1988

The Bog Forest Community at Cranberry Glades, West Virginia

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The Bog Forest Community

at

Cranberry Glades, West Virginia

A Thesis Presented to

The Faculty of the Graduate School

Marshall University

In Partial Fulfillment of

the Requirements for the Degree

Master of Science

by

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May 1988

This thesis was accepted on April 28 1988
Month Day Year

as meeting the research requirement for the Master's Degree.

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ACKNOWLEDGEMENTS

The author should like to express her sincere gratitude to the following persons for their various roles in the successful completion of this investigation:

Dr. Dan K. Evans for his gentle but firm advice and guidance, for allowing me to control my project, and "being there" as a friend;

Dr. David L. Edens for introducing me to Cranberry Glades, for his guidance and advice during my undergraduate years in which this investigation had its beginnings, and for being a friend who had words of encouragement and also played the devil's advocate. Also, thanks for not quitting even though I ran you through all those Rhododendron thickets;

Dr. Stanley W. Ash for serving on my committee and for his advice on various aspects of this study;

Dr. Donald C. Tarter for serving on my committee and his constant stream of trivia questions and jokes which lightened many days;

Dr. Bonnie L. Dean for reviewing the manuscript and twisting the ever present screwdriver;

Mrs. Victoria B. Paul, my resident linguist and grammarian, for proofreading the manuscript and her words of encouragement;

The faculty, staff, and fellow graduate students of the

Department of Biological Sciences, Marshall University, for their friendliness and helpfulness whenever needed.

I extend my sincere appreciation to the Marshall University Research Board for financial assistance in a portion of this investigation.

I should also like to acknowledge Dr. Charles J. Sheviak, Curator of Botany, New York State Museum, Albany, New York, for his annotation of the specimens of *Listera cordata* and *L. smallii*.

Last, but by no means least, I should like to thank my daughter, Megan; my parents, Basil and Mary Casdorph; my grandparents, Noble and Bessie Jenkins; and my sister and her husband, Sally and James Laine, for their patience, understanding, support, and encouragement throughout the course of this investigation. I hope this will hold some semblance of sense as you read it, and that you know it would not have been possible without all that you have given me.

ABSTRACT

An investigation of the Bog Forest Community of the Cranberry Glades Botanical Area and Cranberry Wilderness, Monongahela National Forest, West Virginia, revealed a dominance of mixed conifers and northern hardwoods. The composition of the forest was determined through vegetational analysis of the forest strata using the list-count quadrat method. Tsuga canadensis, Betula alleghaniensis, Prunus serotina, and Picea rubens were dominant while eight additional species in the arboreal stratum were found to be tolerant subordinates. Rhododendron maximum dominated the understory/shrub stratum forming thickets along the interior boundary of the bog forest. The herbaceous stratum was characterized by species generally affiliated with the northern coniferous forest, although herbaceous species of the mixed mesophytic forest were also present in small percentages. The ground stratum also reflected a northern aspect with the presence of hummock formation and the carpeting of fallen logs by Bazzania, Dicranum, Hypnum, and Thuidium.

A floristic list of the vascular plants was compiled and consisted of 115 species representing 86 genera and 47 families. Five species classified as rare and endangered were found within the bog forest: Corallorhiza trifida, Ilex collina, Listera cordata, L. smallii, and Polemonium van-bruntiae. Eight genera of bryophytes were identified

within the ground stratum of the bog forest.

Comparisons were drawn between the present bog forest, the bog forest of Darlington (reported from the 1930's and 1940's), and that of Edens (reported from the late 1960's and early 1970's). The bog forest community has exhibited retrogressive succession west of Long Glade and along the floodplain of the Cranberry River, and has been observed to be encroaching upon areas of the open bogs from a westerly direction.

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CHAPTER I

INTRODUCTION

The study area, the Cranberry Glades Botanical Area and portions of the Cranberry Wilderness, lies within the Monongahela National Forest, Pocahontas County, West Virginia. The area contains an isolated bog community, Cranberry Glades (hereinafter referred to as the Glades), a southern outpost of a northern bog (Braun, 1950). This unique botanical area is 14 km west of Marlinton, the county seat, on WV Route 39. Many northern species, plant and animal, are found within this area, many reaching and/or approaching the southern limit of their range, including such plants as: *Amelanchier bartramiana*, *Andromeda glaucophylla*, and *Cornus canadensis*; and animal species of: *Microtus chrotorrhinus* (yellow-cheeked meadow mouse), *Sorex personatus* (masked shrew), and *Empidonax alnorum* (alder flycatcher) (Strausbaugh and Core, 1971, 1973; Brooks, 1911).

This investigation dealt solely with the vegetation of the Bog Forest Community, covering 32 ha, one of six vegetational communities of the Glades, originally defined by Darlington (1942, 1943).

The Glades cover approximately 243 ha of somewhat level area at an elevation of 1024 - 1036.58 m. Surrounding the Glades are Cranberry, Kennison, and Black Mountains, whose elevations range from 1292.68 m to 1378.05 m (Figure 1).

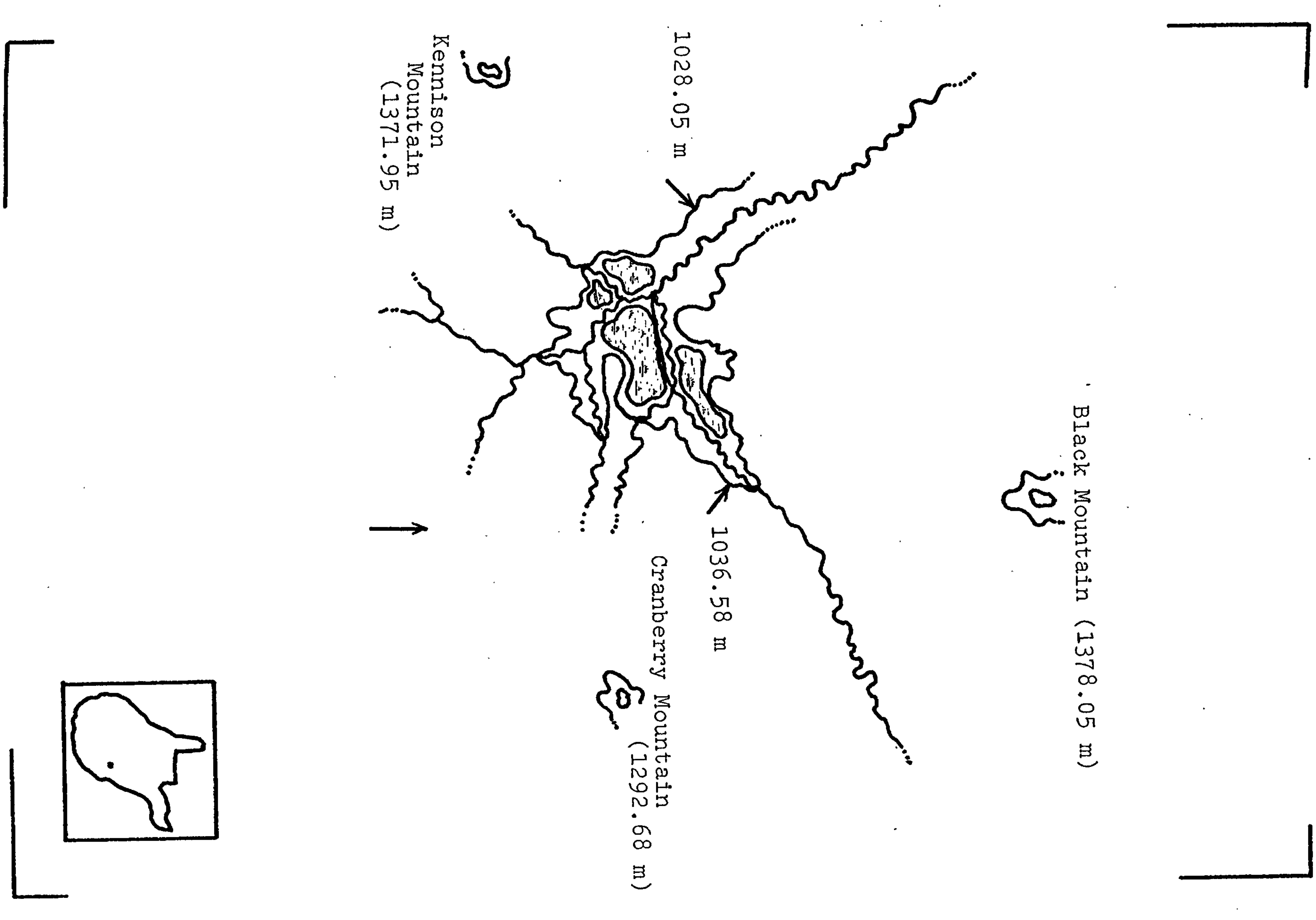
Physiographically, the Glades and the Cranberry Wilderness lie in the Unglaciated Allegheny Plateau of the Appalachian Plateau Province (Darlington, 1942; Braun, 1950).

