil. Re-examination of this control after a 6-month growing period gave identical results.

A second control contained uninfected Bahia grass plants and seeds. Three and 6-months after seed germination, young roots were microscopically examined. Colonization by *G. margarita* was not observed. Soil analysis indicated absence of azygospores in the soil.

A third control contained inoculum plants with azygospores removed from the roots. Examination of the soil for azygospores after a 3 and 6-month period indicated the absence of fungal structures.

## Discussion

An interesting correlation between the presence of arbuscules and the presence of azygospores was noted. Azygospores were found only in cultures whose inoculum plants retained their associated azygospores. Arbuscules, however, were found in all young plant roots that had grown with plants containing the fungus (inoculum plants) regardless of azygospore presence.

Though investigators have speculated on the significance of azygospores in the spread of colonization in plant roots, until this time to our knowledge, no research has been conducted in this area. Results of the present study suggest that the mycorrhizal colonization caused by *Gigaspora margarita* can spread from colonized roots to uninfected roots without the presence of azygospores. We do not assume, however, that other species of *Gigaspora* or other genera of mycorrhizal fungi behave in this manner. Information gathered from our experiments with *G. margarita* also suggests that azygospores may produce two kinds of

mycelia: one that produces azygospores and one that colonizes plant roots. Differentiating these mycelia remains pertinent work for future investigators.

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# Psychology/ Sociology/ Archaeology Section

## Scientific Examination of Claims of the Paranormal: The Case of Astrology

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### Abstract

The case for the existence of verifiable paranormal phenomena is critically examined in light of increasing reports. These are usually anecdotal, yet they are found credible by the populace. One such phenomenon, astrology, was examined by having subjects attempt to compare their real life events with those predicted by astrology. Of 358 attempts only 23 (6%) were "hits," which is lower than chance. Despite many such negative findings by scientists, belief in the paranormal remains relatively strong. Implications for scientific enterprise are given and suggestions are made for bringing scientific thinking to the populace.

### Introduction

Claims of the existence of verifiable paranormal phenomena are becoming more frequent. Senator Claiborne Pell recently called for increased funding of research into extrasensory perception and psychokinesis. Pell, ranking Democrat on the Senate Foreign Relations Committee, admitted he has never had a psychic experience but became convinced of their existence after talks with Soviet scientists last summer. A Congressional Research Service report (Dodge, 1983) suggests that the Russians are years ahead of us in development of psychic powers for strategic purposes.

Public Broadcasting's *Nova* series recently attempted to find a scientific basis for the existence of the paranormal. *Nova* devoted 45 minutes to dramatized recreations of research by parapsychologists and others who claim positive findings but allowed only eight minutes for the opinions of skeptics, and only the believers were permitted to make summarizing comments at the program's conclusion.

Astrology is a case in point. Nearly every newspaper carries a horoscope column. Astrologer Sidney Omarr claims to be syndicated in 300 newspapers. His books, and those of other astrologers such as Jeanne Dixon, often occupy as much bookstore shelf space as do books on fitness and nutrition. The astrologers frequently offer anecdotal evidence and garner support with references to celebrities who agree with them. The present study examines the accuracy of astrological predictions of the type found in newspapers, books, and magazines.

### Methods

To test the accuracy of astrology, we asked 358 introductory psychology students to reflect on the events of the previous day and to select the most accurate of twelve predictions for that day. We eliminated those who had read their horoscopes already. The predictions were authentic and were taken from the astrologers' newspaper columns and books. However, the predictions were presented in scrambled order and without the identifying dates or signs. Each student's task was to briefly read all 12 horoscope statements and then mark the one that seemed most relevant to his or her personal life events from the previous day. Hindsight and the previous day's 12 horoscope statements should allow an individual to correctly select (hit) his prediction, assuming astrology is to some extent valid.

### Results

Whether or not the subjects were believers in astrology, the results were consistent: Horoscopes had no relevance to life events. Only 6% of our subjects correctly identified their previous day's horoscope. Chance alone would have yielded better results, about 8% (Table 1). Accuracy varied from a high of 11% correct selection by students using the *Dell Purse Books* horoscope statements to 2% by students using Sidney Omarr's book.

Also of interest is that Omarr's book and newspaper predictions differed for any given day, no doubt necessarily reducing accuracy for one or the other source. We examined one astrologer's (Omarr) predictions on two different days for the same source, newspapers, with similar results, 5% and 4% hits.

**Table 1. Percentage of Subjects Correctly Identifying Their Astrological Predictions That Were Made by Each of Seven Astrology Sources**

SOURCE	NO. OF SUBJECTS	CORRECT HITS
Sidney Omarr (newspaper)	40	5%
Sidney Omarr (book)	49	2%
Jeanne Dixon	43	9%
Carroll Righter	45	9%
<i>American Astrology</i>	60	3%
Sidney Omarr (newspaper)	49	4%
<i>Dell Purse Books</i>	72	11%
TOTAL	358	6% (n=23)

## Discussion

Our results are consistent with those of other researchers (Dean and Mather, 1977). Yet, astrology somehow retains acceptance in our culture. This is troublesome, or should be, to those who value science.

To study the paranormal a group of skeptical thinkers has formed the Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP). CSICOP is led by Paul Kurtz, Professor of Philosophy at the State University of New York at Buffalo, and includes eminent scientists such as astronomer Carl Sagan, behavioral psychologist B. F. Skinner, and a professional magician, James Randi. Randi has devoted much of his energy to demonstrating how researchers that are predisposed toward it can easily convince themselves that they have witnessed paranormal phenomena. For example, Randi (1983) trained two students to perform psychic-like tricks such as mind reading (ESP) and spoon bending (psychokinesis). The students went to the McDonnell Laboratory for Psychical Research at Washington University in St. Louis and demonstrated their paranormal powers. After much testing under supposedly controlled scientific conditions, Randi's students were proclaimed by the Laboratory's researchers to truly possess psychic ability.

There may be several reasons why our society collectively suspends its good judgment to believe in the paranormal such as astrology, ESP, and the like. First is our tendency toward self-aggrandizement. It is highly reinforcing to believe that supernatural powers lie untapped within us. Second, explanations are satisfying in themselves, and we will accept an improbable one rather than grapple with the uncertainty that arises when events are not explained. Third, quite simply it is *easier* to explain an event by referring to one's stars or paranormal powers than to exhaustively study and reconstruct the real reasons events happen. Fourth, the paranormal has elaborate interest value. Magical explanations capture and hold our attention. This tendency to believe in magic is itself variable according to fairly reliable behavioral laws (Padgett & Jorgenson, 1982). Fifth, scientific progress may, ironically, increase belief in the paranormal. Incredible scientific advances tend to make us believe that anything is possible.

How should the scientific community respond to the continuous stream of paranormal claims? There are several possible answers. We should reject the claims, such as astrology, that have been thoroughly tested and found invalid. We can test new claims as they arise. We can insist that education include cultivation of a skeptical eye toward self-aggrandizing explanations of behavior and events. This may prove to be the best insurance against misinformation that leads to, among other things, frivolous funding of research into paranormal phenomena. Perhaps Senator Pell would do better to recommend federal dollars for research into the development of critical thinking skills in our children. Then in a generation or two our culture would be more likely to objectively evaluate claims of the paranormal.

If we fail to do this we, the scientific community, risk leaving the populace to the vagaries of non-scientific thinking. In every field from



anatomy to zoology our findings will have less impact and science will continue to take a back seat to non-science among large segments of the populace.

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### On the Universality and Necessity of Social Hierarchies

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#### Abstract

In this paper we examine the arguments for the universality and functional necessity of hierarchies in formal organizations generated from both hierarchy theory and the functionalist perspective in organization theory. First, we make a distinction between social hierarchies and other forms of hierarchies on the basis of control. Next, by using secondary and historical analysis we offer evidence of the existence of non-hierarchical human organizations and propose that hierarchy is neither universal nor a necessary functional requirement of an organization. In light of the above findings, we attempt to formulate an alternative

theory of hierarchy. The basic claim of our theory is that where an elite exists, or has developed in society, it will perpetuate hierarchies in organizations as a means of safeguarding or enhancing its positions of considerable interests and power.

## Introduction

In this paper we examine the arguments for the universality and functional necessity of social hierarchies generated from both hierarchy theory and the functionalist perspective in organization theory. The primary focus of our paper is on the hierarchical structures found in formal organizations. By using secondary and historical analysis we offer evidence of the existence of non-hierarchical human organizations and propose that hierarchies are neither universal nor functionally necessary. This proposal, in turn, leads to the problem of explaining the widespread presence and perpetuation of hierarchies in organizations. In light of our findings we contend that social hierarchies are artificially imposed on organizations and are not the result of either a natural evolutionary process or human nature. Furthermore, in examining the human motivations behind the existence of hierarchies, it is our conclusion that hierarchies are imposed on organizations and perpetuated by the elite of a society. From this view, the hierarchical structure in organizations is seen as offering the elite a means of maintaining control in order to preserve its power and protect its interests. On this basis we attempt to formulate a bare outline of an alternative theory of hierarchy in the final section of our paper.

## *Literature Review*

The most widely accepted explanation for the existence and perpetuation of social hierarchies comes from the functionalist perspective in organizational sociology and hierarchy theory. Although hierarchy theory embraces the study of all forms of hierarchies (physical, social, and artificial) its basic assumptions about social hierarchies are quite similar to, and consistent with, those found in the functionalist perspective of organization theory.

In both theoretical perspectives a social hierarchy is generally described as a unidirectional chain of offices where each lower office is under the control and supervision of a higher one (Weber 1947; Pattee 1973). This definition tends to presuppose the idea that social hierarchies are naturally associated with some form of organizational or social structure. In addition to the concepts of offices and controls these theories further characterize social hierarchies as being both universal and functionally necessary for the efficient operation of human organizations.

Social hierarchies are usually regarded as being universal in the sense that they are the inevitable result of the natural evolution of complex systems. In terms of the above definition this would also mean that hierarchical control is an inevitable result of evolution. According to Pattee (1973), in biological evolution increasing complexity of organization is

always accompanied by new levels of hierarchical controls. From the viewpoint of the functionalist perspective this same idea applies to the evolution of social organizations. The seemingly universal existence of hierarchical controls in social organizations is usually explained by one of three possible reasons. The first states that hierarchical control is in some way a law of nature (Pattee 1973). The second reason is that it is an intrinsic part of human nature (Mosca 1939). And finally, there exists the idea that hierarchical control is functionally necessary for human organizations in that it constitutes the most efficient arrangement for any complex system (Simon 1973, Tannenbaum 1974).

