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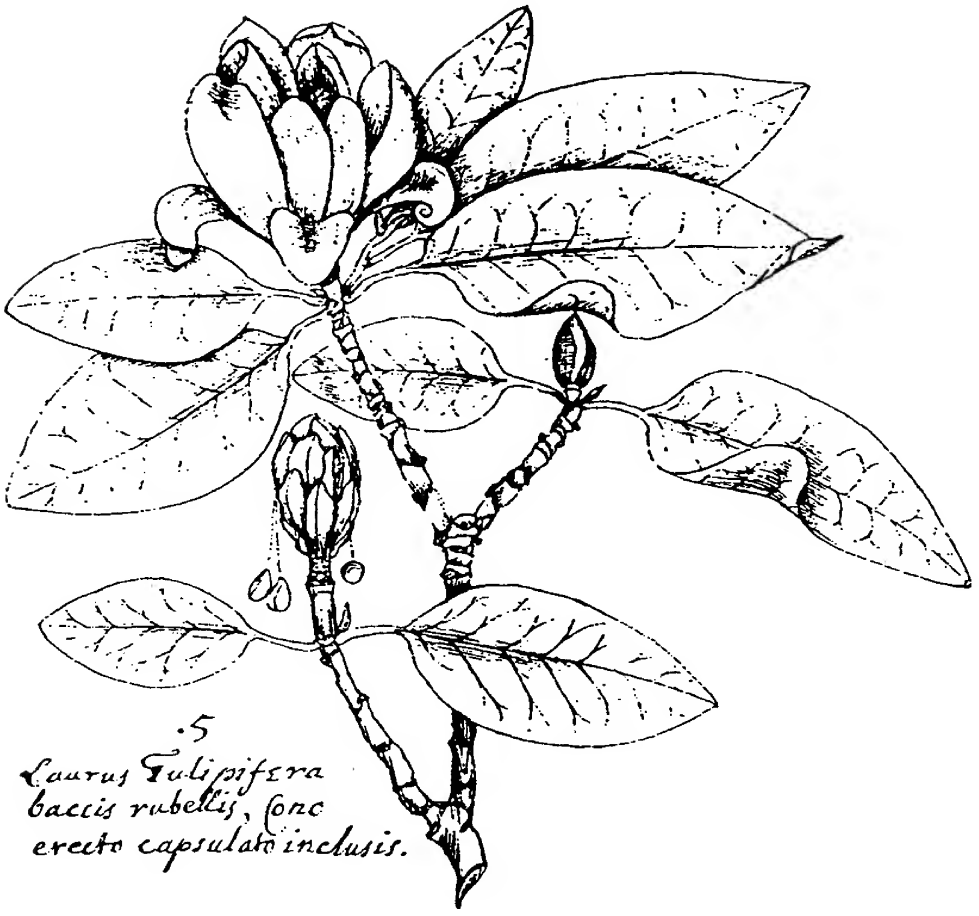
A JOURNAL DEVOTED TO THE NATURAL HISTORY OF VIRGINIA



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Original drawings by John Banister, sent to Bishop D. H. Compton in 1689. Figures 90 and 50, respectively, in folio in Sir Hans Sloane's MS 4002 in the British Museum. Photocopies courtesy of Joseph and Nesta Ewan.

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Number 50, 2018

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Natural History of the Southern Bog Lemming in Southeastern Virginia

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ABSTRACT

The isolated subspecies of Southern Bog Lemming of southeastern Virginia, *Synaptomys cooperi helaletes*, has been studied extensively since its "rediscovery" in the Great Dismal Swamp in 1980. Multiple studies using pitfall traps, starting in the Great Dismal Swamp National Wildlife Refuge and then extending elsewhere in southeastern Virginia and adjacent northeastern North Carolina, have revealed lemmings to be much more widespread and often more common than previously believed, with their presence now confirmed as far west as Surry and Sussex counties, about 30 km east of Petersburg, Virginia. When present, lemmings often are among the most numerous members of the small mammal community. Even in appropriate habitat, its presence seemingly is determined by its proximity to another arvicoline rodent, the Meadow Vole, *Microtus pennsylvanicus*, which usually is larger and perhaps competitively and behaviorally dominant.