At the turn of the century the forested portions of the area were timbered extensively, and narrow gauge railroads were employed to remove the timber (Strausbaugh, 1934; Scott, pers. comm. 1984; Buck, pers. comm. 1984). Remnants of the railroad are present today throughout much of the area, and it is possible to traverse trails of man and animal along the old railroad beds. Trees found in the beds are descendants of those removed nearly eighty years ago, evidence of secondary succession.

A bog forest, as described and defined by Lewis et al. (1928) and Moss (1953a), is a bog in which the coniferous trees have become dominant and the associated species, Sphagnum and sedges, more or less suppressed. It is a seral community in the succession of bogs.

This investigation was conducted to (1) describe and define the Bog Forest Community as it exists in the Southern Appalachians in the vicinity of Cranberry Glades in terms of its vegetative composition, (2) to compose a floristic listing of the vascular plants found therein, and (3) the identification of rare, endangered, and vulnerable species, as defined and designated by the U.S. Fish and Wildlife Service and the West Virginia State Department of Natural Resources (Clarkson et al., 1981). Successional trends were also observed and reported with respect to the

Figure 1. Map showing Cranberry Glades and surrounding mountains.



invasion of the open bogs by the bog forest, and the degradation of bog forest on the periphery of the open bogs in various sections.

CHAPTER II

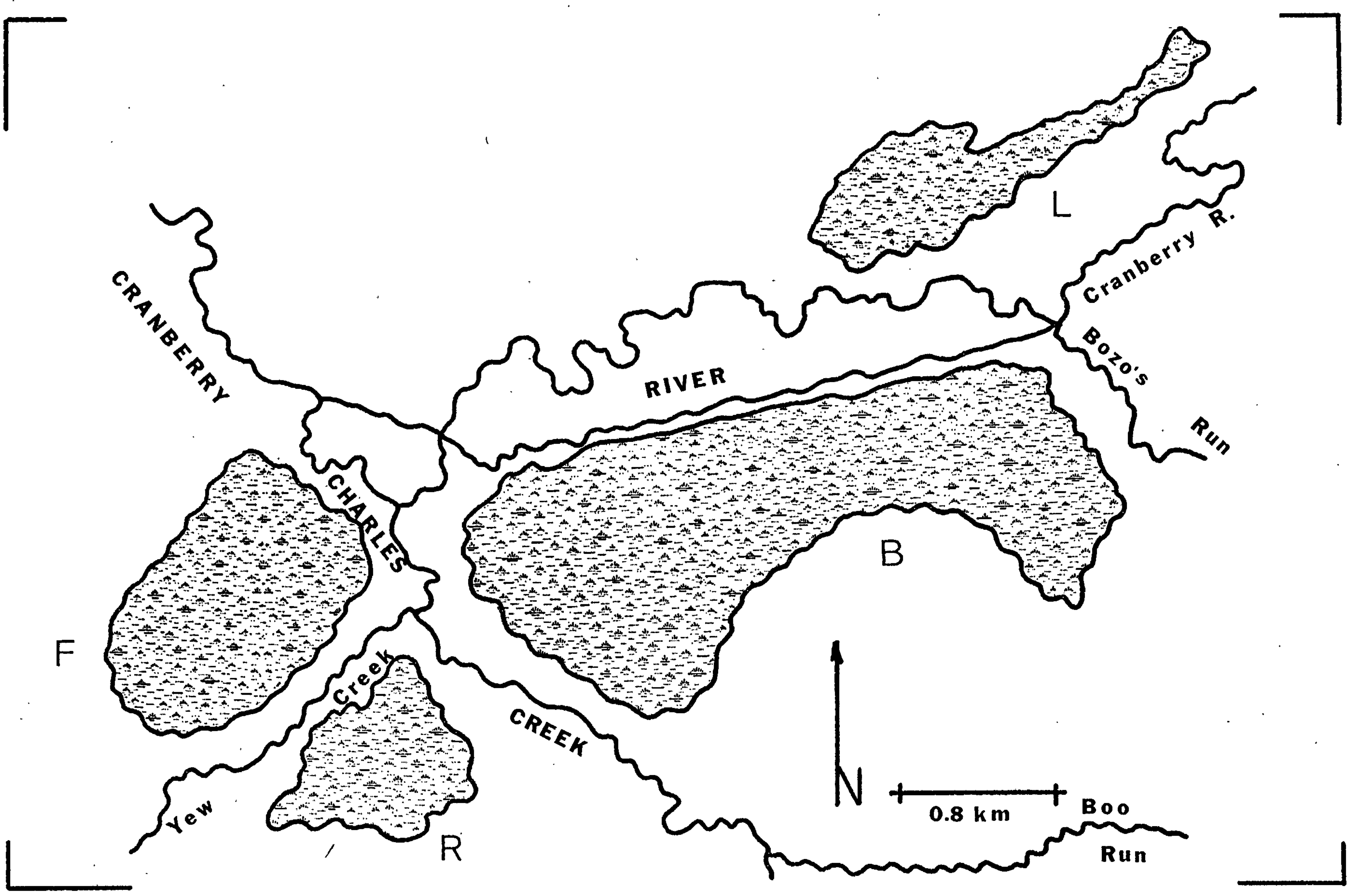
REVIEW OF LITERATURE

The Glades and the Cranberry Wilderness area are well known to most botanists and other investigators. This review reflects that knowledge and considers the literature pertaining to bog forests.

In 1911 the individual glades, open bogs covering 49 ha, were described and named (Brooks, 1911). Brooks (1911) described five glades of which only four are recognizable today; Big Glade (24 ha), Flag Glade (11 ha), Long Glade (8 ha), and Round Glade (3 ha) (Figure 2). Little Glade (approximately 1 ha) has apparently yielded to succession and is not recognizable today (Brooks, 1911; Edens, 1973). The nomenclature of the glades originating with Brooks has been followed by Darlington (1942, 1943), Rigg and Strausbaugh (1949), Core (1955), Clarkson (1960, 1966), and Edens (1973, 1977). Controversy arose in the literature with the reversal of Flag and Round Glades in Strausbaugh (1934), Brooks (1945), and a map from Core's article (1955). Edens (1972) clarified the naming of Flag and Round Glades, but the U.S.D.A. Forest Service continues today in the incorrect identification of these two glades as may be noted by traversing the boardwalk which transects Flag Glade (11 ha, 28 acres) and Round Glade (3 ha, 8 acres).

Figure 2. Locations and names of individual glades.

B Big Glade (24 ha)
F Flag Glade (11 ha)
L Long Glade (8 ha)
R Round Glade (3 ha)



The first comprehensive investigation of the Glades was conducted by H. Clayton Darlington (1942, 1943), who investigated the origin, substrate, and vegetation of the Cranberry Glades. Darlington defined six vegetational communities, one of which was the bog forest, although it appears to have been only cursorily investigated.

Other papers have appeared in the literature; Edens and Ash (1969) and Tarter and Hill (1979).

A second comprehensive study of the Glades was conducted by D. L. Edens (1973, 1977), who investigated the status of the bog communities and succession in the 31 years following Darlington. Although Edens' investigation was inclusive of the bog forest, it too appears to have been limited in its scope with regard to the bog forest.

Lewis et al. (1928) described the swamp, moor, and bog forest vegetation of three phytogeographical regions in Central Alberta, Canada, from an ecological standpoint, and in doing so provided a workable definition of a bog forest. Rigg (1940) in his study of the development of bogs in North America concluded that sphagnum bogs proceed through stages of succession which result in a climax stage, a forest, dominated by mixed conifers and northern hardwoods. Gates (1942) discussed several plant associations found in bogs which included [bog] forest types. Conway (1949) studied the bogs of central Minnesota and the characteristics of the bog forest both as a unity and as a number of discrete types based upon maturity, successional substages, such as early, mature, and late bog forests. Danserau and Segadas-Vianna (1952) conducted an ecological study of bogs within eastern North America, describing the structures of the communities involved and a general outline of the dynamics involved in bog vegetation. Moss (1953a, 1953b) described the floristic composition and ecological relationships of several forest communities, including bog forest which he considered as a subclimax in the sphagnum bog sere.

CHAPTER III

METHODS AND MATERIALS

The assessment of the composition of the bog forest was made through the use of quadrats. The arboreal stratum was sampled prior to that of the remaining strata, in 1984 and 1986-1987, respectively, thereby preventing the strict usage of nested quadrats in sampling the forest vegetation. All quadrats were located in the same manner regardless of strata throughout the 32 ha study area.

Location of the quadrats was determined by random compass bearings prior to entering the forest as described by Oosting (1956) and Pandeya et al. (1968). Arbitrary points of origin were established by landmarks through the use of aerial photographs, topographic maps, and a map indicating possible bog forest boundaries (Edens, 1973). All bearings were plotted and adhered to in the field except in cases in which unforeseen irregularities fell within the sampling. Quadrats were systematically distributed along the predetermined compass bearings, left and right of said bearings, at predetermined random distances (Pandeya et al., 1968).