The idea that the hierarchical structure is functionally necessary for human organizations is perhaps the most prevalent reason given for the existence of social hierarchies. In particular, the hierarchical structure is considered as being functionally necessary for the operations and achievement of goals in an organization. For Simon (1973), hierarchic structures provide the most viable form for any system of even moderate complexity. The literature of the functionalist perspective in organization theory basically asserts that all organizations must satisfy numerous functional requirements (i.e., cooperation and coordination, etc.) if they are to survive and attain goals. Hierarchy, therefore, is seen as a necessary pre-requisite for the actualization of these requirements. These functional requirements are determined and directed by the offices and positions at the highest levels of the hierarchies (see Gulick 1937; Olsen 1968; Michels 1962; and Tannenbaum 1974). The general assumption underlying the functionalist argument is that the hierarchical structure serves to maintain harmony and increase efficiency in an organization by satisfying the needs of all its members. This set of conclusions, however, seems to be arrived at from an analysis of the cause of hierarchy in terms of its consequences rather than its antecedents. Furthermore, this justification seems to assume that the goals and motivations of the lower levels are congruent with those of the higher levels.

From examining the literature on hierarchical structures in general we found two characteristics which distinguish social hierarchies from other forms of hierarchies. First, social hierarchies are structured in terms of control where each higher level has control over all the levels below it. Physical hierarchies, on the other hand, are based upon levels of complexity which do not always exhibit the characteristic of control. Second, according to Bunge (1969), true hierarchies are completely a human invention and are not found in nature. For Bunge, social hierarchies are characterized by a unidirectional action rather than the reciprocal action found in nature. Together, these characteristics indicate that social hierarchies are unique and their study should be independent from other forms of hierarchy. Also, they show that social hierarchies are a purely human invention and not the inevitable result of a natural evolutionary process.

### Methods

Even if we accept the idea that social hierarchies are a human invention and not a natural law we are still left with two possible explanations

for their seemingly universal existence. In order to test the ideas that social hierarchies exist because they are either a product of human nature or functionally necessary for social organizations we employed secondary and historical analysis to search for non-hierarchical social organizations and structures. To this end, we examined both the anthropological and sociological research literature on human organizations.

## Results

The first example of a non-hierarchical social structure that we found comes from Walter Miller's (1959) study of the tribes of the Central Algonkian Culture. The Europeans who first made contact with these tribes were surprised to find that they look down upon and refuse to comply with direct commands made by anyone. The most that a person in a "leadership" position can do is to make suggestions about a course of action which others, as individuals, are free to follow or not as they see fit. All such positions are temporary, lasting only as long as a particular undertaking.

Nor is the absence of hierarchy confined to so-called "primitive" people. From modern society Stinchcombe (1970) gives us another example of where coordination and related activities are accomplished in other ways than through the bureaucratic hierarchy. His example is that of craft organization. In contrasting bureaucratic with craft administration he makes the point that decisions, which in mass production were made outside the work milieu and communicated bureaucratically, in construction work were actually part of the craftman's culture and socialization, and were made at the level of the work crew. He further indicates that the only "orders" in the building industry are in the form of contracts.

Another example of craft organization was found in the steel industry prior to 1892. Stone (1974) tells us how, before this year, skilled steel workers organized the industry and the owners contracted with them to supply steel. The owners did not control the steel-making process. It was only after the victory of the owners over the union at the termination of the Homestead lockout that an organizational hierarchy was created specifically so that labor could be controlled by management. Marglin (1974) contends that initially, when the capitalist hierarchy was used for coordination, the need for hierarchical integration was contrived by the micro-division of labor. This insured a place as coordinator of the production process for the capitalist, thus guaranteeing his power and profit position.

Rothschild-Whitt (1979) speaks of the many "alternative" organizations created during the 1970s. Her study is based on some 5000 alternative organizations nationwide listed in a 1976 directory. She refers to them as collectivist organizations. According to Rothschild-Whitt, like the anarchists, the aim of these organizations is not the transference of power from one official to another, but the abolition of the pyramid in toto: organization without hierarchy.

## Discussion

It appears that hierarchy is neither a universal nor necessary feature of organizations, since some organizations have operated effectively without the hierarchical characteristics. The existence of these non-hierarchical organizations further dispels the idea that hierarchical control is in some way an intrinsic part of human nature.

Although hierarchy is neither a universal nor necessary attribute of organizations, it might be argued that hierarchically coordinated organizations are more efficient than organizations coordinated by other means. What is the evidence in this regard? Assuming that centralized structure can be equated with hierarchical control and decentralized structure with the absence of hierarchical control, the evidence pertaining to efficiency is as follows. Decentralized structures, according to Vroom (1969), have an advantage for tasks which are difficult, complex, or unusual, while centralized structures are more effective for those which are simple and routinized. This would tend to support Marglin's (1974) conclusion that the micro-division of labor was a good justification for capitalist hierarchical coordination and control. Since the micro-division of labor broke tasks down into their simplest components the centralized capitalist power structure afforded the most viable form of control and coordination.

In the final analysis, which organizational structure and division of labor is more efficient depends on who is defining efficiency and in terms of what criteria. As Rueschemeyer (1977) indicates, what is efficient in terms of one preference structure may be wasteful by other criteria. How efficiency is defined is always and inevitably determined by varied interests and value commitments. Thus there can be no simple agreement that organizations with hierarchical coordination are the most efficient. Furthermore, it is essential to inquire into the values and interests of those who would make such an assertion.

It is our contention that the widespread presence of hierarchy in organizations is not explainable in terms of natural laws, human nature, or functional prerequisites such as coordination. Instead, we feel that it is explainable in terms of extra-organizational considerations subsequently to be dealt with in some detail.

As to the origins of hierarchy, or for that matter, stratification in general, one can only speculate. Harris (1978), for example, sees the origin of hierarchy in the primordial division of labor between the sexes. Lenski (1966), however, views the origin of hierarchy in terms of the possession of power (ultimately force) and the struggle for societal surplus. However, a consideration of the initial causes of hierarchy can be viewed as analytically separate from the question of the causes of its perpetuation. The subsequent discussion will concentrate on the latter.

Hierarchy is an effective means by which the elite of a society can preserve its power and maintain control of a society as well as quickly initiate whatever changes may be necessary to protect its position. If the elite can control, strongly influence, or be those in top policy and administrative positions in the important organizations of a society, then its

interests will be protected and enhanced. It is this usefulness of hierarchy for the elite that explains its widespread presence in organizations.

The various organizational characteristics surrounding hierarchy have changed throughout history (e.g., traditional to rational bureaucracy), but hierarchy has remained. In modern times, we see examples of changes in hierarchical organizations in the form of modifications, but not complete abolition of hierarchy. The basic question remains, is this because of internal organizational necessity or for external organizational control?

It is our thesis that among the alternatives for coordination, hierarchical coordination is chosen by the elite who form organizations because it helps to insure their own power positions in the organization and in society. The former is a secondary consideration while the latter is a primary one from the point of view of the elite. Eisenstadt (1961) develops this theme further by suggesting that bureaucratic organizations develop in relation to such differentiation in the social system. For Eisenstadt, bureaucratic organizations perform important functions in that they can help in coping with some of the problems arising out of such differentiation (i.e., organization of adequate services and coordination of large-scale activities). In addition, he claims that such bureaucratic organizations are usually created by certain elites (rulers, economic entrepreneurs, etc.) to deal with the problems outlined and to assure for these elites both the provision of such services and strategic power positions in the society.

Specifically, how is hierarchy useful to an elite in the maintenance of its position? First, it is useful because it operates in favor of those at the top and against those at the bottom. No one in lower level positions can veto an order coming from the top. However, recommendations coming from lower levels may be vetoed at any higher point in the hierarchy. Second, it provides a means for monitoring and controlling lower level subordinates with the help of higher level subordinates. Third, hierarchy places various forms of power and authority at the disposal of the elites.

Although there is a widespread existence of hierarchy in organizations, we also discovered organizations in which hierarchy was not the defining characteristic. Thus, we were led to conclude that hierarchy is neither universal nor a necessary functional requirement of an organization.

In light of the above findings, we attempted to formulate a bare outline of an alternative theory of hierarchy. Our theory does not predict universality, but only that where an elite exists, or has developed in a society, it will perpetuate hierarchies in organizations as a means of safeguarding or enhancing its own positions of considerable power. Although we did not specifically consider the reward system in our alternative explanation, the protection of the interests of the elite would obviously include a reward system which was organized in their favor.

## Conclusion

In conclusion, it is our opinion that the existence of non-hierarchical organizations opens the door for further research on other viable forms of organizational structures.

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# Site Distribution, Cultural Models and Prehistoric Lithic Scatters from the Eastern West Virginia Uplands

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## Abstract

Problems in the interpretation of upland lithic scatters based on six years of archaeological site survey and test excavations on the Monongahela National Forest are reviewed and compared with adjacent areas. Settlement models previously described for the uplands are discussed and a derived model based on testing of selected lithic scatters is presented. However, it is argued that settlement distribution models are limited in scope and useful primarily as predictors of site locations. Directions for current and future research on lithic scatters are discussed.

## Introduction

Over the past six years, archaeological research on the Monongahela National Forest has included both compliance oriented project surveys by paraprofessionals and problem-oriented survey and testing by staff archaeologists and contractors.

Research prior to 1981 was limited to relatively few survey and test excavation projects and site reports by collectors. Most of this work occurred in the broader river floodplains of the Tygart (Broyles 1964, 1967), Cheat (Jensen 1970), and South Branch of the Potomac rivers (Sites 1968; Geier et al. 1981). A collector interview survey of Nicholas County by McMichael (1965) identified numerous upland sites. Several contract archaeological survey projects have been accomplished, notably surveys of proposed routes of Corridor H and the Highlands Scenic Highway (Cunningham and Barse 1979). Further work is summarized in the Monongahela National Forest Cultural Resource Overview (Davis 1978).

Brashler (1984a), in a summary of archaeological survey and limited test excavations on the Monongahela, observed similarities to the diffuse end of Cleland's (1976) Focal-Diffuse model in Archaic settlement patterns, and suggested approaches for future research. Since that time selected upland sites have been tested. These excavations have suggested a number of problems apparently inherent in the interpretation of upland sites.



The objective of this paper is to review what the authors see as problems common to the interpretation of upland lithic scatters and to review and suggest models and procedures for interpreting these limited data sets.

### **Directions of Current Research**

Archaeological surveys on the Monongahela National Forest have identified 265 sites described as lithic scatters in our forest records (Monongahela National Forest Site File). These upland scatters occur in all environmental zone associations on the Forest (Brashler 1984a). As a result of those surveys the authors were able to construct a testable site distribution/settlement model for the area.

In addition, excavations have been conducted at 30 test sites during the past four years (Figure 1). It was hoped that these excavations would enhance our knowledge of area settlement patterns and provide insight beyond strictly cultural-historical data. But we have been disappointed in that goal for a variety of reasons.

### **Problems in Data Collection at Upland Lithic Scatters**

During test excavations numerous problems common in upland lithic scatter studies were encountered. Similar problems have been discussed by other researchers in the eastern uplands including Foss (1983) and Tolley (1983) in the Blue Ridge, Geier in the Ridge and Valley (1983), and others.