Keywords: competition, meadow vole, *Microtus pennsylvanicus*, *Synaptomys cooperi*.

INTRODUCTION

The Southern Bog Lemming, *Synaptomys cooperi*, is a short-tailed rodent in the family Muridae, subfamily Arvicolinae (formerly Microtinae), a subfamily with a worldwide distribution in the northern latitudes, and includes the only rodents active year-round in high Arctic environments. *Synaptomys cooperi* is distributed in eastern North America from the Canadian maritime provinces westward to southern Manitoba and western Minnesota, southward through the eastern part of the Great Plains, and eastward in the cooler montane habitats of the southern Appalachians. Isolated populations are known from Meade County in southcentral Kansas, Dundy County in southwestern Nebraska, the Great Dismal Swamp region of southeastern Virginia and adjacent North Carolina, and the Pine Barrens region of New Jersey. C. H. Merriam (1896) believed the Southern Bog Lemmings discovered in the Great Dismal Swamp to be distinctive from others and thus named it a new species, *Synaptomys helaletes*, but later this taxon was relegated to subspecies status (Wetzel, 1955), so it is now called *Synaptomys cooperi helaletes*.

Baird (1858) proposed the name *Synaptomys* because he believed its features represented a link between true lemmings (*Lemmus*) and mice. The one other species in the genus, *Synaptomys borealis*, overlaps with *S. cooperi* only in the southern parts of its distribution, which extends beyond the Arctic Circle. Much more is known about the biology of *Synaptomys cooperi* because population studies have been conducted in eastern Kansas (Gaines et al., 1977), eastern Illinois (Beasley & Getz, 1986), western Virginia (Linzey, 1984), and southeastern Virginia (Rose & Ford, 2012). Across its distribution there are hints that the Southern Bog Lemming is more able to coexist with Prairie Voles (*Microtus ochrogaster*) than with Meadow Voles (*M. pennsylvanicus*).

GENERAL CHARACTERISTICS

The Southern Bog Lemming is a thick-bodied, short-tailed rodent with grizzled brownish fur above and gray fur below (Fig. 1). Each sex of *S. c. helaletes* averages about 28 g, with some individuals weighing up to 47 g (Rose, 2006; Rose & Ford, 2012). Rose (2006) found the sex ratio of *S. c. helaletes* is 1:1, and both sexes have similar total lengths, about 120 mm, of which the tail is about 20 mm. Its tail is about as long as the hind foot, and only half as long as that of its closest relative in southeastern Virginia, the Meadow Vole. Its blunt snout hides a pair of grooved upper incisors, a feature

Fig. 1. Photograph of Southern Bog Lemming, *Synaptomys cooperi* (credit Wayne Van Devender).

distinguishing this rodent from others of similar size in southeastern Virginia. Its small ears are nearly obscured by the long fur and the eyes also are small.

DISTRIBUTION

Like the other isolated subspecies, *Synaptomys cooperi helaletes* was believed to have a restricted distribution, probably limited to the historic Great Dismal Swamp of Virginia and North Carolina, which when Europeans colonized Virginia may have had an area of 1,800 km^2 (Lewis & Cocke, 1929). The Great Dismal Swamp, a distinctive geological feature of the mid-Atlantic coast, developed during the Holocene and is characterized by peaty soils, high water table, especially in winter, and cooler and wetter habitats than in nearby uplands, qualities that likely enabled *S. c. helaletes* to survive in place after the last Pleistocene glacier retreated northward starting about 10,000 years ago, taking with it most other boreal species.