The arboreal stratum was sampled through the use of the list-count method, quadrats measuring 10 X 25 m, and count of only those individuals whose diameter at breast height (dbh) was greater than 10 cm. The understory/shrub, herbaceous, and ground strata were sampled using nested quadrats. Quadrats measuring 4 X 4 m were established for sampling the understory/shrub layer with a ¼ X 4 m quadrat for the sampling of the herbaceous and ground strata.

The vegetation of the understory/shrub, herbaceous, and ground strata (lower strata) was assessed according to percent cover, employing five classes of cover to maintain objectivity (Oosting, 1956). The five cover classes employed were as follows:

Class 1 covering less than 5% of the ground

Class 2 covering 5 - 25%

Class 3 covering 25 - 50%

Class 4 covering 50 - 75%

Class 5 covering 75 - 100%

All strata of the forest were sampled during the growing season and seven permanent quadrats were established throughout the forest and sampled during each season to observe any and all changes within the herbaceous and ground vegetation.

The study area was sampled throughout the growing season on a bi-monthly basis to ensure adequate sampling with respect to seasonality of the vegetation. Voucher collections were made of plants found within sampled quadrats and throughout the forest. Identification of vascular plants was made from Strausbaugh and Core (1970, 1971, 1973, 1977) and Fernald (1950). Bryophytes collected within the study area were identified primarily to the generic level according to Crum and Anderson (1980). All specimens have been accessioned into the Marshall University herbarium (MUHW).

Density, frequency, and dominance were determined for species encountered within the arboreal stratum according to standard methods (Cain and Castro, 1959). Relative values were calculated and their sum per species used in calculating the Importance Value (IV) (maximum value of 300) which in turn was employed to determine the dominants of the stratum.

Frequency and cover (dominance) were determined for species within the understory/shrub, herbaceous, and ground strata following standard methods (Cain and Castro, 1959). The Importance Value (maximum value of 200) of each species was determined by the sum of the relative values for species within the lower strata, and also used in the determination of the dominants within these strata.

CHAPTER IV

RESULTS

Floristic List

The vascular plants of the bog forest are listed in Appendix A, taxa alphabetically by family, genus, and species. The list has been categorized as pteridophytes, gymnosperms, and angiosperms (monocots and dicots) and summarized in Table 1. One hundred fifteen taxa representing 86 genera and 47 families are listed. Those taxa classified as rare and endangered by the West Virginia Department of Natural Resources in cooperation with the U.S. Fish and Wildlife Service (clarkson et al., 1981) have been indicated by an asterisk (*) following the species name (Appendix A).

Bryophytes collected within the study area have been listed in Table 2, taxa alphabetically by family and genus. Eight genera representing 8 families have been listed.

As the vegetative composition of the bog forest was investigated with respect to vertical stratification, the results have been subsequently reported in like fashion; arboreal, understory/shrub, herbaceous, and ground strata.

Arboreal Stratum

Within the total 1 ha sampled, 969 individuals met the minimum dbh criterion. Twelve species were identified in the arboreal stratum: *Acer rubrum*, *A. saccharum*, *Aesculus octandra*, *Betula alleghaniensis*, *Fagus grandifolis*, *Picea*

Table 1. Summary of the flora of the Bog Forest Community at Cranberry Glades, West Virginia.

Taxa	# Species	% Flora
Pteridophytes	19	16.52
Gymnosperms	3	2.61
Angiosperms		
Monocots	27	23.48
Dicots	66	57.39
Total	115	100.00

Table 2. Bryophytes of the Bog Forest Community at Cranberry Glades, West Virginia.

Family	Genera
Dicranaceae	*Dicranum* Hedw.
Hypnaceae	*Hypnum* Hedw.
Lepidoziaceae	*Bazzania* S. F. Gray
Leucobryaceae	*Leucobryum* Brid.
Mniaceae	*Mnium* Hedw.
Polytrichaceae	*Polytrichum* Hedw.
Sphagnaceae	*Sphagnum* L.
Thuidiaceae	*Thuidium* B.S.G.

rubens, *Prunus serotina*, *Pyrus americana*, *Quercus rubra*, *Tilia americana*, *Tsuga canadensis*, and *Ulmus rubra*. Values of dbh ranged from 10.0 cm (minimum), which happened to be that size which the author could 'choke,' to 103.0 cm which the author and assistant together were unable to 'hug.' The average dbh value was 31.86 cm.

Basal area was calculated per species, and ranged from 0.03 m^2 for *U. rubra* to 16.69 m^2 with respect to *T. canadensis*. Total basal area was 63.62 m^2, with an average basal area value of 0.08 m^2. The minimum density was 1 per hectare and the maximum, 229 per ha. Extrapolation of the total density, 969 individuals per ha, to that for the 32 ha bog forest was determined as 31,008 individuals with an average dbh of 31.86 cm. Frequency values ranged from 1:40 (2.5% of the quadrats) with respect to *Q. rubra* and *U. rubra*, to 38:40 (95% of the quadrats) for *T. canadensis*. Dominance values ranged from 0.03 m^2/ha (*U. rubra*) to 16.69 m^2/ha (*T. canadensis*) (Table 3).

Values for relative density ranged from 0.10 with respect to *Q. rubra* to 23.63, *T. canadensis*. Relative frequency ranged from 0.48 (*Q. rubra* and *U. rubra*) to 18.36 (*T. canadensis*), and relative dominance values ranged from 0.05 (*U. rubra*) to 26.11 (*T. canadensis*). Importance values ranged from 0.74(*U. rubra*) to 68.10 (*T. canadensis*) (Table 3).

The dominant arboreal species, in order of their importance (Table 3), are *T. canadensis*, *B. alleghaniensis*, *P. serotina*, and *P. rubens*.

Table 3. Density (DENS), relative density (RD), frequency (FREQ), relative frequency (RF), dominance (DOM), relative dominance (RDOM), importance value (IV), and percent composition (COMP) of species of the arboreal stratum.

Species	DENS (stems ha^{-1})	RD (%)	FREQ (% of plots)	RF (%)	DOM (m^2 ha^{-1})	RDOM (%)	IV	COMP (%)
Tsuga canadensis	229	23.63	95.0	18.63	16.69	26.11	68.10	22.70
Betula alleghaniensis	216	22.29	90.0	17.39	9.93	15.63	55.31	18.44
Prunus serotina	122	12.59	62.5	12.08	11.21	17.65	42.32	14.11
Picea rubens	129	13.31	70.0	13.53	9.54	15.03	41.87	13.96
Acer saccharum	97	10.01	52.5	10.14	6.11	9.61	29.76	9.92
Fagus grandifolia	99	10.22	60.0	11.59	3.99	6.28	28.09	9.36
Acer rubrum	59	6.09	60.0	11.59	5.10	8.03	25.71	8.57
Tilia americana	7	0.72	10.0	1.93	0.46	0.73	3.38	1.13
Aesculus octandra	3	0.31	7.5	1.45	0.18	0.28	2.04	0.68
Pyrus americana	5	0.52	5.0	0.97	0.18	0.29	1.78	0.59
Quercus rubra	1	0.10	2.5	0.48	0.20	0.31	0.89	0.30
Ulmus rubra	2	0.21	2.5	0.48	0.03	0.05	0.74	0.25
Total	969	100.01*	517.5	99.99*	63.62	100.00	299.99*	100.01*

* Due to rounding errors, relative density, relative frequency, and percent composition do not sum to 100, and importance values do not sum to 300.

Understory/Shrub Stratum

Within the total 1024 m^2 area sampled, fourteen species were identified as being understory/shrub species and/or saplings of arboreal species: A. pensylvanicum, A. saccharum, A. octandra, B. alleghaniensis, F. grandifolia, Ilex collina, Kalmia latifolia, P. rubens, P. serotina, Rhododendron maximum, Sambucus canadensis, T. americana, T. canadensis, and U. rubra.

Cover values were calculated per species in terms of total cover and percentage absolute cover (Table 4). Absolute cover values ranged from 0.04 percent (P. serotina, T. americana, and U. rubra, each) to 17.50 percent (R. maximum). Frequency values, in terms of 64 quadrats, ranged from 1:64 (3.13%, P. serotina, T. americana, and U. rubra) to 30:64 (46.88%, R. maximum).

The extremes with respect to relative cover and relative frequency ranged from lows of 0.13 and 0.942 to a high of 28.30, P. serotina, T. americana, U. rubra; R. maximum, respectively (Table 4).

The dominant species within the understory/shrub stratum, based upon importance value, was R. maximum (Table 4).

