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Classification and Ecological Interpretation of Mafic Glade Vegetation on Buffalo Mountain, Floyd County, Virginia

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Buffalo Mountain is a monadnock which rises abruptly above the hilly terrain of the Blue Ridge upland in Floyd County, Virginia (Dietrich, 1970). Maximum elevation is 1210 m (3971 feet), and according to the Geologic Map of Virginia (Calver, 1963), the bedrock is the Lynchburg Formation. More recent geologic investigations determined the bedrock to be amphibole gneiss, a metamorphosed volcanic rock of the Alligator Back Formation in the Lynchburg Group of the Blue Ridge Anticlinorium (W. S. Henika, personal communication).

Buffalo Mountain has for years attracted the attention of botanists whose sporadic visits were concentrated largely around the open summit and rich, north slope forests. The first comprehensive floristic inventory of the mountain was conducted as a class project by Virginia Polytechnic Institute and State University undergraduate students, under the direction of Duncan M. Porter. Their unpublished report listed 272 species of vascular plants, and referred to the grassy summit and south slope as a naturally treeless bald which was probably maintained by shallow soil, fast runoff of rainwater, and exposure to the afternoon sun (Porter, 1975). Recognizing that this type of vegetation could be a very significant natural heritage resource, we located all such openings on an aerial photograph and conducted a brief but intensive vegetation study. We decided that the colloquial term, glade, was a better descriptor for the openings because they were not restricted to the summit, and were most often associated with bedrock outcrops. The purpose of this paper is to classify, describe, and better understand this glade vegetation in relation to environmental conditions. A secondary goal is to document the community and habitat relations of the rare plant species which inhabit the glades.

Materials and Methods

Five 10 m x 10 m plots of representative glade vegetation were sampled on August 22 and September 13, 1991. Plots were situated along the slope gradient from the summit to the lowest glade on the south slope. We recorded aspect, slope, topographic position, elevation, surface substrate, the cover-abundance class of each vascular plant species in the plot, and noted species present immediately outside the plot in similar vegetation. Floristic data were analyzed using Braun-Blanquet tabular methods (Westhoff and Maarel, 1973) to generate provisional community-types. Relationships between this new classification and prior classifications of similar vegetation were examined. Site factors and edaphic conditions were evaluated to help determine synecological relationships among the community-types. Nomenclature of vascular plants follows Harvill et al. (1992).

Results and Discussion

The glades change markedly in their floristic composition from the summit to the lower mid-slope, and thus represent an extensive and nearly continuous vegetation gradient. Environmental factors which appear to have

Table 1. Environmental data and general vegetation characteristics of Buffalo Mountain glades.

Plot Number	1	2	3	4	5
Aspect/Slope (%)	S/16-30	NW/75+	SW/8-16	S/30-65	SE/30-65
Topographic Position	crest	upper	upper	upper-mid	lower-mid
Elevation (meters)	1189	1189	1176	1128	1036
Surface Bedrock (%)	85	50	-	7	10
Surface Boulders (%)	-	-	2	2	2
Surface Gravel (%)	15	-	1	3	1
Surface Mineral Soil (%)	-	50	97	88	87
Vegetation Physiognomy	herbaceous	thicket	shrubland	shrubland	shrubland
No. of Vascular Plant Species	8	36	34	39	63

the greatest influence on the nature of the vegetation are topographic position, elevation, and the amount of surface mineral soil (Tables 1 & 2). The glade vegetation was classified using three hierarchical levels: alliance, association, and subassociation (Table 2). Within this hierarchical structure, each community-type was named using three characteristic or diagnostic plant species. The rectangles, or boxes, within Table 2 represent differential-species of the community-types, and to a certain extent, portray a community gradient which extends from the summit downslope to the lowest glade, encompassing a 153 m (492 feet) elevation change (Table 1). The communities generally have distinct boundaries recognized in the field by aggregations of the differential-species.