With few exceptions, the sites are shallow in nature, with most extending less than 20 centimeters below the ground surface. Most sites are represented by scatters of lithic debris with debitage making up more than 95% of the site assemblage. Numbers of tools as well as tool categories are poorly represented. There is a general lack of diagnostic artifacts. Our tested lithic scatters have also lacked any demonstrable stratigraphic context. There is a general lack of evidence for features of any kind. Low pH values (pH 4-5) are a limiting factor in the preservation of any organic material or other environmental data including a lack of carbonized material for radiocarbon dating. Finally, few of the lithic scatters we have investigated represent single occupations. We apparently are not looking at discreet units, but rather at multiple components.

The limitations for interpretation imposed by these problems have focused the attention of most archaeologists on developing settlement models and site distribution patterns before culture history is clearly understood.

### **Settlement Models and Patterns**

Reviewing the literature on upland sites and lithic scatters, numerous settlement models are suggested. Recently published models near our study area include those proposed by Wall (1981), for the Western Maryland coal region, and Gardner (1983), Stewart (1983) and Barber (1983) for the Blue Ridge. Cunningham (1983) has proposed a settlement/sub-

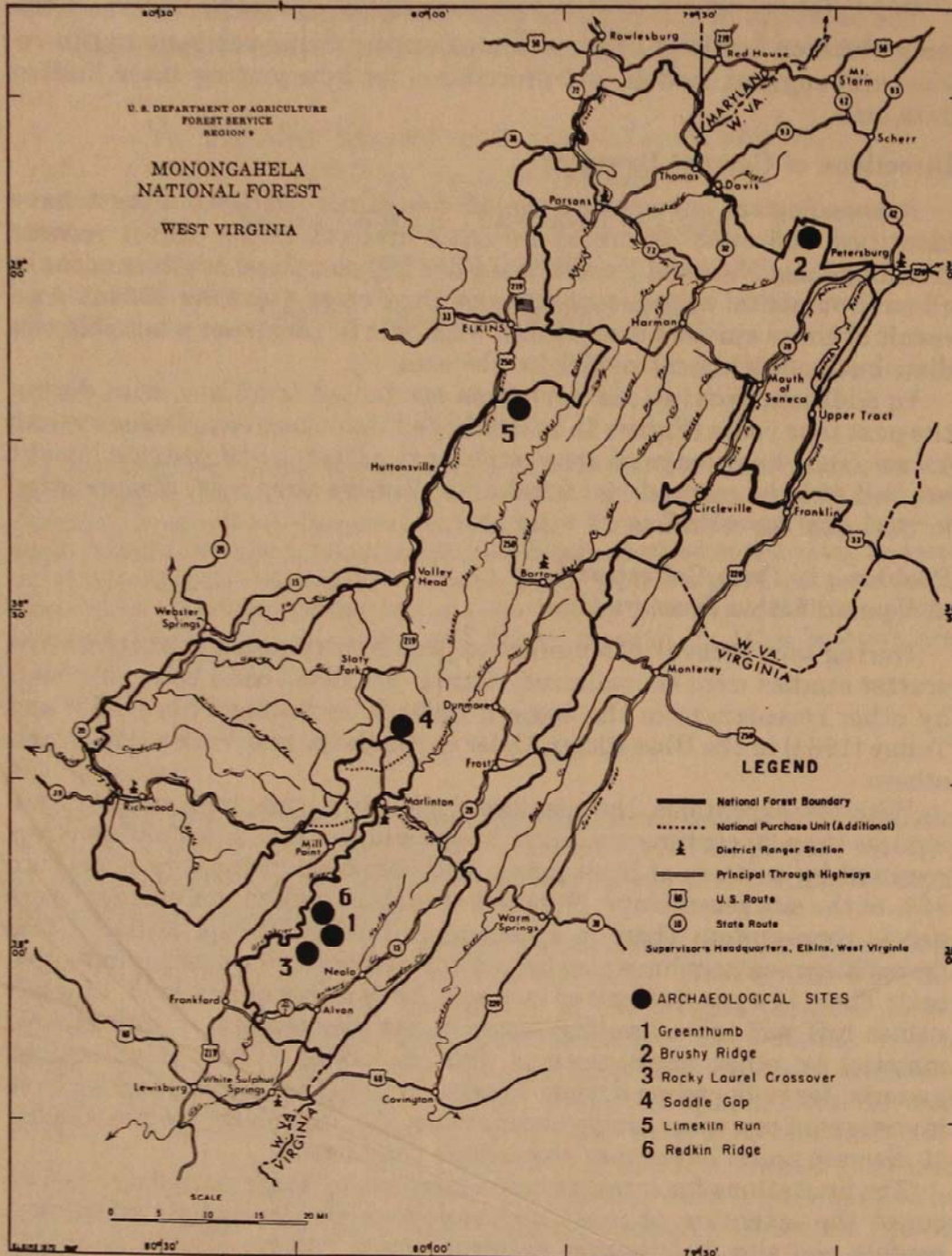


FIGURE 1. Locations of Archaeological Sites Discussed Within the Text.

sistence pattern in the Ridge and Valley section of the Potomac Highlands of eastern West Virginia. Geier (1983) outlined a settlement sequence for the headwater streams of the James River in Virginia's Ridge and Valley.

Some of these models identified functional types of sites with each type having a specific role in the settlement-subsistence system. Most of

the models were constructed from a subjective ordering of variables rather than a quantitative attempt to cluster the sites as noted by Foss (1983).

With the exception of Gardner's (1983) discussion of Paleo-Indian settlement near preferred lithic sources, most models only mention this period due to the lack of known sites. They contain a similar theme of Middle-Late Archaic Period fission and fusion from base camps to procurement sites to temporary stations, a pattern that many note may have continued in some manner from the Archaic through the Woodland Period in much of the eastern uplands. Most agree there was a decreased use of the uplands during the Woodland Period, however (Cunningham 1983; Foss 1983; Stewart 1983; Wall 1981), with more intense settlement along floodplains and terraces, especially during the later Late Woodland and Late Prehistoric.

#### **Proposed Settlement Model and Examples from the Monongahela National Forest**

Based on survey and test excavations, the authors have proposed a settlement model with a site typology similar to that of Foss (1983) for the Shenandoah National Park. Included is a site typology of base camps, procurement-exploitative camps, transient stations and special function sites.

There is currently no real evidence to differentiate floodplain base camp sites from upland base camps as Foss has done in the Shenandoah National Park (1983). Floodplain base camps have been examined on the Tygart and North Fork of the South Branch of Potomac River drainages. The sites are large (.40 to 1.2 hectares), multicomponent loci containing extensive lithic workshops with a variety of tool types, limited features and a general lack of stratigraphic context. Upland base camps we have investigated are located in special settings with the greatest potential for maximum habitat diversity and access to adjacent drainages and ridgetops.

One upland base camp, the Greenthumb site, was tested in 1984. The site is located on the north and south banks of the headwaters of Laurel Run near White Sulphur Springs at an elevation of 853 meters. Over 4,000 artifacts were recovered from 22 square meters at the site. Greenthumb is multicomponent with one fluted projectile point base recovered as well as numerous Middle-Late Archaic and Woodland diagnostics. Two prehistoric hearth features were noted at the site based on fire cracked rock concentrations and scattered charcoal insufficient for dating purposes. The site is shallow with no stratigraphy and with evidence of cultural mixing probably due to its setting in an active headwater floodplain. The site is adjacent to a .40 hectare marsh with easy access to the extensive ridgetops of Slabcamp and Hopkins Mountains (Lesser and Brashler 1984a).

Another upland base camp is located on a flat at the juncture of the head of two stream tributaries on the Fore Knobs in the northeastern end of the Monongahela near Petersburg, West Virginia. The Brushy

Ridge site lies at an elevation of 914 meters in a setting halfway between the valley of Jordan Run and the South Branch of the Potomac and the high altitude wetlands of Dolly Sods on the Allegheny Front. The site has not been tested but survey and examination of a vandalized area revealed it to be a large multicomponent site with evidence of diverse tool types, including over 60 projectile points, an extensive lithic workshop and features. Brushy Ridge diagnostics include Early Archaic through Late Woodland types including MacCorkle, Savannah River and other broadspear points, Jacks Reef points, chert and grit tempered ceramics; and Levanna and Madison-like triangular points (Brashler 1984b).

Wall has suggested that the Brushy Ridge site was located in a setting to best exploit the high altitude wetlands of the Allegheny Front above as well as to make lithic resource procurement and hunting/foraging trips down to the floodplains of Jordan Run and the South Branch of the Potomac (Wall 1986).

Procurement-exploitative sites are located in topographically favored areas, such as at the confluence of tributary streams, on upland flats or protected benches, near large springs or in strategic mountain gaps with access to different drainages. These sites are the probable result of smaller task-specific group forays from upland base camps. The functional variability of recovered artifacts indicates these sites were geared to the exploitation of one or more locally available resources. Procurement-exploitative sites tend to be smaller than the upland base camps, sometimes multicomponent with an emphasis on Late Archaic diagnostics and evidence of repeated occupation. No stratigraphy or features are evident.

Rocky Laurel Crossover is a procurement-exploitative site located in a low gap connecting two prominent ridge systems approximately three kilometers southwest of the Greenthumb base camp site at the southern end of the Monongahela. The site was tested in 1984 and lies at an elevation of 908 meters. Identifiable diagnostic projectile points from the site include Brewerton side-notched, Buffalo stemmed, Lamoka, and Savannah River. Most specimens are made of local chert but several are of quartzite. Rocky Laurel Crossover is an extensive site covering the entire gap and adjacent ridge flat. There is evidence of more primary lithic reduction activity than at the adjacent Greenthumb base camp.

Discrete activity areas at the site may represent repeated occupations through time. No features were revealed during test excavations of nine square meters.

We believe Rocky Laurel Crossover was strategically located along a transportation route in the low gap for easy access to the adjacent Hopkins Mountain or Peach Orchard Ridge tops as well as the headwaters of two major stream drainages (Lesser and Brashler 1984b).

Another procurement-exploitative site located in the southern part of the Monongahela National Forest was tested in 1985. The Redkin Ridge site is located on an upland ridge flat separating two drainages. The site is located approximately 6.5 kilometers northeast of the Rocky Laurel Crossover site at an elevation of 877 meters. Shovel tests and four test

excavation units at the shallow site yielded 350 pieces of lithic debitage. The lithic reduction categories at Redkin Ridge are similar to those at Rocky Laurel Crossover, as is the small percentage of tools recovered. Like most upland lithic scatters on the Monongahela, the site is shallow, extending to maximum depth of 20 centimeters below the ground surface. No diagnostic artifacts were revealed. No features were evident. The site lies along the edge of a short steep slope with a prominent view below into the drainage of Red Run. The site may have been a hunting station located strategically for ambush or lookout purposes and visited repeatedly through time (Lesser 1985a).