Herbaceous Stratum

The total area sampled, 64 m^2, yielded fifty-two species within the herbaceous stratum. Of these 52 species, 9 species were represented as seedlings of arboreal/understory species: A. rubrum, A. saccharum, A. spicatum, F. grandifolia, P. rubens, P. serotina,

Table 4. Total cover (TOTCOV), absolute cover (ABSCO), relative cover (RCOV), frequency (FREQ), relative frequency (RF), and importance value (IV) for understory/shrub species.

Species	TOTCOV (%)	ABSCO (%)	RCOV (%)	FREQ (% of plots)	RF (%)	IV
Rhododendron maximum	1120.0	109.38	59.66	46.88	28.30	87.96
Fagus grandifolia	237.5	23.19	12.65	32.81	19.81	32.46
Tsuga canadensis	200.0	19.53	10.65	25.00	15.09	25.74
Picea rubens	122.5	11.96	6.52	21.88	13.21	19.73
Acer saccharum	65.0	6.35	3.46	9.38	5.66	9.12
Acer pensylvanicum	35.0	3.42	1.87	6.25	3.77	5.64
Ilex collina	52.5	5.13	2.80	3.13	1.89	4.69
Betula alleghaniensis	7.5	0.73	0.40	4.69	2.83	3.23
Aesculus octandra	7.5	0.73	0.40	4.69	2.83	3.23
Sambucus canadensis	5.0	0.49	0.27	3.13	1.89	2.16
Kalmia latifolia	17.5	1.71	0.93	3.13	1.89	2.82
Prunus serotina	2.5	0.24	0.13	1.56	0.94	1.07
Tilia americana	2.5	0.24	0.13	1.56	0.94	1.07
Ulmus rubra	2.5	0.24	0.13	1.56	0.94	1.07
Total	1877.5	183.34	100.00	165.65	99.99*	199.99*

* Due to rounding errors, relative frequency and importance value do not sum to 100 and 200, respectively.

P. americana, R. maximum, and T. canadensis; and were considered within the herbaceous layer, as they were less than 10.0 cm in height. The remaining 43 species were herbaceous in nature (pteridophytes, monocots, and dicots) (Table 5).

Cover values were calculated per species in terms of total cover and percentage absolute cover. Importance values were determined as the sum of the relative cover and relative frequency values, with respect to four groups of vascular plants: pteridophytes, monocots, dicots, and arboreal/understory seedlings (Table 5). Determination of importance value was also made of an additional category, no herbaceous cover, as 13 of 64 quadrats exhibited this condition. In considering species individually with respect to their importance values, 23 species accounted for 80 percent of those found within the herbaceous stratum (Table 6).

Consideration of aspect dominance/seasonal variance was also made with respect to the components of the herbaceous stratum (Table 6). The establishment of 7 permanent plots and their composition throughout the seasons was indicative of vegetational variations with respect to seasonal changes within the herbaceous stratum. This aspect dominance exhibited within the herbaceous stratum of the permanent plots included, but was not limited to those species found within temporal plots (Table 6).

Table 5. Total cover (TOTCOV), absolute cover (ABSCO), relative cover (RCOV), frequency (FREQ), relative frequency (RF), and importance value (IV) for groups of plants within the herbaceous stratum.

Group	# Species	TOTCOV (%)	ABSCO (%)	RCOV (%)	FREQ (%)	RF (%)	IV
Pteridophytes	10	347.5	542.97	11.33	39.06	20.83	32.16
Monocots	20	335.0	523.44	10.92	37.50	20.00	30.92
Dicots	13	567.5	886.72	18.50	50.00	26.67	45.17
Seedlings	9	517.5	808.59	16.87	40.63	21.67	38.54
No Herbaceous Cover	--	1300.0	2031.25	42.38	20.31	10.83	53.21
Total	52	3067.5	4792.97	100.00	187.50	100.00	200.00

Table 6. Importance values (IV) and aspect dominance (AD) of 23 vascular species, constituting 80 percent of the herbaceous stratum.

Species	IV	AD
Prunus serotina	17.272	Estival
Acer rubrum	14.255	Estival
Caulophyllum thalictroides	13.239	Estival
Dryopteris spinulosa	12.447	Vernal & Estival
Oxalis montana	10.380	Vernal & Estival
Maianthemum canadense	9.856	Vernal
Lycopodium lucidulum	6.942	Perennial
Allium tricoccum	6.570	Vernal
Acer saccharum	6.357	Estival
Milium effusum	6.089	Estival & Autumnal
Dicentra spp.*	5.827	Vernal
Lycopodium annotinum	5.773	Perennial
Symplocarpus foetidus	5.773	Vernal & Estival
Fagus grandifolia	5.723	Estival
Claytonia caroliniana	5.619	Vernal
Impatiens spp.*	5.454	Estival
Lycopodium obscurum	4.930	Perennial
Pyrus americana	4.503	Estival
Picea rubens	4.450	Perennial
Dryopteris marginalis	3.552	Perennial
Dennstaedtia punctilobula	3.552	Vernal & Estival

* Genera represented by two species within the bog forest, distinguishable by inflorescence which was not always present. *Dicentra* spp. may be identified by their tubers, but the author chose not to uproot individuals in quadrats.

Ground Stratum

Classification of plants within the ground stratum was made with respect to growth form: procumbent, prostrate, and/or creeping vascular plants; as well as the inclusion of those plants commonly considered as components of the ground layer, bryophytes (Oosting, 1956). Also considered within the stratum were litter and the presence of bare ground.

The total area sampled, 64 m^2, yielded 3 vascular species and 7 genera of bryophytes. Cover values were calculated for all plants, in addition to that of litter and bare ground in terms of total cover and relative cover. Frequency values and relative frequency values were also determined for the aforementioned (Table 7).

The importance values for each species/genera, and litter/bare ground, were determined by summing their respective relative values. The importance of the various components of the ground stratum are indicative of the conditions exerted upon said stratum by the arboreal and understory/shrub strata, and their indirect competition with species of these strata, and vice versa (Oosting, 1956).

With respect to relative cover, values ranged from 0.06 percent (Leucobryum and Rubus hispidus, each) to 84.48 percent (litter). Relative frequency values ranged from 0.893 percent (Leucobryum and R. hispidus, each) to 49.107 percent (litter) (Table 7).

Table 7. Total cover (TOTCOV), relative cover (RCOV), frequency (FREQ), relative frequency (RF), importance value (IV), and percentage composition (COMP) of components of the ground stratum.

Component (Genus/Species)	TOTCOV (%)	RCOV (%)	FREQ (%)	RF (%)	IV	COMP (%)
Litter	3485.0	84.48	85.938	49.107	133.587	66.80
Bare Ground	77.5	1.88	3.125	1.786	3.666	1.83
Dicranum sp.	135.0	3.27	15.625	8.929	12.199	6.10
Hypnum sp.	55.0	1.33	18.750	10.714	12.044	6.02
Bazzania sp.	175.0	4.24	12.500	7.143	11.383	5.69
Thuidium sp.	95.0	2.30	12.500	7.143	9.443	4.72
Mitchella repens	15.0	0.36	9.374	5.357	5.717	2.86
Sphagnum sp.	57.5	1.39	6.250	3.571	4.961	2.48
Mnium sp.	20.0	0.48	4.688	2.679	3.159	1.58
Galium trifolium	5.0	0.12	3.125	1.786	1.906	0.95
Leucobryum sp.	2.5	0.06	1.563	0.893	0.953	0.48
Rubus hispidus	2.5	0.06	1.563	0.893	0.953	0.48
Total	4125.0	99.97*	175.001	100.001*	199.971*	99.99*

* Due to rounding errors, relative cover, relative frequency, and percentage composition do not sum to 100, and importance values do not sum to 200.

CHAPTER V

DISCUSSION

By definition, in general terms, a community is an aggregation of living organisms having mutual relationships among themselves and the environment. The term community may be applied to any vegetation unit, from the very local to the regional, and represents a basic ecological unit (Oosting, 1956). Characteristics of plant communities: physiognomy, growth form of dominant plants, stratification, competition, density, frequency, and dominance; of qualitative and quantitative methods enable the investigator to determine the community structure of a particular vegetation unit, and relate the community to the environment in which it exists.

Stratification within plant communities strongly influences the development of the community as do various other factors, e.g. competition, dependence, light, temperature, edaphic conditions, etc., and within forests the arboreal (canopy) stratum generally contains those species which control and characterize the community, the dominant species.

As previously indicated, twelve species were encountered in the arboreal stratum. The dominants, determined by their respective importance values, were:

T. canadensis, *B. alleghaniensis*, *P. serotina*, and *P. rubens*, mixed conifers and northern hardwoods (Table 3). Of the eight remaining species, three were designated as major tolerant subordinates: *A. saccharum*, *F. grandifolia*, and *A. rubrum*; and five as minor tolerant subordinates: *T. americana*, *A. octandra*, *P. americana*, *Q. rubra*, and *U. rubra.* By definition, tolerant subordinates are those species which possess the ability to exist under the conditions created/influenced by the dominant species and whose removal from the community would not greatly alter the community's character (Oosting, 1956).