The *Sorbus americana-Kalmia latifolia/Saxifraga michauxii* Alliance is a prevalent type of oligotrophic vegetation found on exposed, high elevation summits in the southern Appalachian region. Similar, if not identical, vegetation has been described as heath bald communities in North Carolina (Tucker, 1972; Schafale & Weakley, 1990). This alliance is alpestrine in character and occurs on several different bedrock types in Virginia including Catoctin greenstone at Hawksbill and Stony Man Mountains and Pedlar granite at Spy Rock (G. P. Fleming, unpublished data). On Buffalo Mountain the alliance is represented by the two associations described below.

The *Paronychia argyrocoma-Potentilla tridentata-Arenaria groenlandica* Association is a type of lithophytic vegetation which occupies bedrock crevices and shallow accumulations of disintegrated rock and soil material amid lichen and moss covered bedrock outcrops near the summit. In this association *Paronychia argyrocoma* forms distinct "cushions", an adaptation well suited to the rigors of an exposed montane environment (Figure 1).

The *Hamamelis virginiana-Rhododendron catawbiense-Physocarpus opulifolius* Association occurs as a dense thicket along the upper northwestern slope and in sheltered rocky hollows where deeper soils exist. Woody species typically show twisted, flagged, or wind-sculptured growth form resulting from severe exposure. Mesophytic forbs such as *Aster umbellatus, Dennstaedtia punctilobula,* and *Maianthemum canadense* are characteristic of the herb layer.

The *Andropogon gerardii-Liatris graminifolia-Senecio pauperculus* Alliance is a rare type of "mafic" glade vegetation characterized by the magnesium loving/tolerant plants *Senecio pauperculus, Lilium grayi, Castilleja coccinea, Solidago rigida, Physocarpus opulifolius,* and *Polygonum tenue* (T. J. Rawinski, unpublished data). The term mafic is a mnemonic adjective derived from *ma*gnesium and *ferric*, and is used to describe rocks composed chiefly of dark-colored ferromagnesian minerals (Radford et al., 1981). The Glades region of Grayson County is the only other Virginia site known to support this alliance. Soils there have an average calcium:magnesium ratio of 0.37 (T. J. Rawinski, unpublished data), comparable in this respect to serpentine soils (Kruckeberg, 1967; Walker, 1954). The soils at Buffalo Mountain have not yet been chemically analyzed, but we suspect similarly low calcium:magnesium ratios. The alliance occurs on the south side of Buffalo Mountain and includes the two well-defined associations described below.

The *Salix occidentalis-Helianthemum bicknellii-Aletris farinosa* Association is an extremely rare community-type which appears to be endemic to the upper southern slope of Buffalo Mountain. It occurs on mineral soils and has a grassland or shrubland physiognomy (Figure 2). Nutrient regime is oligotrophic, judging by the knee-high