One more procurement-exploitative site merits discussion. The Saddle Gap site is located in a prominent ridge saddle on a grazing area near Edray in Pocahontas County. Site elevation is 1146 meters. The site area is currently open pasture land. Test excavations at Saddle Gap were conducted in 1984. Seven projectile points and bases were recovered along with a small assortment of bifaces and scrapers. One Kirk corner-notched projectile point was recovered during surface survey. The remaining diagnostics are all Morrow Mountain II points, suggesting a Middle Archaic occupation. No features were revealed during the testing. Most artifacts were in the first 20 centimeters below ground surface and no charcoal or environmental data was present. The Saddle Gap site covers .60 hectares but revealed a much lighter density of lithics than the other investigated sites.

Almost 4,000 prehistoric artifacts were recovered in 22 square meters excavated at the Greenthumb base camp and almost 1,800 in nine square meters at Rocky Laurel Crossover. In nine square meters excavated at Saddle Gap, only 398 artifacts were revealed. But the significant category at Saddle Gap is the percentage of ground and pecked stone recovered at the site—5.3% of the entire collection. It seems likely that these represent a nut processing industry, but other functions are possible. These artifacts are generally absent from the other investigated sites. This data suggests that Saddle Gap may have been a short-term nut gathering and processing site occupied during the Middle Archaic as part of the seasonal pattern of exploitation which was developing (Wall 1981; Jennings 1974; Lesser and Brashler 1984c). However, given the problems mentioned above, we can't be sure that points are associated with the nut processing material.

Transient stations are the small, (usually less than 12 meters in diameter) temporary, almost ephemeral types of sites documented in our research. Four transient stations have been tested on the Monongahela National Forest. All are high altitude sites, ranging in elevation from 1265 to 1340 meters. Transient stations are also common at lower elevations however and these sites are the most widely scattered and numerous we have noted. They occur in all types of land forms with little demonstrable associations to water sources or other resources (Foss 1983). They are most commonly found in low gaps, however. Low gap transient stations tested on the Monongahela commonly manifest a very limited amount of lithic debitage, rarely any tools or diagnostic artifacts

of any kind or other indicators of even temporary occupation (Brashler 1984). We believe many of these low gap transient sites may represent short term camping locations for small groups along prehistoric travel routes. Since many low gap locations are natural crossover points for game animals, the sites may also represent short-term hunting stations. It is interesting to note that many of these site locations display modern hunting debris and permanent tree stand platforms (Brashler 1984c; Lesser 1985b). One special function site was tested on the Monongahela National Forest in 1983. Limekiln Run is a lithic reduction site located on a sandstone bench near an outcrop of Greenbrier series limestone on the west slope of Cheat Mountain near Beverly, West Virginia, at 731-853 meters above sea level. From the limestone outcrop, Greenbrier chert was collected or extracted and transported to the site for reduction. The artifact assemblage consisted primarily of raw material, cores and various categories of reduction flakes, more than 96% of which was the local Greenbrier chert type. Little material representative of activities other than reduction was revealed.

Five projectile points recovered suggest a Late Archaic occupation. Most of the tool types were fashioned from non-local materials suggesting a curated tool kit brought to the site (Schindler et al. 1982). Again, the site was shallow with no evidence of features or stratigraphic development (Brashler and Lesser 1985).

### Discussion

Rather than looking at site distribution and settlement patterns, we have begun looking at the types of questions that can be addressed with the limited data sets described above. Questions about prehistoric exchange and travel routes may be approached by careful study of the diversity of chert types in site collections.

In our Monongahela National Forest research, many of the diagnostic artifacts recovered are made of non-local cherts. We have some rhyolite from the east as well as numerous Flint Ridge specimens recovered from the North Fork Valley. Many of our non-local cherts are not even identifiable at present. Such studies are currently limited by a general lack of precision in our knowledge of chert sources.

Cooperation between archaeologists in different portions of the Appalachians is needed to determine lithic sources. Our attempts to do so with geologists have met with failure due to differing philosophical perspectives and research orientations.

Another example of going beyond site distribution with lithic scatter studies involves our analysis of the Limekiln Run reduction site. With 584 pieces of lithic material, we were able to gain insight into tool technology and reduction strategies used on a little known chert type in the Plateau Region (Brashler and Lesser 1985).

We are also currently investigating intra-site variability in lithic types on a large lithic scatter at Seneca Rocks excavated last fall. Testing has revealed differing distributions of chert and sandstone debitage which may enable us to define multiple components despite a lack of stratigraphy.

Settlement models as currently used are actually settlement distribution patterns which describe human-land relationships (human ecology). They are functional in character and are limited in scope. Existing models are useful primarily as site location predictors for land managers and say relatively little about behaviors associated with social organization, mortuary and religious behavior, or for that matter, much about subsistence or economics.

We would prefer to be able to develop and rely on models which allow a clearer insight into the more complex behavior of past peoples as opposed to their choices of site location. This is especially true in areas where topography severely limits choice.

Parsons (1972) has noted that conceptual requirements of settlement pattern archaeology stem from a general failure of anthropologists to develop adequate models from historical and ethnographic data. These data can be used to help structure the known archaeological record, to help formulate new questions and new problems, and to design new research programs. For example, in a recent review of ethnographic and historic literature, Malouf (1987) compiled historic and ethnographic accounts relating to distances Indians are willing to travel for various purposes. John McCullough, a captive among the Delaware between 1756 and 1764, noted that the Indians would return with only the skin of a deer killed a long distance from camp, sending their wives for the carcass later. A 19th century account of the Delaware and Shawnee in Missouri suggests that they established hunting camps some eight to ten miles above their town (Peck in Malouf 1987). Thus, it would appear that ethnographic and historic literature can be useful for developing better models and perhaps can also provide more humanistic interpretations of culture history allowing us to look at lithic scatters as byproducts of activities engaged in by real people not simply ubiquitous problematical phenomena.

### Conclusion

Lithic scatters are integral parts of an overall settlement system which can never be fully understood without their investigation (Glassow 1985). Based on tested scatters in the eastern West Virginia uplands, data sets from lithic scatters are often limited in their ability to yield cultural data. Refining our settlement models to include anthropological and ethnographic data may be the key to understanding and interpreting the cultural adaptations represented by upland sites.

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# Zoology

## Section

*Chaetogaster limnaei* (Oligochaeta: Naididae)  
in Three Species of Aquatic Snails  
from Mason County, West Virginia

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### Abstract

*Chaetogaster limnaei* was recovered from 157 of 206 (76.2%) *Helisoma anceps*; 34 of 71 (47.9%) *Physa* sp.; and 24 of 63 (38.1%) *Lymnaea (Pseudosuccinea) columella* over a nine month period (March through November 1984). A three way Chi-Square contingency test of prevalence rates verified that *H. anceps* was the "preferred" host species while *L. (P.) columella* was the least desirable host species. Differences in mean intensity levels of 4.9, 3.8, and 5.3 for *H. anceps*, *Physa* sp., and *L. (P.) columella*, respectively, were not significant. Regression analyses revealed positive correlations between size of infected host and number of *C. limnaei* individuals present for all three host species, however, only one regression curve—that plotted for height of *L. (P.) columella* versus number of *C. limnaei* individuals—was significantly different from zero.

### Introduction

While working on a project involving larval trematode infections, snails were frequently found infected by *Chaetogaster limnaei*, von Baer, an aquatic annelid worm long known for its association with gastropod molluscs (Walton, 1906; Sperber, 1948). As a result, records were kept to determine: 1) prevalence and intensity of *C. limnaei* infections in three target snail species, 2) if any species of snail was a "preferred" host, and 3) if there was any correlation between intensity of *C. limnaei* infection and size of host.

## Materials and Methods

Three hundred forty snails—206 *Helisoma anceps* (Menke, 1830); 71 *Physa* sp.; and 63 *Lymnaea (Pseudosuccinea) columella* Say, 1817—were collected from McClintic Wildlife Station Pond #6, West Virginia (MG 07540746 USGS Topographic Map, Cheshire Quadrangle 1968, Photo-revised 1975) over a nine month period in 1984, and examined for *Chaetogaster limnaei*. Surface water of Pond #6 had pH values of 6.9 to 7.3, a CaCO<sub>3</sub> content of 3 to 4 gr/gal, and dissolved oxygen levels of 3 to 11 mg/l. Water temperatures for collection dates are given in Table 1.

When collected, each snail was placed in a separate snap-cap vial with ~ 100 ml of pond water (to preclude migration of naids from one snail to another) then transported to the lab. Snails were kept segregated in a Freas Model 816 low temperature incubator at temperatures approximating water temperature on date of collection. Within six to 24 hours of capture, all snails were measured for shell diameter (*H. anceps*), or shell height (*Physa* sp., *L. (P.) columella*) with vernier calipers to the nearest 0.1 mm. Snails were then dissected and examined individually with the aid of a Zeiss stereomicroscope. The number of *C. limnaei* individuals was recorded for each snail.

*Chaetogaster limnaei* individuals were examined alive in water mounts, and identified by using the key of Hiltunen and Klemm (1980). Additional specimens were killed either by freezing, or with 10% buffered formalin, stained with diluted Semichon's acid carmine (in 70% ethanol), dehydrated in an ethanol series, and cleared in methyl salicylate before mounting in Kleermount®.

The ecological terms of prevalence and mean intensity follow the definitions of Margolis et al. (1982).

## Results and Discussion

*Chaetogaster limnaei* infections were found in all three species of snails examined (Tables 1 and 2). Differences in prevalence rates, based upon a 3 x 2 Chi-Square contingency table, were significant ( $P = 0.0001$ ). The "selectivity" for hosts (*Helisoma anceps* in this case) is not unique. Buse (1974) introduced 30 *C. l. limnaei* individuals (removed from *Lymnaea peregra*) into a 30 cm diameter bowl with four snails each of *L. peregra*, *L. stagnalis*, and *Planorbis corneus*. After seven days he found that, "... the worms were equally distributed between *L. peregra* and *P. corneus*, but did not infect *L. stagnalis* to any extent."

When compared with two other studies in West Virginia, the prevalence rate of 76.2% for the "preferred" host, *H. anceps*, was noticeably lower than the 93.4% recorded for *H. trivolvis*, the red Ram's Horn (Joy and Welch, 1984), but higher than the 55.3% for *Oxytrema canaliculata*, the operculate river snail (Joy and McBride, 1983).