The minor tolerant subordinate species were encountered in quadrats in which the relief appeared to significantly increase as compared to that within the majority of the quadrats/forest. With an increase in relief, there were also changes in the edaphic conditions as well as the vegetation. Edaphic conditions shifted from boggy/organic substrate to drier, rockier substrate in those quadrats which contained the minor tolerant subordinates as relief increased. The presence of these five species may be indicative of an ecotone between the Bog Forest Community and the Transition/Deciduous Forest, the latter terminology according to Darlington (1942, 1943).

With respect to the understory/shrub stratum, *R. maximum* was determined as the dominating species within the stratum based upon importance values (Table 4). *Rhododendron* maximum was found to establish thickets along the outer periphery of the bog forest, between the forest and the open bogs, and between the forest and Alnus-Viburnum stream thickets in the floodplain of the Cranberry River.

Throughout the herbaceous stratum a high degree of presence was noted with respect to arboreal species seedlings (Table 5). This coupled with successful competition in the understory/shrub layer appears to indicate that the dominants of the arboreal stratum are successful with respect to interspecific competition, and indeed control and characterize the community.

Homogeneity of the bog forest was indicated through the results of cluster analysis with regard to the dominant species. This characterization, mixed conifers and northern hardwoods, throughout the forest was exhibited in the appearance and importance of species whose affiliations are of more northern regions, and extends throughout all strata.

The bog forest, as exhibited in Cranberry Glades, possesses characteristics of the northern coniferous forest (boreal forest), the hemlock-white pine-northern hardwoods region, and the mixed mesophytic forest region of the deciduous forest formation as defined by Braun (1950) upon consideration of all strata.

The northern character of the forest was exhibited not only within the arboreal stratum, as evidenced by the dominants, but also in the lower strata. Northern species emphasizing the northern affiliation of the community (thereby lending a northern character to the forest) were: *A. pensylvanicum*, *A. spicatum*, *Viburnum alnifolium*, *V. cassinoides*, and *Taxus canadensis* within the understory/shrub layer; *Aralia nudicaulis*, *Caltha palustris*, *Circaea alpina*, *Clintonia borealis*, *Cypripedium acaule*, *Dryopteris spinulosa*, *Galium trifolium*, *Habenaria orbiculata*, *Listera cordata*, *Lycopodium annotinum*, *L. clavatum*, *L. lucidulum*, *L. obscurum*, *Maianthemum canadense*, *Medeola virginiana*, *Osmunda cinnamomea*, *Oxalis montana*, *Trientalis borealis*, and *Trillium undulatum* as components of the herbaceous stratum (Lewis et al., 1928; Conway, 1949; Braun, 1950; Moss, 1953b). The forest floor exhibited a substantial degree of litter cover as well as hummock formation and carpeting of fallen logs by *Bazzania*, *Dicranum*, *Hypnum*, *Mnium*, *Thuidium*, and *Sphagnum* as found in more northern bog forests (Lewis et al., 1928; Conway, 1949; Moss, 1953b).

Ecological equivalent species, although taxonomically different, complete the characterization of the forest in relation to northern affiliation. Two dominant species, *B. alleghaniensis* and *P. rubens*, are the equivalents of *B. papyrifera* and *P. mariana* found within bog forests in Alberta as discussed by Moss (1953b). Within the understory/shrub stratum, *Ledum groenlandicum* and *Chamaedaphne calyculata* have been replaced by *R. maximum* and *Kalmia* *latifolia* in the bog forest at Cranberry Glades (Lewis et al., 1928; Moss, 1953b).

The appearance of *Listera cordata*, a circumboreal species, and *L. smallii* within the bog forest emphasizes the mixture of northern characteristic species and species of the deciduous forest formation found within mountainous regions. Stands of *L. cordata* and *L. smallii* were not only found within the bog forest, but the stands overlapped. *Listera cordata* has been reported by Cody and Munro (1980) to be distributed from Newfoundland and Labrador to British Columbia, in southern Alaska, southward to western North Carolina, and westward in the mountainous areas of California. Recently, the distribution of *L. cordata* within North Carolina has been questioned, as previous voucher specimens were found to be incorrectly identified, according to Mellichamp et al. (1987). The distribution of *L. smallii* has been reported as occurring in Pennsylvania, West Virginia, Georgia, and eastern Tennessee mountain regions (Fernald, 1950; Radford et al., 1964). These areas lie within the deciduous forest formation as defined by Braun (1950), and share a common factor, their location within the Appalachian Mountains and the elevations attained in these mountains.

Although the Bog Forest Community exhibits northern characteristics with respect to the northern coniferous forest and hemlock-white pine-northern hardwoods region, the community may not be classified as an outlier of the hemlock-white pine-northern hardwoods region as the forest also contains a definitive understory/shrub stratum of R. maximum and mesophytic arboreal hardwood species, although not as dominants, e.g. F. grandifolia, A. rubrum, and A. saccharum, etc. (Braun, 1950).

Herbaceous species of wide distribution, throughout the mixed mesophytic forest, were also present in the bog forest: Allium tricoccum, Botrychium virginianum, Caulophyllum thalictroides, Claytonia caroliniana, Dicentra canadensis, D. cucullaria, Polystichum acrostichoides, Trillium erectum, etc., thereby exhibiting vegetation characteristic of mesophytic forests of lower elevations (Braun, 1950; Oosting, 1956).

Although characteristic vegetative species of mesophytic forests are present in the bog forest at Cranberry Glades, the northern affiliated species largely determine the dominants and this mixed conifer and northern hardwood forest clearly indicates its affiliation with more northern bog forests, an outlier of a northern bog and its associated communities.

Successional Trends

In comparison to the two previous comprehensive investigations of Cranberry Glades, those of Darlington (1942, 1943) and Edens (1973, 1977), components of the Bog Forest Community are indeed different today (Table 8). These differences include not only percent composition dissimilarities with respect to dominant species, but also

Table 8. Comparison of the dominant species of the Bog Forest Community (values expressed as percent composition).

Species	Darlington (1942)	Edens (1973)*	Kokesh (1987)*
Tsuga canadensis	12	22	23
Betula alleghaniensis	8	29	18
Prunus serotina	--	--	14
Picea rubens	75	30	14
Fraxinus nigra	5	--	--
Tilia americana	--	8	1

* Importance values converted to percent composition.

the inclusion of species which this investigation did not encounter, Fraxinus nigra as reported by Darlington (1942, 1943), and the exclusion of a dominant species, P. serotina, by both Darlington (1942, 1943) and Edens (1973, 1977).

Information pertaining to the methodology used by Darlington (1942, 1943) in his assessment of the bog forest was unavailable beyond that which indicated a quadrat study, of unknown number and size, and the dominants ranked according to percent composition. With respect to the inclusion of the bog forest in the investigation by Edens (1973, 1977), only two areas were quantitatively investigated: along Yew Creek and the eastern edge of Big Glade. Discounting the data from the Yew Creek area, an area of great disturbance and alteration of the community due to, at that time, recent timbering and road building, the sample size on the eastern edge of Big Glade was significantly smaller, 100 m^2 as compared to 1 ha (10.000 m^2), and therefore extremely limited and possibly biased in comparison to the present investigation (Edens, 1973).

Within the understory/shrub stratum, R. maximum as the dominant species was in agreement with the findings of Edens (1973) and Darlington (1942, 1943) although Darlington indicated neither its importance nor the degree of presence. Secondary to R. maximum with respect to importance values, sapling of arboreal species, F. grandifolia, T.canadensis, and P. rubens, were found within the understory/shrub stratum. The relative importance of these species with respect to composition indicated successful competition in relation to R. maximum within the stratum.