Synaptomys cooperi helaletes was discovered when the U.S. Bureau of Biological Survey sent a team, headed by A. K. Fisher, to conduct a survey of plants and animals in the Great Dismal Swamp. From 1895 to 1898, Fisher's team spent a total of 23 weeks collecting many kinds of organisms there, including 23 Southern Bog Lemmings in kill traps. Later efforts to find lemmings in the Swamp were futile, including multiple efforts by Smithsonian Curator Charles O. Handley (1979), until Rose (1981) collected 13 Southern Bog Lemmings in pitfall traps at three locations in the northwest section of the Great Dismal Swamp National Wildlife Refuge (hereafter "Refuge") in late winter of 1980. Later studies extending outward from the Refuge revealed Southern Bog Lemmings at numerous locations in Virginia Beach, Chesapeake, and Suffolk (all former counties) and as far west as Isle of Wight County, where they were caught in pitfall traps at eight of 14 sites (Rose, 2005). Later, evidence of populations was detected at 10 sites farther west, in Southampton, Surry, and Sussex counties, and confirmed when Southern Bog Lemmings were caught in live traps at three of five locations in these counties (Rose, 2011).

Their presence in western Surry and Sussex counties, within 30 km of Petersburg, Virginia, suggests that Southern Bog Lemming populations might be found even farther west. With the addition of these three counties, the known distribution of *S. cooperi helaletes* has been extended to 7,000 km^2 (2,700 mi^2), much broader in Virginia than previously believed.

FORM AND FUNCTION

As in other arvicoline rodents, the dense fur, short tails, and short ears are adaptations for conserving heat in the north temperate environments in which most populations of Southern Bog Lemmings live. The same features that conserve heat create heat-dumping problems in summer for boreal species living in temperate locations, probably resulting in them becoming more nocturnal during the warmest months in order to avoid life-threatening heat stress. For Southern Bog Lemmings, information on such behavioral changes is unknown but adjustments in the timing of their breeding season are suggestive (see Reproduction).

The distinctive feature of the alimentary canal is the large spiral-shaped caecum, useful in the foregut fermentation that is crucial to extracting energy from their low-caloric foods, such as grasses, sedges, and mosses. Other arvicoline rodents have large caeca, but only the caecum of the Southern Bog Lemming has the spiral shape, a feature that increases the surface area without increasing the capacity of the caecum. The caecum slows the flow of digesta through the gut, allowing microbial action and fermentation sufficient time to break down and release simple sugars and amino acids for absorption in the small intestine. It is unclear why the spiral-shaped caecum is present in *Synaptomys* but not in other arvicoline rodents.

The efficiency of digestion is increased by Southern Bog Lemmings practicing coprophagy (i.e., the eating of feces). Soft pellets, plucked before they drop to the ground, are swallowed after chewing, and their second passage through the alimentary canal extracts nitrogen and water, and retains more minerals than initial digestion (Kenagy & Hoyt, 1980). Coarse pellets with undigestible fibers, the product of the second passage, are allowed to drop to the ground at latrines.

Like other arvicoline rodents, *S. c. helaletes* is active year-round and thus must find the calories to sustain itself day to day. Fat stores probably play a minor role in winter survival because Southern Bog Lemmings (also Prairie and Meadow Voles) have little body fat at any time of year (pers. obs.). Arvicolines, and presumably *S. c. helaletes*, have high metabolic rates, higher than rodents of similar size that live in more temperate locations. The reasons for their high metabolic rates are not entirely understood but may be related to their high biotic potential, such as their ability to double population size in as little as a month via their short gestation and nursing periods. Many arvicoline rodents, including Southern Bog Lemmings, undergo multi-annual population cycles; in eastern Kansas, populations of *S. c. gossii* underwent multi-year cycles on two sample grids but had annual cycles on a third grid (Gaines et al., 1977). No pattern was evident in the population study of *S. c. helaletes* in Suffolk, Virginia (Rose & Ford, 2012). After nearly a century of study, the reasons for multi-year population cycles in arvicoline rodents remain unclear (Krebs, 2013).