Plot Number	1	2	3	4	5
SORBUS AMERICANA-KALMIA LATIFOLIA/SAXIFRAGA MICHAUXII ALLIANCE					
Sorbus americana (SL)		2+	p		
Kalmia latifolia (H/SL)	+/	/2-	/p		
Saxifraga michauxii	1-	+			
Solidago randii *	p	+	+		
Gaylussacia baccata (H/SL)	p/	/1-			
Paronychia argyrocoma-Potentilla tridentata-Arenaria groenlandica Association					
Paronychia argyrocoma	2-	+			
Potentilla tridentata *	1-	+	1+		
Arenaria groenlandica *	+	+			
Hamamelis virginiana-Rhododendron catawbiense-Physocarpus opulifolius Association					
Hamamelis virginiana (SL)		2-			
Rhododendron catawbiense (SL)		1-			
Physocarpus opulifolius (H/SL)		/p		/p	+/+
Aronia prunifolia (SL)		1+			
Asplenium montanum		r			
Aster umbellatus		1-	+		
Betula alleghaniensis (SL)		1-			
Diervilla lonicera (SL)		1-			
Lycopodium selago *		+			
Lysimachia quadrifolia		+			
Maianthemum canadense		1-			
Menziesia pilosa (SL)		1-			
Prenanthes roanensis *		p			
Smilax tamnoides (SL)		+			
Tsuga caroliniana (SL)		+			
ANDROPOGON GERARDII-LIATRIS GRAMINIFOLIA-SENECIO PAUPERCULUS ALLIANCE					
Andropogon gerardii			1-	1-	+
Liatris graminifolia			+	1-	+
Senecio pauperculus			p	1+	1+
Andropogon scoparius	1+	1+	3	4	4
Allium cernuum			+	+	+
Aster dumosus			1+	+	+
Aster linariifolius			r	+	1-
Carya ovata (H/SL)			1+/2-	/p	/1+
Dichanthelium commutatum			+	+	+
Euphorbia corollata			+	1+	+
Lechea racemulosa			+	+	+
Pycnanthemum tenuifolium			+	2-	2-
Sericocarpus linifolius			+		+
Thalictrum revolutum			+	+	+
Woodsia scopulina			p	p	+
Salix occidentalis-Helianthemum bicknellii-Aletris farinosa Association					
Salix occidentalis	p		2-		
Helianthemum bicknellii *			+		
Aletris farinosa			p		
Habenaria ciliaris			p		
Lilium grayi *			p		
Polygala sanguinea			+		
Quercus alba (SL)			1+		
Rhynchospora globularis			p	+	
Salix humilis			p		
Juniperus virginiana-Quercus stellata/Castilleja coccinea Association					
Juniperus virginiana (H/SL)				+/1+	r/2-
Quercus stellata (H/SL)				1+/2-	/2+
Castilleja coccinea *				p	+
Asclepias verticillata				+	+
Galium pilosum				p	+
Helianthus divaricatus				p	1-
Muhlenbergia capillaris				+	1+
Polygonum tenue				+	+
Scleria pauciflora				1-	1-
Sorghastrum nutans				+	1+
Talinum teretifolium				+	p
Liatris spicata-Solidago rigida-Zizia aptera Subassociation					
Liatris spicata					1-
Solidago rigida *					+
Zizia aptera					1+
Aristida purpurascens					+
Fraxinus americana (SL)					1-

Table 2, Part 1. Provisional classification of Buffalo Mountain glade vegetation showing differential-species of the community-types, denoted by the boxes.

Plot Number	1	2	3	4	5
Danthonia spicata	+	+	1+	1-	+
Agalinis tenuifolia			p		r
Agrostis hyemalis		+	+	+	+
Amelanchier arborea (SL)		+			+
Antennaria plantaginifolia				+	+
Aristida dichotoma				+	+
Asplenium platyneuron					+
Aster divaricatus		1-			+
Aster undulatus				p	
Bromus pubescens					+
Bulbostylis capillaris				+	+
Campanula divaricata		r		+	
Carex complanata					+
Carex pensylvanica		2-			+
Carex umbellata			+		
Castanea dentata (SL)		+			
Cheilanthes lanosa				+	
Coreopsis major		1-	1-	+	
Crataegus flabellata (SL)		1-	+		
Dennstaedtia punctilobula		1+			
Dichanthelium acuminatum				p	
Dichanthelium depauperatum				+	
Festuca rubra		+	+		
Galium latifolium					+
Heuchera villosa		+			
Houstonia caerulea			+		
Houstonia purpurea					+
Hypericum gentianoides	+		+		+
Hypericum hypericoides				1-	
Hypericum punctatum				+	
Hypoxis hirsuta					+
Hystrix patula					+
Lespedeza virginica					+
Linum medium				+	
Mitchella repens		+			
Muhlenbergia mexicana					p
Ostrya virginiana (SL)					p
Panicum philadelphicum					+
Paronychia fastigiata					p
Pinus virginiana (SL)					1-
Poa compressa					+
Polypodium virginianum		p			
Potentilla simplex					1-
Prunus serotina					r
Quercus rubra (SL)		1+	1+		
Rosa carolina			+	1-	1-
Rubus flagellaris			1-	+	
Selaginella rupestris				+	+
Solidago arguta				p	
Solidago bicolor					+
Solidago juncea					p
Solidago nemoralis			+	+	1-
Solidago ulmifolia					+
Spiranthes cernua					+
Spiranthes gracilis					r
Sporobolus vaginiflorus					+
Uvularia perfoliata				p	
Vaccinium pallidum			1-		+
Vaccinium stamineum			1+	1-	
Viola fimbriatula			p	+	+

Shrub layer species, 1 to 6 m tall, are denoted by (SL); species occurring in both the herbaceous layer and the shrub layer are denoted by (H/SL), with the slash separating the herbaceous and shrub layer cover-abundance values in the table.