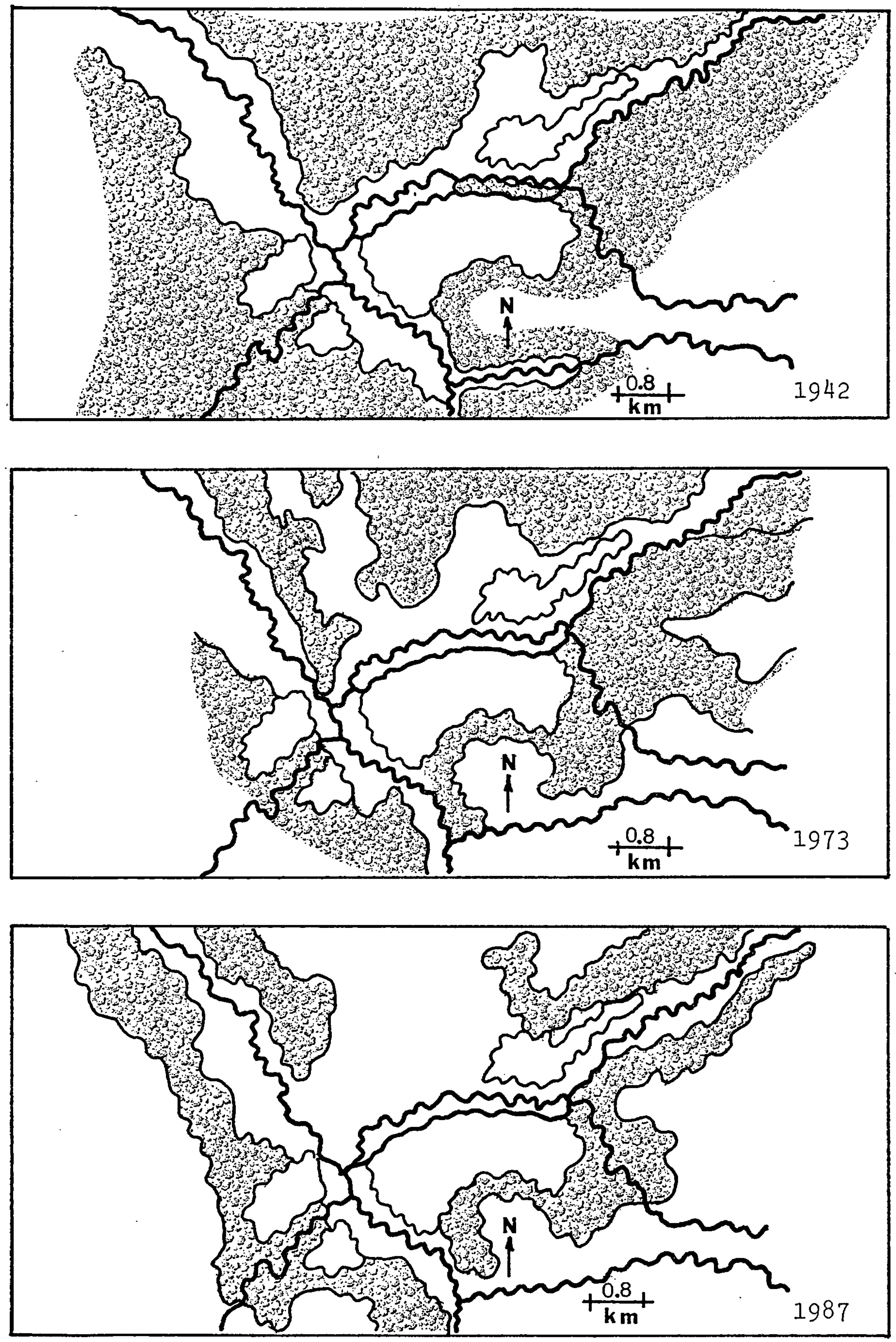
Throughout the herbaceous stratum a high degree of presence, percent composition, has been noted with respect to arboreal species (Table 5). This, coupled with successful competition in the understory/shrub layer, appears to indicate that the dominants of the arboreal stratum are successful with respect to interspecific competition, and that continued success of these species will enable the dominant species to continue controlling and characterizing the Bog Forest Community.

Darlington (1942, 1943) reported the Bog Forest Community to be found along the entire periphery of the open bogs. Thirty-one years later, Edens (1973, 1977) indicated a loss of bog forest in the floodplain of the Cranberry River, degrading to Alnus-Viburnum stream thickets, and west of Long Glade, degrading to Carex "fields." Presently, the bog forest has been observed to have continued in its degradation west of Long Glade, with the establishment of a savannah-like area populated by Carex spp. and Crataegus spp. (Figure 3).

Edens (1973) also indicated that the bog forest was encroaching upon areas of the open bogs in western Flag Glade, southern and western Round Glade, and slightly in southwestern Big Glade. Currently, arboreal species of A. rubrum, B. alleghaniensis, P. rubens, P. serotina, and

Figure 3. Comparison of the Bog Forest Community as of 1942, 1973, and 1987.

1942 Darlington
1973 Edens
1987 Kokesh



T. canadensis have established saplings and small trees (dbh between 10.0 cm and 16.0 cm) within the areas cited by Edens (1973). Small thickets of *R. maximum* have also developed in these areas of Flag, Round, and Big Glades, as well as the establishment of arboreal species.

The interior boundary of the Bog Forest Community lies along the periphery of the open bogs except in those areas of the Cranberry River floodplain in which *Alnus*-*Viburnum* stream thickets have developed (Edens, 1973). In the areas of the Cranberry River floodplain, the bog forest abuts the *Alnus*-*Viburnum* stream thickets. With respect to elevational terms of the interior boundary of the bog forest, the bog forest may be found within the same elevation as the valley/open bogs, approximately 1024 m (U.S. Geological Survey, 1973, 1977).

The exterior boundary of the Bog Forest Community has been largely determined as those points at which the relief significantly increases over that of the interior boundary. The exterior boundaries were more difficult to assess, and have been determined to exist at elevations of approximately 1036 m in the eastern, northern, and southern portions of the valley, and approximately at an elevation of 1028 m in the western portion of the valley (U.S. Geological Survey, 1973, 1977).

In terms of relief, as it increased within each directional portion of the valley (north, south, east, and west), edaphic conditions shifted from a saturated/very moist organic dominated substrate to drier inorganic dominated substrate, and the vegetation present shifted in its composition to that tolerable of more mesic conditions in comparison.

Rare and Endangered Plants

Those vascular plants classified as rare and endangered by the West Virginia Department of Natural Resources in cooperation with the U.S. Fish and Wildlife Service (Clarkson et al., 1981) have been so indicated by an asterisk (*) in Appendix A.

Within the Orchidaceae, two genera and three species were encountered in the Bog Forest Community: Corallorhiza trifida, L. cordata, and L. smallii. A small stand of C. trifida was found west of Flag Glade in an area of the bog forest characterized by organic substrate, saturated to the point at which it was considered 'muck.' Growing within the same area were small individuals of Ilex collina, considered as having a restricted range and appearing only locally within West Virginia (Clarkson et al., 1981). Listera cordata and L. smallii were found to be restricted to an area of the bog forest near Round Glade, and the stands to be overlapping. According to the literature, L. smallii has been reported from Cranberry Glades (Netting, 1932; Clarkson, 1960, 1966). Listera cordata, although reported from Randolph County by Brooks (1936), over several ranges of the Cheat Mountains by Clarkson (1960, 1966), and probable habitat sites described as "mossy woods and swamps" by Clarkson et al. (1981), *L. cordata* has not been previously reported in the literature as occurring at Cranberry Glades.

Aside from *I. collina*, mentioned previously in conjunction with *C. trifida*, one other dicot has been located within the bog forest which has been accorded vulnerable status in the report by Clarkson et al. (1981). *Polemonium van-bruntiae*, Polemoniaceae, reaches the southern limit of its range at Cranberry Glades according to Strausbaugh and Core (1973) and Clarkson et al. (1981). *P. van-bruntiae* has been found within the bog forest in areas near Round and Big Glades, and near the Cranberry River floodplain northwest of Flag Glade.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The Bog Forest Community is characterized as a mixed conifer and northern hardwoods forest of T. canadensis, B. alleghaniensis, P. serotina, and P. rubens. Within the understory/shrub stratum of the forest R. maximum dominates and forms thickets along the periphery of the forest in relation to the open bogs. The herbaceous stratum is characterized as northern in its abundance of species generally affiliated with northern coniferous forests. i.e. A. nudicaulis, C. alpina, L. cordata, L. annotinum, L. lucidulum, M. canadense, etc., and yet also evidences its relationship with the mixed mesophytic forest by the presence of C. thalictroides, C. caroliniana, T. erectum, etc.

The relation of the Bog Forest Community to surrounding communities as described by Darlington (1942, 1943) and Edens (1973, 1977) lies in that it is one of the 'last stages' of bog succession. This is not to imply that the bog forest is a climax community, for evidence provided in this investigation indicates that changes have occurred in the composition and location of the community over the course of the last forty-six years at least. Presently the bog forest, indeed the entire Glades area, is undergoing secondary succession as a result of man's encroachment and interference. Picea rubens, B. alleghaniensis, and T. canadensis have been components of the forested area at Cranberry Glades since the initiation of the sedge swamp sere (Darlington, 1942, 1943). This was confirmed by pollen analysis of peat samples to maximum depth of approximately four meters, and the location of logs of P. rubens and T. canadensis throughout the peat of the bogs, extending to the bottom of the peat (Darlington, 1942, 1943).

Retrogressive succession, as described by Lewis and Dowding (1926) is evidenced with respect to the bog forest with the establishment of the Alnus-Viburnum stream thickets in the Cranberry River floodplain and the presence of a savannah-like area of Carex spp. and Crataegus spp. west of Long Glade. Offsetting these degradations are the establishment of bog forest in areas of previously open bogs.