Seasonal patterns in prevalence rates were not evident in the present study (Table 1). Similarly, Joy and Welch (1984) found that monthly prevalence of *C. limnaei* in *H. trivolvis* from March through November was relatively constant. Still, seasonal patterns in prevalence for *C. limnaei* infections have been observed. For example, Joy and McBride

Table 1. Prevalence (P) and mean intensity (I) of *Chaetogaster limnaei* in snails from McClintic Pond #6

Collection Date (1984)	water temp. °C	<i>Helisoma anceps</i>		<i>Physa</i> sp.		<i>L. (P.) columella</i>	
		P	I	P	I	P	I
30 Mar	12	10/10	4.8 ± 2.5	2/10	4.0 ± 4.2	5/10	8.4 ± 5.9
8 Apr	16	14/16	4.2 ± 2.5	0/9	—	1/4	2.0 ± 0
23 Apr	15	18/19	7.2 ± 3.3	2/7	1.5 ± 0.7	2/3	13.0 ± 15.6
10 May	26	10/15	3.5 ± 2.3	11/13	3.5 ± 2.2	2/2	8.5 ± 9.2
11 Jun	31	9/10	2.3 ± 1.4	9/12	5.3 ± 2.8	0/0	—
26 Jun	32	11/12	4.4 ± 1.7	0/6	—	1/4	1.0 ± 0
16 Jul	32	11/11	8.5 ± 4.4	4/8	1.8 ± 1.0	2/5	1.0 ± 0
26 Jul	26	15/23	4.6 ± 4.0	1/1	2.0 ± 0	0/0	—
11 Aug	26	8/18	4.4 ± 4.8	0/0	—	0/0	—
27 Aug	26	5/9	6.0 ± 6.4	4/4	4.3 ± 2.1	2/11	2.5 ± 2.1
4 Sep	22	11/13	5.7 ± 4.0	0/0	—	0/0	—
14 Sep	22	14/19	4.0 ± 2.9	0/0	—	2/7	1.5 ± 0.7
29 Sep	12	7/15	3.4 ± 1.9	0/0	—	0/0	—
16 Nov	6	14/16	4.1 ± 1.9	1/1	4.0 ± 0	7/17	4.0 ± 3.9
		157/206	4.9	34/71	3.8	24/63	5.3

(1983) noted that prevalence of *C. limnaei* in *O. canaliculata* paralleled mean water temperatures and was highest (at 100%) for July, August, and September. Streit (1974) reported an earlier seasonal peak (at 100% for May and June) for this naiad species infecting the river limpet, *Ancylus fluviatilis*. Gruffydd (1965) noted that high prevalence rates for *C. limnaei* in *Lymnaea pereger* occurred during February through May (100%) and again in November ( $\cong 90\%$ ). He added that prevalence was virtually zero in June because of large numbers of young snails hatching that were not infected. Young (1974) reported a similar seasonal pattern for *C. l. limnaei* on *Physa frontalis* and *L. pereger*, while Buse (1971) reported a decrease of *C. l. vaghini* in *L. stagnalis* populations after May or June also due to hatching of young snails.

Table 2. Number of observed cases of *C. limnaei* infection in three different snail species from McClintic Pond #6

Species of Snail	Number of Snails in Sample		
	infected	non-infected	total
<i>H. anceps</i>	157	49	206
<i>Physa</i> sp.	34	37	71
<i>L. (P.) columella</i>	24	39	63
	215	125	340

Intensity levels (mean number of *C. limnaei* per infected snail) were generally low; 4.9, 3.8, and 5.3 for *H. anceps*, *Physa* sp., and *L. (P.) columella*, respectively (Figures 1, 2, and 3; Table 1). An ANOVA (F ratio) revealed no significant difference between those means at the .05 level. Overall intensity levels were similar to those reported by Joy and McBride (1983), but somewhat less than the  $\leq 18$  recorded by Joy and Welch (1984). Not all *C. limnaei* infection intensities are low, however. Gruffydd (1965) reported a peak intensity in May (mean  $\sim 40$ ), while Gamble and Fried (1976) noted that the number of *C. limnaei* per snail (*Physa acuta*) "... varied from a few to 70 during the spring and summer ..." while the infection intensity declined precipitously during the winter.

Gruffydd (1965) was the first to suggest that host size may be correlated with intensity of infection. Although he provided no specific calculations he did state that, "... in general, large snails harbor more *Chaetogaster* than smaller snails." Buse (1971) noted a positive correlation between size of snail (*L. stagnalis*) and number of *C. l. vaghini* individuals. Streit (1974) was more specific, noting that the number of *Chaetogaster* was highly correlated with host length ( $r = 0.880$ ). Conversely, Joy and Welch (1984) demonstrated a negative correlation between shell diameter of *H. trivolvis* and number of *C. limnaei* individuals was positively correlated with snail size, although that correlation was

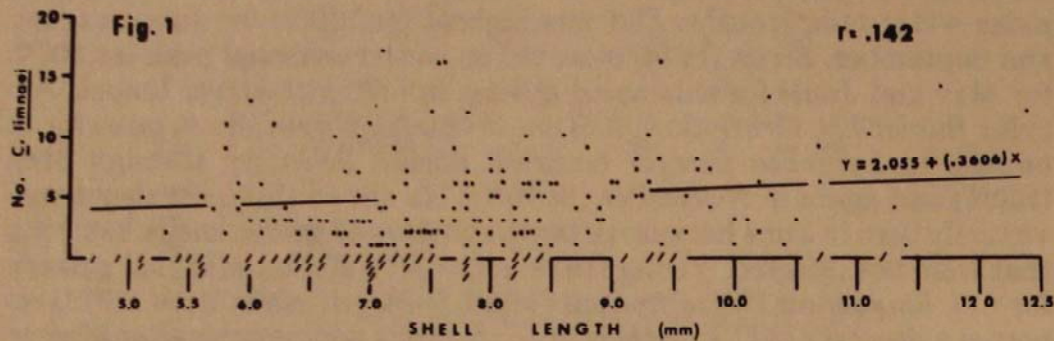


FIGURE 1. Scatter diagram depicting relationship between *Helisoma anceps* shell diameter and number of *Chaetogaster limnaei* individuals. Each dot = single infected snail; each slash = single non-infected snail. Slope of regression curve = 0 ( $t = 1.789$ ;  $p = .075$ ).

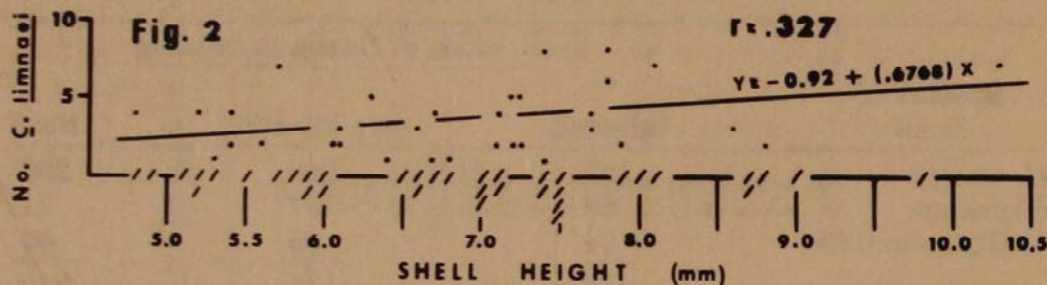


FIGURE 2. Scatter diagram depicting relationship between *Physa* sp. shell height and number of *Chaetogaster limnaei* individuals. Each dot = single infected snail; each slash = single non-infected snail. Slope of regression curve = 0 ( $t = 1.95$ ;  $p = .059$ ).

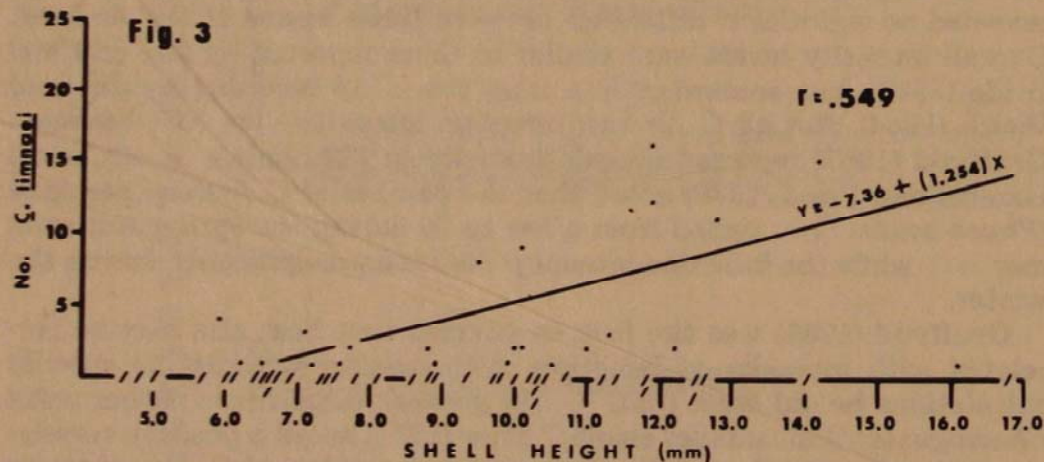


FIGURE 3. Scatter diagram depicting relationship between *Lymnaea (P.) columella* shell height and number of *Chaetogaster limnaei* individuals. Each dot = single infected snail; each slash = single non-infected snail. Slope of regression line  $\neq 0$  ( $t = 3.078$ ;  $p = .005$ ).

significantly different from zero only for *L. (P.) columella* (Figs. 1, 2, and 3).

#### Acknowledgments

I am indebted to Dr. Carol Stein, The Ohio State University Museum of Zoology, for identifying the snails *Helisoma anceps*, and *Lymnaea (Pseudosuccinea) columella*. Thanks are also extended to Dr. Joseph Lichtenstein and Dr. Stuart Thomas, Marshall University, for statistical assistance.

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**Food Habits of the Freshwater Drum, *Aplodinotus grunniens* (Rafinesque) (Pisces: Sciaenidae) from the Gallipolis Locks and Dam, Ohio River**

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**Abstract**

Food habits of freshwater drum, *Aplodinotus grunniens* (Rafinesque), from the Ohio River at Gallipolis Locks and Dam, were determined in October and November 1981 and from March through November 1982. Drum were found to feed most intensively in the summer. Regression analysis of the number of stomachs with food and seasonal water temperature exhibited a high positive correlation ( $r = 0.80$ ). Fishes were the most important food item, both by weight (80.2%) and frequency of occurrence (90.2%). The emerald shiner, *Notropis atherinoides* (Rafinesque), was the primary fish consumed during the study with the gizzard shad, *Dorosoma cepedianum* (Lesueur), becoming more important as the year progressed. Aquatic invertebrates, mainly the trichopterans *Hydropsyche orris* and *Cheumatopsyche* sp., served as secondary food sources in the drum's diet. Crayfishes, *Corbicula* clams, and terrestrial invertebrates were of minor importance. Food habits of adult drum varied little with either season or size.