* Species considered to be rare in Virginia, according to Ludwig (1993).

Cover-Abundance Scale:

r	single individual	2+	12.5-25% cover
+	several, < 1% cover	3	25-50% cover
1-	1-2% cover	4	50-75% cover
1+	2-5% cover	5	75-100% cover
2-	5-12.5% cover	p	present outside plot

Table 2, Part 2. Additional species documented from Buffalo Mountain glade vegetation.

Figure 1. The lithophytic *Paronychia argyrocoma-Potentilla tridentata-Arenaria groenlandica* Association, showing the cushion growth form of *Paronychia argyrocoma.*

Figure 2. The *Salix occidentalis-Helianthemum bicknellii-Aletris farinosa* Association, an oligotrophic, edaphically maintained community-type apparently endemic to Buffalo Mountain.

Figure 3. Savanna-like vegetation of the *Juniperus virginiana-Quercus stellata/Castilleja coccinea* Association, here represented by the *Liatris spicata-Solidago rigida-Zizia aptera* Subassociation. The robust grass in the photograph is *Andropogon gerardii.*

stature of *Andropogon gerardii* and the absence of nutrient demanding plants (sensu Rawinski, 1992). Bluff Mountain in Ashe County, North Carolina is the only other site known to support similar high elevation mafic glade vegetation. Species shared between these two sites include *Helianthemum bicknellii, Aster linariifolius, Coreopsis major, Andropogon scoparius, Danthonia spicata, Potentilla tridentata, Aletris farinosa, Andropogon gerardii, Liatris graminifolia, Quercus alba, Kalmia latifolia, Vaccinium stamineum,* and *Salix humilis* (Schafale and Weakley, 1990; Tucker, 1972). Distinguishing species of the Buffalo Mountain vegetation include *Salix occidentalis, Sericocarpus linifolius, Senecio pauperculus, Woodsia scopulina, Habenaria ciliaris,* and *Rhynchospora globularis.* Absent from Buffalo Mountain are the Bluff Mountain species *Gentiana crinita, Helianthemum propinquum, Liatris aspera,* and *Phlox subulata.*

The *Juniperus virginiana-Quercus stellata/Castilleja coccinea* Association occurs on upper-mid to lower-mid slope positions. Colluvial processes and pronounced lateral drainage of water enrich the shallow soils here, as evidenced by head-high *Andropogon gerardii* and nutrient demanding plants (sensu Rawinski, 1992) such as *Solidago rigida, Solidago arguta, Bromus pubescens, Hystrix patula,* and *Helianthus divaricatus.* Wind exposure does not seem to be an important environmental factor, but instead, the rainless periods of summer and the southern aspect create extremely dry soils. The glade vegetation appears to be maintained by stressful edaphic conditions, although very old burn scars on the base of the gnarled and stunted *Quercus stellata* trees indicate past fire. Characteristic plants of this association include *Talinum teretifolium, Sorghastrum nutans, Muhlenbergia capillaris,* and *Asclepias verticillata.* The *Liatris spicata-Solidago rigida-Zizia aptera* Subassociation is a savanna-like (sensu Nelson, 1985) expression of the aforesaid association which occurs on the lowest glade (Figure 3). It is comparatively species-rich, containing an impressive total of 12 grass genera (Table 2). Conspicuous species such as *Liatris spicata, Solidago rigida, Zizia aptera, Solidago juncea, Paronychia fastigiata, Muhlenbergia capillaris,* and *Muhlenbergia mexicana* do not appear in Porter's (1975) flora of Buffalo Mountain, suggesting that this community's remote location kept it hidden from discovery until our work in 1991. To our knowledge, no other site in Virginia supports this type of vegetation, and very few sites can match its spectacular display of summer wildflowers.