REPRODUCTION

Litter size of necropsied *S. c. helaletes* females (n = 9) collected in pitfall traps was 2.56, but some other females had same-sized placental scars numbering 4, 5, and 6; these values conform with litter sizes in other subspecies (Rose, 2006). Pregnant females were recorded for all months from November through June, but none from July-October. This suggests that Southern Bog Lemmings in southeastern Virginia may suspend breeding during the warmest months, perhaps because of problems with dealing with summer heat. Although the November-June pattern of reproduction seen in females is not as clear for male *S. c. helaletes*, the absence of epididymal convolutions from July-September indicates that males were infertile during this period. The winter breeding of Southern Bog Lemmings in southeastern Virginia is different from northern populations, where breeding usually is suspended in mid-winter (Linzey, 1983). Part of the reason for continued winter breeding of *S. c. helaletes* may relate to the continual growth of grasses, sedges, and softrushes during the mild winters in southeastern Virginia, where the mean January high temperature is 9° C. Using external features only, *S. c. helaletes* near the Refuge in Suffolk (Rose & Ford, 2012) showed high levels of reproductive readiness throughout the 18-month study: 84% of adult females showed two of three reproductive features and 52% of males had descended testes; monthly values did not depart greatly from these values, suggesting year-round reproduction.

There is little information on reproduction from other populations or subspecies of *S. cooperi.* Connor (1959) attempted to breed Southern Bog Lemmings in the laboratory but only one female produced litters (n = 6) and a total of 22 young during a 26-week period. The average interval between litters was 23-26 days, indicating a post-partum estrus and breeding soon after the birth of a litter, a common feature in arvicoline rodents. Much remains to be learned about the patterns of reproduction in the geographic populations of Southern Bog Lemmings.

ECOLOGY

Although *Synaptomys cooperi* sometimes is found in forests (Krupa & Haskins, 1990; Linzey, 1983), its diet is composed almost exclusively of herbaceous vegetation (Linzey, 1984; Rose & Ford, 2012), including mosses and fungi, but mostly grasses and sedges, plants rarely found in forests with closed canopies. Fruits of huckleberries and blueberries were important foods in New Jersey and bark and roots were eaten sometimes too (Connor, 1959). In southwestern Virginia, broomsedge (*Schizachyrium scoparium*) was the most important food during summer and mosses in winter (Linzey, 1984). In the only study of diet of *S. c. helaletes* from southeastern Virginia, feces obtained from 3-7 lemmings each season showed that seeds and sedges dominated the winter diet; in spring, sedges remained important but significant amounts of grasses and mosses were also eaten (Rose & Ford, 2012). The summer diet was nearly 80% cane (*Arundinaria* sp.), with seeds and sedges comprising most of the rest. In autumn the diet was more varied, with cane and grasses combining for about 80%, followed by sedges, lichens, and seeds. In this study, soft rushes (*Juncus* spp.) were sometimes consumed, but were never more than 5% of seasonal diets. By contrast, in habitat under powerlines in the Dismal Swamp, Rose & Stankavich (2008) sometimes found piles of the spaghetti-like pith of *Juncus* left after Southern Bog Lemmings had peeled and eaten the green cover from this soft rush; this behavior seemed to be more common in winter. The discarded 3-4 cm sections of cane near latrines of green feces indicate its frequent consumption by Southern Bog Lemmings in southeastern Virginia. Most plants in the diet are found in damp or wet environments and some, such as the sedges (*Carex*), soft rushes (*Juncus*), and spikerushes (*Eleocharis*), are obligate wetland plants.

The presence of Southern Bog Lemmings in these habitats often is indicated by 3-4 cm cut and discarded sections of grasses, sedges, or cane and by latrines with their distinctive green feces. These fecal pellets are 5-6

mm long and 2-3 mm wide and rounded at both ends, in effect sausage-shaped (Rose, 2016). The reasons for the feces being green are unknown, but may relate to the unique spiral-shaped caecum.