**Introduction**

The freshwater drum, *Aplodinotus grunniens* (Rafinesque), is a commercial fish rather than a sport fish even though it is taken incidentally by anglers for other species (Scott and Crossman, 1973). United States and Canadian commercial fisheries have a combined annual catch of 3 to 5 million drum from the Great Lakes. A number of investigators, including Forbes (1878), Ewers (1933), Dendy (1946), Daiber (1952), Swedberg (1966), Priegel (1967), Griswold and Tubb (1977), and Sule et al. (1981), provided some general information on the food habits of *Aplodinotus*, but only Rafinesque (1819), Hulbert and Schwarze (1910), and Forbes and Richardson (1920) provided brief notes on populations in the Ohio River. The objectives of this investigation were to determine: (1) diet composition of an Ohio River drum population, (2) whether or not food items vary seasonally, and (3) the feeding relationships among different size classes of drum.

**Materials and Methods**

*Study area.* Gallipolis Locks and Dams is one in a series of flood and navigational control dams situated on the Ohio River at river mile 279



(latitude 38°40'53" N, longitude 82°11'22" W; U. S. Army Corps of Engineers, 1980). Its navigational pool extends 67.6 km upriver to Racine Locks and Dam and 49.9 km (31 mi.) up the Kanawha River to Winfield Locks and Dam. Gallipolis Locks and Dam is in the Middle Ohio Valley, between Gallia County, Ohio and Mason County, West Virginia and within the Kanawha section of the Appalachian Plateau Physiographic Province.

*Methods.* A weekly creel survey, conducted immediately below the Gallipolis Locks and Dam in October and November 1981 and from March through December 1982, provided us with 186 drum stomachs donated by cooperative fishermen. The following disadvantages are recognized in using angler-caught fish for food habits: (1) mainly hungry fish are caught, (2) angling may increase incidence of regurgitation, and (3) problems in not recognizing stolen bait in stomachs.

Total length for all specimens was measured to the nearest millimeter then specimens were transported on ice to the laboratory and frozen. Many fish were eviscerated in the field, then viscera were placed in separate plastic bags, transported on ice to the laboratory, and stored in a freezer. In the laboratory, stomach contents were washed into a watch glass and examined with a binocular dissecting microscope. All identifiable organisms and fragments were counted as whole organisms; stomachs containing no distinguishable food items were considered empty.

For each monthly collection the following data were obtained: (1) percentage of stomachs with food in which a particular taxon occurred (the percent frequency of occurrence), (2) percentage of the total number attributed to each taxon, and (3) percentage of total volume (by wet weight) of all taxa made up by the combined assigned weight of each taxon.

Bias owing to partial food digestion was overcome by calculating the original weight of individuals (Lagler, 1956). An approximate live weight was obtained by averaging the weights of 30 undigested individuals of the same species. The assigned weight refers to the average weight for a particular species.

To determine if seasonal variation exists in the feeding habits of the drum, we arbitrarily grouped data as follows: spring (April, May), summer (June, July, August), and fall (September, October, November). An attempt to collect a winter sample was unsuccessful because of poor weather conditions and the absence of fishermen.

Fish were arbitrarily divided into six length classes to determine if food habits varied with size: 249 mm and less, 250-299 mm, 300-349 mm, 350-399 mm, 400-449 mm, and 450 mm and greater.

## Results and Discussion

We examined 216 freshwater drum stomachs, 186 adults and 30 young-of-the-year, from Gallipolis Locks and Dams. Ninety-six (51.6%) of the adult and 20 (66.7%) of the smaller drum stomachs contained food. The percent of adult drum stomachs with food was highest in May (77.3) and lowest in September (32.0). Seasonally, the percent of stomachs with food was highest in the summer (56.0) and lowest in the fall (34.3).

A positive correlation ( $r = 0.80$ ) between seasonal water temperature and the number of stomachs with food emerged, suggesting that feeding activities of the drum increase as seasonal water temperature rises.

*Food of adult freshwater drum.* Fishes were the primary food of adult drum, both by frequency of occurrence (80.2%) (Fig. 1) and weight (90.2%). The emerald shiner, *Notropis atherinoides* (Rafinesque), was the most important fish in the drum's diet, occurring in 63.5% of the stomachs with food. This fish also composed 66.1%, by weight, of all fish eaten by *Aplodinotus*. These results are not surprising, for the emerald shiner is the most abundant fish in the Ohio River (Clay, 1975). Other identifiable fish were the gizzard shad, *Dorosoma cepedianum* (Lesueur), and darters, *Etheostoma* spp. Shad were found in 12.5% of the stomachs with food and accounted for 29.1%, by weight, of the piscine portion of the diet. Darters occurred in 3.1% of the stomachs containing food and composed 3.0%, by weight, of all fish.

Dendy (1946) reported that drum in Norris Reservoir substituted a diet of fish for their preferred diet of mollusks. Several species of fish, including the emerald shiner, were found to be of little importance in the feeding habits of drum from western Lake Erie (Daiber, 1952), but Berner (1951) found that fish made up the largest portion, by percent volume, of the drum's diet in the lower Missouri River. Moen (1955) reported that fish were a secondary food source for freshwater drum from four Dickinson County, Iowa, lakes. Fish made up a minute portion of the drum's diet in Lewis and Clark Lake, South Dakota, according to Swedberg (1966, 1968). Priegel (1967) reported that drum fed sparingly on fish in Lake Winnebago, Wisconsin, and Griswold and Tubb (1977) found fish, particularly the gizzard shad, to be of secondary importance as a food source of drum in Sandusky Bay, Lake Erie.

Three crayfishes (*Cambarus* sp.) made up the second highest percent (6.6) by weight of food eaten by the drum. However, they cannot be considered a major food item because they occurred in only 3.1% of the stomachs. Mussels also cannot be considered a major food source, as they composed only 2.0% of all food organisms by weight and exhibited a frequency of occurrence of 2.1%. *Corbicula fluminea* was the only mussel found in drum stomachs in our study.

These findings differ somewhat from those of previous investigations. Forbes (1878) stated that mollusks, particularly freshwater mussels, were the primary food of freshwater drum in Illinois. Forbes and Richardson (1920) found that drum in the Illinois River fed mainly on mollusks with "crawfishes" sometimes being found in their stomachs. Mollusks, with an occasional fish or crayfish included, were the primary food of drum according to Van Oosten (1937). Daiber (1952) found the crayfish *Cambarus* in 13.8% of stomachs examined and ranked it third in overall importance. *Cambarus* and snails were found in several stomachs according to Moen (1955); however, they only accounted for a small portion of the overall diet. Priegel (1967) found that clams composed only a small amount of the drum's food in Lake Winnebago, Wisconsin.

Aquatic invertebrates, excluding crayfish, and mussels accounted for

only 1.2% of the food biomass, but were important numerically (46.2%) and occurred in 21.9% of stomachs (Figure 1). Trichoptera were by far the most important aquatic insects, as they constituted 44.2% by number of all food organisms and occurred in 20.8% of stomachs. Only two caddisflies, *Cheumatopsyche* (10.0% of the total number) and *Hydropsyche orris* (32.8% of the total number), were found in stomachs.

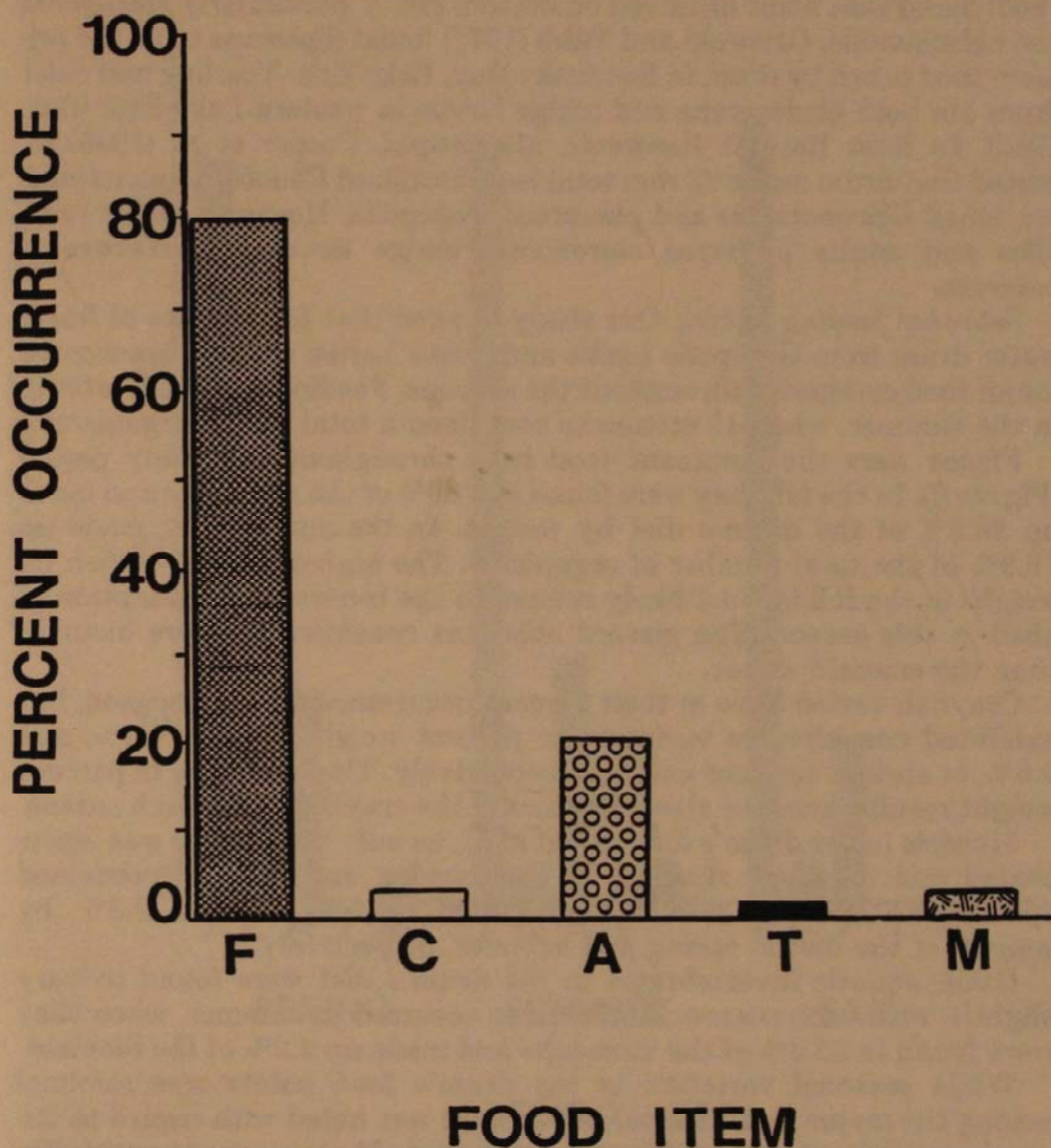


FIGURE 1. Histogram showing percent occurrence of fish (F), crayfish (C), aquatic invertebrates (A), terrestrial invertebrates (T), and mussels (M) in stomachs of freshwater drum from Gallipolis Locks and Dams.