The fate of the bog forest, indeed the entire Glades, appears to hinge on allogenic factors as opposed to autogenic factors. Should stream meandering and erosion proceed to the point at which the glades themselves undergo erosion and drainage, the bog forest community will dominate the area until an association of T. canadensis-B. alleghaniensis becomes established, a transitional association between the northern coniferous forest and the deciduous forest. Current evidence of approximately neutral values of pH with respect to the streams within the bog forest and the Cranberry River, do not indicate that erosion of the glades is currently occurring. The activity of beavers (Castor canadensis) has continued since their role in the formation and maintenance of the bogs, as discussed by Edens (1973, 1977), and has been observed throughout the bog forest with respect to those streams within the bog forest and the Cranberry River. The building of dams impedes the flow of these waters, thereby reducing erosive effects, and their pools aid in the maintenance of boggy, saturated conditions found throughout the bog forest, particularly along the interior boundaries. These pools may also allow for retrogressive succession as the bog forest in the areas of the pools degrades to Alnus-Viburnum stream thickets or to areas which in time may support small open bog communities following the death of species affiliated with the forest.

The bog forest contains at least five species of plants which have been accorded the status of rare and/or endangered, according to Clarkson et al. (1981). These species range from those found at the southern limit of their range, P. van-bruntiae, to those of limited populations in West Virginia, i.e. C. trifida, I. collina, L. cordata, and smallii.

The Bog Forest Community, an outlier of the northern coniferous forest in association with the Glades (a southern outlier of northern bogs), represents but a portion of the most significant and unique botanical area within West Virginia, and the continued protection of the Cranberry Glades Botanical Area and Cranberry Wilderness will to a degree determine its fate. An increase in the activities of man, either those loosely grouped under the umbrella of 'recreation' or 'economic progress,' will have longstanding effects on the community and the area as a whole. The survival of specific species and communities may depend upon the stringent enforcement of the regulations governing the area, and even that may not ensure their survival as the natural phenomenon of succession occurs.

LITERATURE CITED

Braun, E. L. 1950. Deciduous Forests of Eastern North America. Blakiston, Philadelphia, Pennsylvania. 562 pp.

Brooks, A. B. 1911. Forestry and wood industries. West Virginia Geological Survey 5:247-249.

Brooks, M. 1936. Listera cordata (L.) R.Br. found in West Virginia. J. S. Appal. Bot. Club 1(2):15-17.

Brooks, M. 1945. The muskeg farthest south. Audubon Mag. 47:216-223.

Cain, S. A. and G. M. De O. Castro. 1959. Manual of Vegetation Analysis. Harper and Brothers, New York.

Clarkson, R. B. 1960. The vascular flora of the Monongahela National Forest. Unpbl. doctoral dissertation, Department of Biology, West Virginia Univ., Morgantown, West Virginia. University Microfilms, Inc., Ann Arbor, Mich. 614 pp.

Clarkson, R. B. 1966. The vascular flora of the Monongahela National Forest, West Virginia. Castanea 31(1):1-119.

Clarkson, R. B., D. K. Evans, R. Fortney, W. Grafton, and L. Rader. 1981. Rare and endangered vascular plant species in West Virginia. U.S. Fish and Wildlife Service, Department of the Interior. GPO. 76 pp. +iii.

Cody, W. J. and D. Munro. 1980. The genus Listera (Twayblades) in New Brunswick. Can. Field-Nat. 94(4): 443-446.

Conway, V. M. 1949. The bogs of central Minnesota. Ecol. Monog. 19(2):173-205.

Core, E. L. 1955. Cranberry Glades natural area. Wild Flower 31:65-81.

Crum, H. and L. E. Anderson. 1981. Mosses of Eastern North America. Vols. I and II. Columbia Univ. Press, New York. 1328 pp.

Dansereau, P. and F. Segadas-Vianna. 1952. Ecological study of peat bogs of eastern North America. Can. J. Bot. 30:490-520.

Darlington, H. C. 1942. The vegetation of Cranberry Glades, West Virginia. Unpbl. doctoral dissertation, Department of Botany, Univ. of Chicago, Chicago, Illinois. University Microfilms, Inc., Ann Arbor, Mich. 38 pp.

Darlington, H. C. 1943. Vegetation and substrate of Cranberry Glades, West Virginia. Bot. Gaz. 104(3): 371-393.

Edens, D. L. 1972. A correction in the naming of the Cranberry Glades in West Virginia. Castanea 37:229-234.

Edens, D. L. 1973. The ecology and succession of the Cranberry Glades, West Virginia. Unpbl. doctoral dissertation, Department of Botany, North Carolina State Univ., Raleigh, North Carolina. 83 pp.

Edens, D. L. 1977. Cranberry Glades, a unique series of boreal bogs in the Appalachian Mountains of West Virginia, p. 19-37. In H. G. Adkins, S. Ewing, and C. E. Zimolzak, (ed.), West Virginia and Appalachia: selected readings. Kendall/Hunt Publ. Co., Dubuque, Iowa.

Edens, D. L. and S. W. Ash. 1969. The development of a white pine stand in a bog environment at Cranberry Glades, West Virginia. Castanea 34:204-210.

Fernald, M. L. 1950. Gray's manual of botany, 8th edition. American Book Co., New York. 1632 pp.

Gates, F. C. 1942. The bogs of lower Michigan. Ecol. Monog. 12(3):213-254.

Lewis, F. J. and E. S. Dowding. 1926. The vegetation and retrogressive changes of peat areas ("muskegs") in central Alberta. J. Ecol. 14:317-341.

Lewis, F. J., E. S. Dowding, and E. H. Moss. 1928. The vegetation of Alberta. J. Ecol. 16(1):19-70.

Mellichamp, T. L., J. F. Matthews, and P. J. Smithka. 1987. New state and regional records of vascular plants in the Carolinas. Castanea 52(2):95-111.

Moss, E. H. 1953a. Marsh and bog vegetation in northwestern Alberta. Can. J. Bot. 31:448-470.

Moss, E. H. 1953b. Forest communities in northwestern Alberta. Can. J. Bot. 31:212-252.

Netting, J. S. 1932. A second record for Listera smallii Wiegand in West Virginia. Torreya 32:72.

Oosting, H. J. 1956. The Study of Plant Communities: An Introduction to Plant Ecology. W. H. Freeman and Co., San Francisco, California. 440 pp.

Pandeya, S. C., G. S. Puri, and J. S. Singh. 1968. Research Methods in Plant Ecology. Asia Publ. House, Bombay, India. 272 pp.

Radford, A. E., H. E. Ahles, and C. R. Bell. 1964. Guide to the vascular flora of the Carolinas. The Book Exchange, Univ. of North Carolina, Chapel Hill, North Carolina. 383 pp.

Rigg, G. B. 1940. The development of sphagnum bogs in North America. Bot. Rev. 6:666-693.

Rigg, G. B. 1951. The development of sphagnum bogs in North America. II. Bot. Rev. 17(2):109-131.

Rigg, G. B. and P. D. Strausbaugh. 1949. Some stages in the development of sphagnum bogs in West Virginia. Castanea 14(4):129-148.

Strausbaugh, P. D. 1934. Cranberry Glades. Amer. Forests 40:362-364, 382-383.

Strausbaugh, P. D. and E. L. Core. 1970-1977. Flora of West Virginia. West Virginia Bull. Part I, 1970. Part II, 1971. Part III, 1973. Part IV, 1977. West Virginia Univ., Morgantown, West Virginia. 1079 pp.

Tarter, D. C. and P. L. Hill. 1979. Caddisflies (Trichoptera) of the Cranberry Glades in West Virginia. Ent. News 90(4):205-206.

U.S. Geological Survey. 1973. Lobelia topographic quadrangle map. USGS, Washington.

U.S. Geological Survey. 1977. Hillsboro topographic quadrangle map. USGS, Washington.

REFERENCE NOTES

Buck, Edward. 1984. Personal communication. Retired secondary education teacher and naturalist. Richwood, West Virginia.

Scott, Jules. 1984. Personal communication. Retired logger. Hillsboro, West Virginia.

APPENDIX A

The Flora of the Bog Forest Community at Cranberry Glades, West Virginia

Table 1. Vascular plants of the Bog Forest Community at Cranberry Glades, West Virginia.

Pteridophytes

Lycopodiaceae
- _Lycopodium annotinum_ L.
- _L. annotinum_ L. var. _acrifolium_ Fernald
- _L. clavatum_ L.
- _L. flabelliforme_ Blanchard
- _L. lucidulum_ Michx.
- _L. obscurum_ L.
- _L. obscurum_ L. var. _dendroideum_ (Michx.) D.C. Eat.
- _L. tristachyum_ Pursh

Ophioglossaceae
- _Botrychium virginianum_ (L.) Sw.

Osmundaceae
- _Osmunda cinnamomea_ L.
- _O. claytoniana_ L.

Polypodiaceae
- _Asplenium platyneuron_ (L.) Oakes
- _Athyrium angustum_ Presl.
- _Dennstaedtia punctilobula_ (Michx.) Moore
- _Dryopteris marginalis_ (L.) Gray
- _D. spinulosa_ (O.F. Muell.) Watt.
- _Onoclea sensibilis_ L.
- _Polystichum acrostichoides_ (Michx.) Schott.
- _Thelypteris noveboracensis_ Nieuwl.