In southeastern Virginia, Southern Bog Lemmings are part of some small mammal communities but not others, even in appropriate habitats. One reason may be due to its competitive abilities with other species. Evidence that *S. c. helaletes* does not compete well with Meadow Voles was seen in the study in which they and Woodland Voles (*Pitymys pinetorum*) were co-dominants in a regenerating pine plantation in the absence of Meadow Voles (Rose & Ford, 2012). After mature pines were logged on the site, located 2 km west of the Refuge in Suffolk, the stumps and logging debris were bulldozed into parallel windrows about 40 m apart. Loblolly pine seedlings were mechanically planted in the peaty soils, with furrows between rows that filled with water after heavy rains and for much of the winter. These conditions were tolerated by Southern Bog Lemmings and Woodland Voles, which reached modest densities, but none of the larger herbivorous rodents in the region (Meadow Voles, Hispid Cotton Rats [*Sigmodon hispidus*], and Marsh Rice Rats [*Oryzomys palustris*]) was ever trapped during this 18-month field study in which Fitch live traps (Rose, 1994) were used. We did catch seven Eastern Harvest Mice (*Reithrodontomys humulis*), but none during the last 15 months. In all, we caught and tagged 47 Southern Bog Lemmings, 110 Woodland Voles, and 15 Short-tailed Shrews (*Blarina brevicauda*), resulting in densities of up to 14 Southern Bog Lemmings per hectare on one 0.55 ha grid and 32 Woodland Voles per hectare on the other grid.

In field studies near Blacksburg, Virginia, Linzey (1984) presented evidence, based on removal experiments and patterns of co-occurrence, that *Synaptomys cooperi stonei* is not successful in competition for space with Meadow Voles. In another field study, *S. c. stonei* was a regular occupant of clearings in the 4,450-ha Robinson Forest in southeastern Kentucky until Meadow Voles migrated southward into this region, after which it has largely replaced Southern Bog Lemmings in these forest clearings except when densities of Meadow Voles are low (Krupa & Haskins, 1990). In the New Jersey Pinelands, Shenko et al. (2012) also found populations of Southern Bog Lemmings, primarily in wet grassy areas, in the almost complete absence of Meadow Voles. By contrast, Danielson & Gaines (1987) report that *S. c. gossii* in eastern Kansas shows no evidence of microhabitat selection, and thus is a habitat generalist, being able to survive on the sidelines when the more productive habitat is occupied by more competitive species, such as *Microtus*.

Other studies besides Rose & Ford (2012) also indicate that *S. c. helaletes* does not compete well with Meadow Voles in southeastern Virginia. Of the 38 study grids located in and near the Refuge, the 17 grids with Southern Bog Lemmings (n = 102) yielded only two Meadow Voles (Everton, 1985; Rose, 2006). In Isle of Wight County, either Meadow Voles or Southern Bog Lemmings were present on 12 of 14 grids but both species were found on only three grids (Rose, 2005), and when the latter species was present, only 1-2 Meadow Voles were trapped. In general, when Southern Bog Lemmings are present, Meadow Voles usually are not. For example, Everton (1985) caught lemmings on 11 grids, but only one Meadow Vole in these wet sites. Thus, mounting circumstantial evidence is accumulating that Southern Bog Lemmings in Virginia do not compete well with Meadow Voles, to the point that they are absent in habitats with many Meadow Voles and thrive only in their absence.

Additional information on their habitats in southeastern Virginia is provided by field studies in pine plantations in Isle of Wight County (Dolan & Rose, 2007), where *S. c. helaletes* was absent in stands of ages 1, 8, 18, and 24 years: none was caught on 56 0.25-ha grids despite 39,600 traps nights with live traps and 28,500 trap nights with pitfall traps. This is the same county in which Southern Bog Lemmings were found in eight of 14 grids set in the more varied habitats under powerlines (Rose, 2005).

Even in appropriate habitat and in the absence of Meadow Voles, Southern Bog Lemmings have patchy distributions. But when they are present, they often are among the most numerous small mammal in that community (Rose, 2006). In a pitfall study conducted in and near the Refuge, Southern Bog Lemmings were present in 17 of 21 0.25-ha grids, and lemmings (n = 102) were second in abundance to Southeastern Shrews, *Sorex longirostris* (n = 114) on those 17 sites (Everton, 1985; Rose, 2006).