Even though aquatic invertebrates made up a large portion of the drum's diet they still ranked second behind fish in percent of the total number (44.2 to 50.7%). Two previous investigations, Forbes (1878) and Forbes and Richardson (1920), found larval mayflies and dipterans to

supplement the drum's diet. However, the majority of earlier studies differ drastically from the drum studies in the Ohio River. Daiber (1952) stated that aquatic invertebrates, mainly *Hexagenia* and *Gammarus*, made up the bulk of the drum's food supply. Moen (1955) also found aquatic invertebrates, particularly dipterans and trichopterans, to be the single most important food item. In the upper Mississippi River, drum were found to feed mainly on *Hexagenia* (Butler, 1963). Swedberg (1966, 1968) found that adult drum fed on bottom fauna, particularly *Hexagenia* and chironomids. Griswold and Tubb (1977) found dipterans to be the primary food taken by drum in Sandusky Bay, Lake Erie. Yearling and older drum ate both cladocerans and midge larvae in western Lake Erie (Bur, 1982). In Ross Barnett Reservoir, Mississippi, Cooper et al. (1985) reported that drum under 22 mm total length utilized *Chaoborus punctipennis*, small Chironomidae and planktonic copepods. However, larger juveniles and adults preferred chironomid midge larvae and *Hexagenia bilineata*.

*Seasonal feeding habits.* Our study showed that food habits of freshwater drum from Gallipolis Locks and Dams varied slightly among the major food categories throughout the seasons. Feeding was most intense in the summer, when 42 stomachs contained a total of 137 organisms.

Fishes were the dominant food item throughout the study period (Figure 2). In the fall they were found in 87.0% of the stomachs and made up 98.5% of the drum's diet by weight. In the spring they made up 76.9% of the total number of organisms. The higher percent of fish by weight in the fall is most likely related to the increased consumption of shad in this season. The gizzard shad has considerably more biomass than the emerald shiner.

Crayfish varied little in their percent occurrence for each season, but exhibited considerable variation in percent weight: 13.9%, 1.4%, and 0.6%, in spring, summer and fall, respectively. This variation in percent weight results from the size difference of the crayfish eaten each season.

Mussels in the drum's diet varied little, as only one species was represented and only one stomach in both spring and summer contained specimens. *Corbicula fluminea* accounted for only 2.9 and 2.3%, by weight, of the diet in spring and summer, respectively.

Other aquatic invertebrates in the drum's diet were found to vary slightly with each season. Highest use occurred in summer, when they were found in 28.6% of the stomachs and made up 2.2% of the biomass.

While seasonal variation in the drum's food habits was minimal among the major food groups, a difference was noted with regard to the species of fish consumed. In spring, the emerald shiner made up 91.6%, by weight, of all fish eaten, while darters and unidentified fish composed 4.6 and 3.8%, respectively. As spring progressed into summer, gizzard shad became important in the drum's diet, although the emerald shiner was still the dominant fish consumed for the season (65.9% by weight). By the end of fall, shad had become the primary fish taken in terms of biomass (66.6%), while the emerald shiner was of secondary importance. This change in piscine diet was probably related to the increased abundance of young shad observed at the study site as the year progressed.

NO. OF STOMACHS WITH FOOD

31

42

23

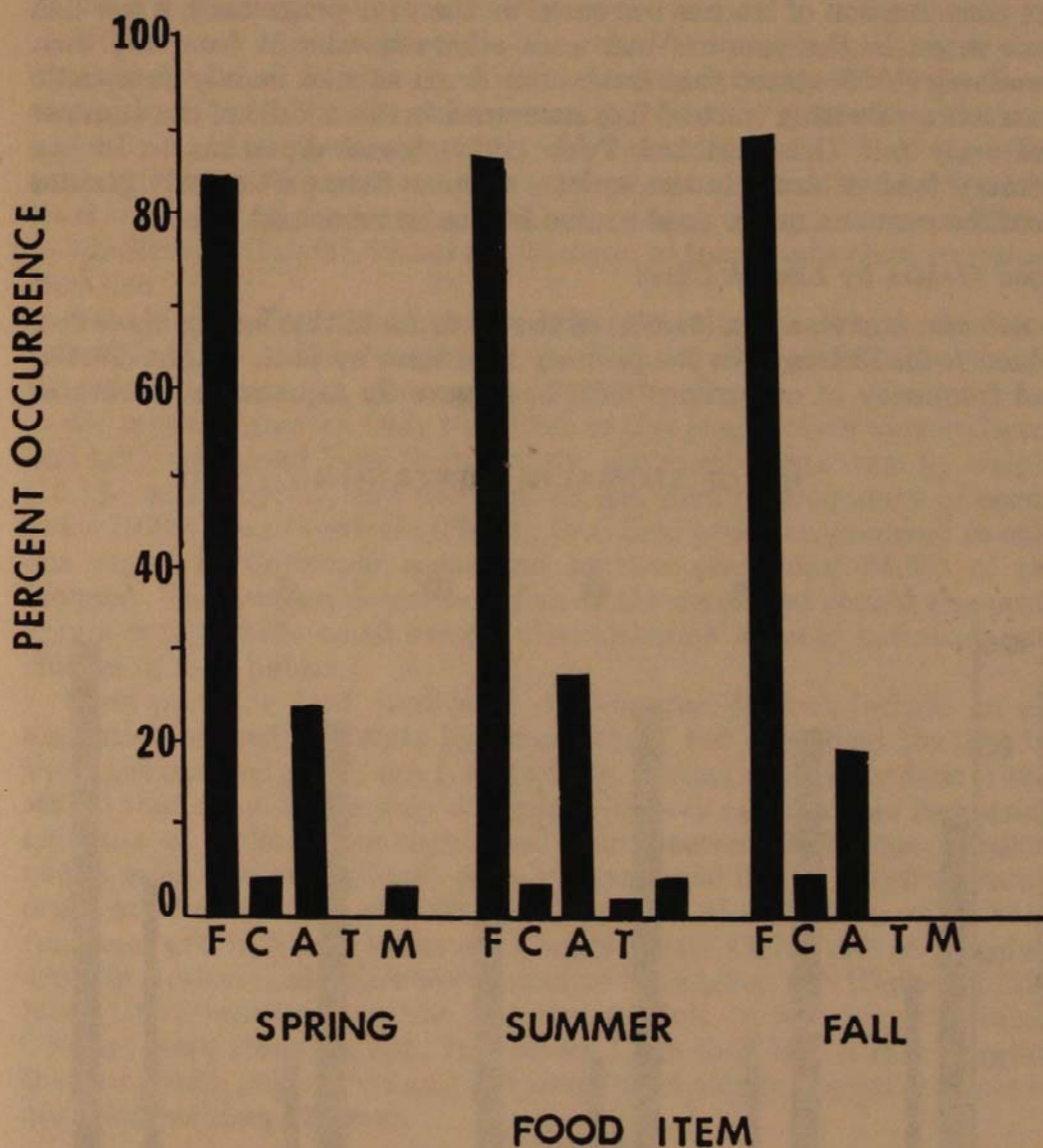


FIGURE 2. Percent occurrence by season of fish (F), crayfish (C), aquatic invertebrates (A), terrestrial invertebrates (T), and mussels (M) in stomachs of freshwater drum from Gallipolis Locks and Dam. Spring = April, May; summer = June, July, August; fall = September, October, November. Numbers above graph indicate number of stomachs that contained food.

Previous studies also showed that drum food habits vary with season. Dendy (1946) found this fish to consume aquatic invertebrates throughout the year, but to rely more heavily on a piscivorous diet from the middle of summer on into the fall. Moen (1955) also found that drum fed mainly on aquatic invertebrates, with young pan fish becoming more important during their peak abundance in late summer. According to Priegel (1967) midges were the main food of drum throughout the year, but consumption of leeches increased as the year progressed; a few fish were eaten in the summer but were otherwise absent from the diet. Swedberg (1968) stated that freshwater drum subsist mainly on aquatic invertebrates with a trace of fish consumed in the middle of the summer and early fall. Griswold and Tubb (1977) found dipterans to be the primary food of drum in the spring, whereas fish, particularly gizzard shad, became the major food source in late summer and fall.

#### Food Habits by Length Class

249 mm and less. Six (31.6%) of the 19 drum in this length class contained food. Fishes were the primary food item by both weight (96.4%) and frequency of occurrence (66.7%) (Figure 3). Aquatic invertebrates

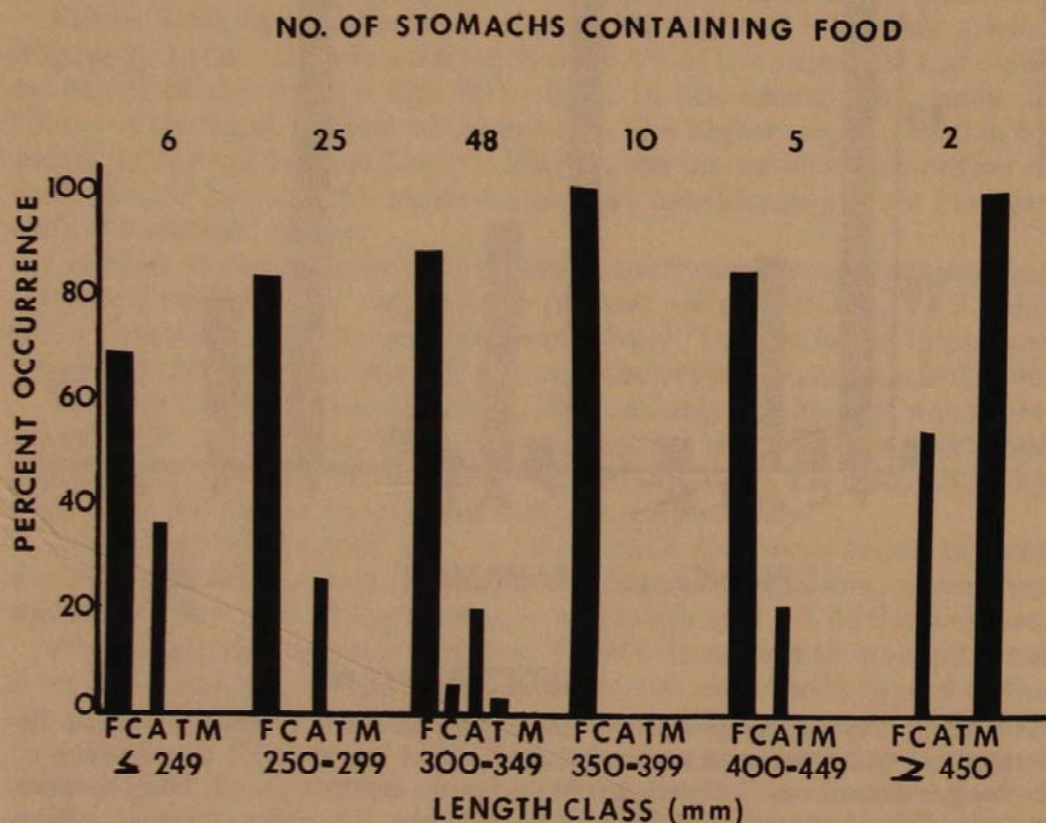


FIGURE 3. Percent occurrence of fish (F), crayfish (C), aquatic invertebrates (A), terrestrial invertebrates (T), and mussels (M) in various length classes of freshwater drum from Gallipolis Locks and Dams. Sample sizes are indicated above graph.

were the only other food used by this size fish. They accounted for 3.6% by weight of the diet and occurred in 33.3% of the stomachs.