Like serpentine soils, glade soils on Buffalo Mountain are characterized by friable consistence, seasonal wetness, erosiveness, bedrock exposures, magnesium-rich parent material, and a distinctive and diagnostic flora. According to Jenny (1980), the petrologic aluminum deficiency and the concomitant retardation in clay formation explain the erosiveness, shallowness, and mineral freshness of many serpentine soils and their conspicuous impact on vegetation. Walker (1954) also postulated that insufficient clay formation may explain the existence of only a thin soil mantle on many serpentine areas. We hypothesize that the soils on Buffalo Mountain are related to serpentine soils, and that clay deficiency indirectly created and maintains the open bedrock glades. Clay deficiency facilitates subsurface lateral drainage of water, which explains the existence of numerous seasonal seeps flowing across the mid-slope glades. The steady flow of seepage water in turn prevents or impedes soil development. Soil material that does form tends to be shallow and "mineral fresh" (sensu Jenny 1980), thus exposing the plant life to a relatively unweathered, high-magnesium soil environment. The glade soils appear to be well-supplied with water during spring and early summer, but during the rainless periods of summer, clay deficiency diminishes soil water holding capacity, thus leading to droughty conditions and xerophytic vegetation. Also, accelerated loss of soil moisture may occur because of the intense heat generated by black bedrock outcrops exposed to the summer sun. Detailed studies of the physical and chemical characteristics of the glade soils on Buffalo Mountain are needed to test or refine these hypotheses. Buffalo Mountain has long been recognized as a magnificent natural area, home to many rare plant and animal species. Our study shows that it also supports extremely rare, edaphically maintained glade communities worthy of continued study, appreciation, and protection.

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The Mammalian Fauna and Ectoparasites of George Washington Birthplace National Monument, Westmoreland County, Virginia

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The George Washington Birthplace National Monument (GWBNM) property includes about 218 hectares on the Potomac River in Westmoreland County, Virginia, about 130 km southeast of Washington, D.C. The property is in the Coastal Plain physiographic province and is very flat. In addition to the historic site and interpretive buildings surrounded by lawns and shrubs, a number of different habitats are found on the property. These include about 80 hectares of mixed-age woodlands dominated by loblolly pine (*Pinus taeda*) but with some hardwoods, mostly white oak (*Quercus alba*), tulip tree (*Liriodendron tulipifera*), and red maple (*Acer rubrum*), 60 hectares of farmland used for hay, 220 hectares of freshwater marsh adjacent to Pope's Creek, several meadows, two freshwater ponds, and a riverfront beach on the Potomac River which is tidal and slightly brackish. No inventory of the mammals of the GWBNM exists. The purpose of this report is to list the mammals observed at GWBNM and to annotate the list with observations and comments on ecology and behavior. The small mammals trapped and handled were examined for ectoparasites, which are also reported herein.

Materials and Methods

Small mammals were sampled primarily by trapping with Sherman and Hav-a-hart live traps. Museum Special snap-back traps and larger rat traps were used occasionally. Large mammals were observed as we walked the grounds or drove the roads, mostly at night. Mist nets were used on two occasions to sample bats.

Specimens were caught, identified, and released. A few of the small mammals killed in traps were saved as skins and skulls and deposited as vouchers in the collection at Northern Virginia Community College. Identifications were based on field characters as given in Burt & Grossenheider (1956) and Webster et al. (1985).

Observations began in March 1986 and continued at irregular intervals through April 1989. Observations were made in all months of the year except December. Twenty-four days of observing were performed with 1-13 observers. Sampling involved 13 nights of trapping. Approximately 480 man hours were spent in the field.

Eleven species of mammals were handled and examined for ectoparasites. Most were brushed with a test tube brush over a white pan and their parasites were then collected from the pan with forceps. Some live-trapped rodents were placed in a paper bag with paradichlorobenzene crystals (PDB) for 2-3 minutes after which the host animal was identified, sexed, and released. Later, the PDB was examined for the presence of ectoparasites. Parasites were preserved in 70% ethanol, decolorized in 10% KOH, dehydrated in an ethanol series, cleared in xylene, and mounted on slides in Canada balsam. These parasites were deposited as voucher specimens in the Northern Virginia Community College parasite collection or the U. S. National Tick Collection.