Gymnosperms

Pinaceae
- _Picea rubens_ (Dietr.) Sarg.
- _Tsuga canadensis_ (L.) Carr.

Taxaceae
- _Taxus canadensis_ Marsh

Angiosperms - Monocots

Araceae
- _Arisaema stewardsonii_ Britton
- _Symplocarpus foetidus_ (L.) Nutt.

Table 1. Continued.

Cyperaceae
- *Carex baileyi* Britton
- *C. fraseri* Andrews.
- *C. intumescens* Rudge
- *C. plantaginea* Lam.

Gramineae
- *Deschampsia caespitosa* (L.) Beauv.
- *Milium effusum* L.

Liliaceae
- *Allium tricoccum* Ait.
- *Clintonia borealis* (Ait.) Raf.
- *Disporum lanuginosum* (Michx.) Nichols
- *Erythronium americanum* Ker.
- *Maianthemum canadense* Desf.
- *Medeola virginiana* L.
- *Polygonatum pubescens* (Willd.) Pursh
- *Trillium erectum* L.
- *T. erectum* L. forma *albiflorum* R. Hoffm.
- *T. undulatum* Willd.
- *Veratrum viride* Ait.

Orchidaceae
- *Corallorhiza trifida* Chatelain*
- *Cypripedium acaule* Ait.
- *Goodyera pubescens* (Willd.) R.Br.
- *Habenaria fimbriata* (Ait.) R.Br.
- *H. lacera* (Michx.) Lodd.
- *H. orbiculata* (Pursh) Torr.
- *Listera cordata* (L.) R.Br.*
- *L. smallii* Wieg.*

Angiosperms - Dicots

Aceraceae
- *Acer pensylvanicum* L.
- *A. rubrum* L.
- *A. saccharum* Marsh
- *A. spicatum* Lam.

Aquifoliaceae
- *Ilex collina* Alexander*

Araliaceae
- *Aralia nudicaulis* L.
- *Panax trifolius* L.

Table 1. Continued.

Aristolochiaceae
- *Asarum canadense* L.

Balsaminaceae
- *Impatiens capensis* Meerb.
- *I. pallida* Nutt.

Berberidaceae
- *Caulophyllum thalictroides* (L.) Michx.
- *Podophyllum peltatum* L.

Caprifoliaceae
- *Sambucus canadensis* L.
- *Viburnum alnifolium* March
- *V. cassinoides* L.

Cornaceae
- *Cornus alternifolia* L.f.

Corylaceae
- *Betula alleghaniensis* Britt.

Crassulaceae
- *Sedum ternatum* Michx.

Cruciferae
- *Cardamine arenicola* Britton
- *Dentaria diphylla* Michx.
- *D. lacinata* Muhl.

Ericaceae
- *Kalmia latifolia* L.
- *Rhododendron maximum* L.

Fagaceae
- *Fagus grandifolia* Ehrh.
- *Quercus rubra* L.

Fumariaceae
- *Dicentra canadensis* (Goldie) Walp.
- *D. cucullaria* (L.) Bernh

Geraniaceae
- *Geranium maculatum* L.

Hamamelidaceae
- *Hamamelis virginiana* L.

Table 1. Continued.

Hippocastanaceae
Aesculus octandra Marsh.

Labiate
Meehania cordata (Nutt.) Britton

Onagraceae
Circaea alpina L.

Orobanchaceae
Epifagus virginiana (L.) Bart.

Oxalidaceae
Oxalis montana Raf.

Polemoniaceae
Phlox stolonifera Sims
Polemonium van-bruntiae Britton*

Polygonaceae
Polygonum sagittatum L.

Portulaceae
Claytonia caroliniana Michx.

Primulaceae
Trientalis borealis Raf.

Pyrolaceae
Monotropa hypopithys L.
M. uniflora L.

Ranunculaceae
Aconitum uncinatum L.
Actaea pachypoda Ell.
Anemone lancifolia Pursh
Caltha palustris L.
Ranunculus septentrionalis Poir.
Thalictrum polygamum Muhl.

Rosaceae
Amelanchier arborea (Michx.f.) Fernald
Prunus serotina Ehrh.
Pyrus americana (Marsh.) D.C.
Rubus hispidus L.

Rubiaceae
Galium trifolium Michx.
Mitchella repens L.

Table 1. Continued.

Saxifragaceae
Mitella diphylla L.
Ribes rotundifolium Michx.
Tiarella cordifolia L.
Scrophulariaceae
Veronica americana (Raf.) Schwein
Tiliaceae
Tilia americana L.
Ulmaceae
Ulmus rubra Muhl.
Umbelliferae
Thaspium barbinodes (Michx.) Nutt.
Urticaceae
Laportea canadensis (L.) Wedd.
Violaceae
Viola blanda Willd.
V. canadensis L.
V. hastata Michx.
V. papilionacea Pursh
V. rotundifolia Michx.

APPENDIX B

Curriculum Vita

CURRICULUM VITA

Amy Casdorph Kokesh

DATE OF BIRTH: 26 October 1956; Charleston, West Virginia

COLLEGES/UNIVERSITIES ATTENDED AND DEGREES:

1986-1988	Marshall University Huntington, WV	MS	Biological Sciences
1987 (Summer)	Western Carolina University Cullowhee, NC		
1979-1985	West Virginia State College Institute, WV	BS	Biology (Magna Cum Laude)
1974-1975	Morris Harvey College Charleston, WV		Biology

MASTER'S THESIS:

1988	The Bog Forest Community at Cranberry Glades, West Virginia (under Dr. Dan K. Evans)

HONORS AND AWARDS:

1988	Association of Southeastern Biologists Travel Award (Meeting in Biloxi, MS)
1987	Marshall University Graduate Student Research Award (I Summer, 1987)
1987	Sigma Xi Scientific Research Society (elected to)
1985	A. P. Hamblin Award, Department of Biology, West Virginia State College
1985	National Science Foundation Graduate Fellowship, Honorable Mention
1985	Beta Kappa Chi National Scientific Honor Society-National Institute of Science: Second Place, Biology Division (presentation to 42nd Annual Meeting)
1984	Alpha Kappa Mu National Scholastic Honor Society (Alpha Delta Sigma Chapter)
1983	Beta Kappa Chi National Scientific Honor Society (Beta Chapter)
1974-1975	Claude Worthington Benedum Foundation Scholarship

PROFESSIONAL ORGANIZATIONS:

American Institute of Biological Sciences
Association of Southeastern Biologists
Sigma Xi Scientific Research Society
Southern Appalachian Botanical Society
West Virginia Academy of Science

PAPERS PRESENTED AT SCHOLARLY MEETINGS:

1988	Effects of Acid-Buffering Capacity on the Seasonal Diversity and Distribution of Benthic Populations in the Cranberry River, a Naturally Acidic Watershed in West Virginia. Meetings Assoc. of Southeastern Biologists, Univ. of Southern Mississippi and Gulf Coast Research Laboratory, Biloxi, MS (with Dr. D. C. Tarter).
1988	The Bog Forest Community at Cranberry Glades, West Virginia: II Understory/Shrub, Herbaceous, and Ground Strata. Meetings Assoc. Southeastern Biologists, Univ. of Southern Mississippi and Gulf Coast Research Laboratory, Biloxi, MS (with Dr. D. K. Evans and Dr. D. L. Edens).
1987	The Bog Forest Community at Cranberry Glades, West Virginia: I Arboreal Stratum. Meetings Assoc. Southeastern Biologists, Univ. of Georgia, Athens, Georgia (with Dr. D. L. Edens).
1985	An Analysis of the Bog Forest Community at Cranberry Glades, West Virginia. Meetings Beta Kappa Chi National Scientific Honor Society-National Institute of Science, Southern University, New Orleans, LA.

PUBLICATIONS:

Kokesh, A. C. and D. C. Tarter. 1988. Effects of acid-buffering capacity on the seasonal diversity and distribution of benthic populations in the Cranberry River, a naturally acidic watershed in West Virginia. Abstract. Assoc. Southeastern Biol. Bull. 35(2):58-59.

Kokesh, A. C., D. L. Edens, and D. K. Evans. 1988. The bog forest community at Cranberry Glades, West Virginia:II understory/shrub, herbaceous, and ground strata. Abstract. Assoc. Southeastern Biol. Bull. 35(2):56.

Kokesh, A. C. and D. L. Edens. 1987. The bog forest community at Cranberry Glades, West Virginia:I arboreal stratum. Abstract. Assoc. Southeastern Biol. Bull. 34(2):90.

Kokesh, A. C. 1987-1988. Principles of Biology - Laboratory Manual. Department of Biology, West Virginia State College, Institute, West Virginia. 81 pp.