*250-299 mm.* Twenty-five (47.2%) of the 53 drum in this length class contained food. Fishes were again the number one food item, accounting for 95.9%, by weight, of the diet; aquatic invertebrates made up the remaining 4.1%. The frequency of occurrence was 80.0% for fish and 24.0% for aquatic invertebrates (Figure 3).

*300-349 mm.* Forty-eight (61.5%) of the 78 drum in this length class contained food of four kinds. Fishes were again the primary food consumed by weight (98.0%) and frequency (85.4%) (Fig. 3). Crayfish composed 1.0% of the food organisms and were found in 4.2% of the stomachs with food. Other aquatic invertebrates accounted for 1.0% of the total weight of all food items, with a frequency of occurrence of 20.8%.

*350-399 mm.* Ten (38.5%) of the 26 drum in this length class contained only fish.

*400-449 mm.* Five (62.5%) of the eight drum in this length class contained food, with fish composing the bulk of all organisms by weight (98.2%) and frequency of occurrence (80.0%) (Fig. 3).

*450 mm and greater.* Only two drum of this length class were collected and both contained food. Surprisingly, the number one item by weight (75.1%) was crayfish, and the number one item by frequency of occurrence (100%) was *Corbicula* (Fig. 3). Crayfish, however, occurred in only one stomach; *Corbicula* accounted for the remaining 24.9% of the biomass. This sudden decrease in fish as the main food source was probably a result of the small sample size, although it could indicate a real change in food habits.

Most previous food studies of *Aplodinotus* did not include an examination of feeding habits by length class, but examined the diet by three age classes: age 0, age 1, and adults. Forbes and Richardson (1920) stated that drum fed mainly on aquatic insects and mingled increasing amounts of mollusks as they grew. Van Oosten (1937) reported that adults subsisted on mollusks with an occasional fish or crayfish. Adult drum ate fish instead of their preferred diet of mollusks, which they could not get, in Norris Reservoir (Dendy, 1946). Only 7.8% of the adult drum in western Lake Erie were found to have taken fish (Daiber, 1952). Moen (1955) reported that the majority of adult drum in four Dickinson County, Iowa lakes ate fish. In western Lake Erie, Bur (1982) reported that decapods, pelecypods and fish were found only in digestive tracts of drum longer than 250 mm.

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Minutes of the Annual Business Meeting  
West Virginia Academy of Science  
62nd Annual Meeting  
Hunt-Haught Hall  
West Virginia State College  
Institute, West Virginia 25112

April 3, 1987

Meeting called to order at 6:15 p.m. April 3, 1987, at West Virginia State College by President Taylor.

Present: John A. Chisler, Thomas K. Pauley, Gary W. Snyder, Charles Hennig, David Jordahl (attending for Dr. Keller), Roy B. Clarkson, Ralph Taylor and Tom Hutto.

Dr. Taylor presented the following changes to be considered by the committee:

1. Make the Proceedings of the Academy a journal of first choice for the publication of papers.
2. Change the organizational structure of the academy.
3. Change the method for succession of officers.

Dr. Taylor suggested that these goals be accomplished by:

1. Retaining Dr. Keller as Editor and adding section editors.
2. Revitalization of the News Letter.
3. Selecting institutional representatives.
4. Having additional executive committee meetings.
5. Accepting papers for publication in the proceedings that are not presented at meetings.

Dr. Chisler suggested publication of the top five papers from the WV Science and Engineering Fair.

1988 Spring Meeting will be on April 2 and 3. Location to be decided at a later date.

Officers for 1987-88 will be as follows:

President—Dr. John A. Chisler  
President Elect—Dr. Steven L. Stephenson  
Treasurer—Dr. Roy B. Clarkson  
Assistant Treasurer in Charge of Library Supervision—John Warner  
Recording Secretary—Dr. Gary W. Snyder  
Editor—Dr. E. C. Keller, Jr.  
WVAS Junior Academy—Dr. J. "Joe" Evans  
Past Presidents—Dr. Ralph Taylor, Dr. Thomas K. Pauley, William Kuryla

Meeting adjourned 7:04 p.m.

October 3, 1987

Dr. Hennig asked that a deadline for receipt of papers be set sometime in late January. The committee set Jan. 22, 1988 as the deadline date.

Dr. Chisler suggested another executive committee meeting for Sunday Feb. 7, 1988 at the Randolph Campus Center, Salem College.

Meeting adjourned 3:11 p.m.

Gary W. Snyder  
Secretary

**WEST VIRGINIA ACADEMY OF SCIENCE  
ANNUAL TREASURER'S REPORT  
1986**

April 3-4, 1987  
WVAS Annual Meeting  
West Virginia State College  
Institute, West Virginia

January 1, 1986 to December 31, 1986

**CASH RECEIPTS**

Balance on hand January 1, 1986 .....	\$12,414.98
Dues .....	\$1,297.00
Institutional Membership .....	1,400.00
Proceedings (Libraries) .....	1,250.00
Contributions (Talent Search) .....	219.00
Annual Meeting .....	554.00
Page Charges .....	603.50
Interest on Savings .....	163.84
Advertisements .....	150.00
Abstract Charges .....	92.00
Industrial Grants .....	450.00
Displays .....	100.00
<b>TOTAL RECEIPTS FOR YEAR .....</b>	<b>\$6,279.34</b>
<b>TOTAL RECEIPTS &amp; BALANCE ON HAND .....</b>	<b>\$18,694.32</b>

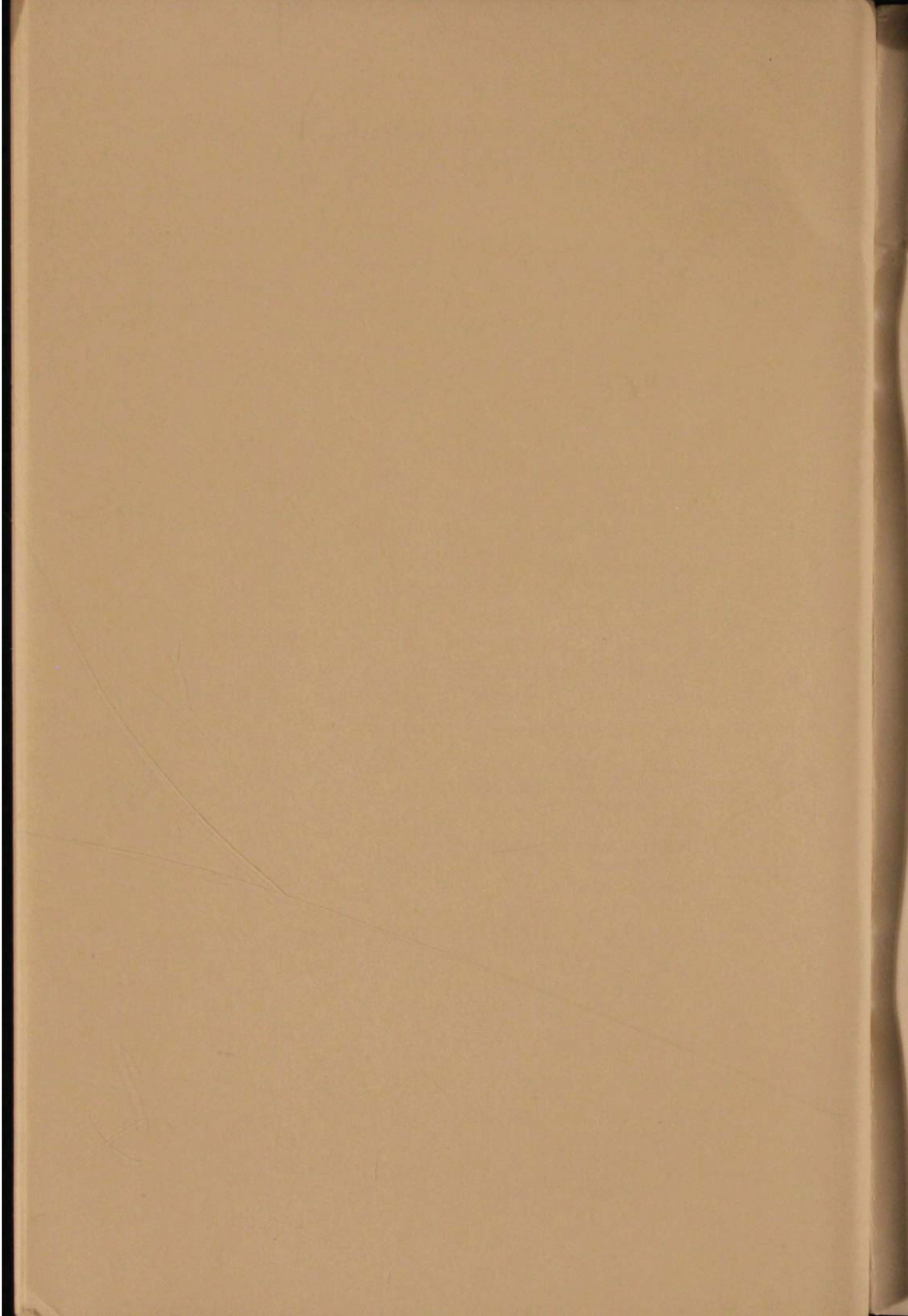
**CASH DISBURSEMENTS**

Printing (McClain) .....	\$1,138.85
Contributions (Jr. Acad. Sci.) .....	2,000.00
Annual Meeting .....	942.15
Postage .....	76.61
National Assoc. of Academy of Science (dues) .	30.00
Miscellaneous .....	144.20
Talent Search .....	264.80
To Savings .....	3,500.00
<b>TOTAL DISBURSEMENTS .....</b>	<b>\$8,096.61</b>
<b>BALANCE DECEMBER 31, 1986 .....</b>	<b>\$10,597.71*</b>
(Savings—\$4,059.59)	
(Checking—\$1,270.54)	
(Certificate of Deposit—\$5,267.58)	

Respectfully submitted,

Roy B. Clarkson, Treasurer, WVAS

\*It must be noted that printing Vol. 57 Nos. 2, 3 & 4 of the Proceedings would ordinarily have been paid for during the year, 1986. This balance needs to be reduced by that amount (\$4000.00+) in order to reflect our true financial picture. The Financial Records of WVAS were audited on April 1, 1987, and found to be correct.—E. C. Keller, Jr. and D. F. Blaydes.



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