Synaptomys cooperi helaletes often does not readily enter live traps. For example, Rose & Stankavich (2008) observed that latrines with green feces were common but Southern Bog Lemmings were not trapped until the 10th month of biweekly live trapping in the Dismal Swamp; then 13 different lemmings were tagged over the next few weeks. Linzey (1984) had such low recapture success after a year of trapping Southern Bog Lemmings with small Sherman traps that she used unbaited dropping boards to determine relative abundance and spacing patterns thereafter. I believe that *S. c. helaletes* is more prone to entering live traps during winter, perhaps finding the mixed seed baits worth the risk of

entering Fitch live traps then but not at times when their energy requirements are more easily met. The patchy distributions and reluctance of Southern Bog Lemmings to enter live traps inhibit efforts to understand their role in rodent communities in southeastern Virginia.

In January and February of 2011, I tested the idea that green feces could be used to accurately predict the presence of *S. cooperi* (Rose, 2011). I carefully searched 27 sites across Southampton, Sussex, and Surry counties in southeastern Virginia, places with grassy and sedge habitats suitable for Southern Bog Lemmings but beyond their known distribution. I spent 1-3 hours at each site, and detected latrines with green feces at 10 sites, indicating their possible presence. Then I placed baited Fitch live traps at five of these 10 sites, and in two nights of trapping caught four Southern Bog Lemmings at three of these sites, confirming that green feces are a good predictor of their presence. In late June 2014, I applied the same methods to determine whether the two isolated subspecies in the Midwest were still present. After spending a day searching for green feces at each of the localities in Kansas and Nebraska where the isolated subspecies of *Synaptomys cooperi* had been discovered, I found no evidence for *S. c. paludis* at the fish hatchery near Meade, Kansas, but multiple evidences of *S. c. relictus* at and especially downstream from the fish hatchery near Parks, Nebraska.

From 2002 to 2012, my students and I conducted monthly live trapping on 1-ha grids to evaluate the small mammal communities at two sites in southern Chesapeake. These old fields were dominated by grasses that had vegetated abandoned farm fields, mostly bluestem (*Andropogon virginicus*) and panic grasses (*Panicum* spp.), plants that Everton (1985) reported having the highest total contacts in association with the presence of Southern Bog Lemmings. Some places on the grids were wet and harbored clumps of soft rushes, spikerushes, and wool grass (*Scirpus cyperinus*). Meadow Voles were common on both grids, reaching high densities of ca. 50/ha on one grid and over 150/ha on the other, and hispid cotton rats were common too, but in all of these years of trapping we never caught any *S. c. helaletes*. I believe this is the strongest evidence, together with Rose & Ford (2012), that the lemming populations cannot persist with populations of Meadow Voles. Despite one or two individuals of each species sometimes being taken on the same pitfall grid, in general, if *S. c. helaletes* is present, Meadow Voles usually will be absent. It is entirely circumstantial evidence for *S. c. helaletes*, but studies over the years have increasingly supported that contention.

BEHAVIOR

I have found the Southern Bog Lemming to be more docile than most rodents, and easily handled after removal from live traps. When placed in the bottom of a bucket, it is more likely to sit on its haunches, "rest," or nibble on seeds rather than to "run laps" around the perimeter, as most rodents do at first capture. By contrast, a Meadow Vole of similar size often will sit on its haunches, raise its snout skyward while baring its teeth and squeak, in an aggressive posture.

It is unclear whether Southern Bog Lemmings make and maintain runways, as many arvicoline rodents do, but they do leave the characteristic piles of clippings and use latrines, usually along runways. The discarded clippings have diagonal cuts on the ends, and average 3-4 cm for Southern Bog Lemmings, similar lengths to those cut by Meadow Voles but shorter by half compared to Cotton Rat cuttings. The cuttings of the lower sections of grasses and sedges are discarded, probably because they are more fibrous and less nutritious, and seemingly only the upper sections and their seeds are consumed. We can imagine a Southern Bog Lemming sitting on its haunches, cutting, discarding, repeating both many times, and finally consuming the younger, fleshier and (probably) more nutritious upper sections and seeds of grasses and sedges, all the while sitting at the base of a clump of grass or sedge, mostly protected from view by birds of prey.

The blunt appearance of the snout is accentuated when the facial hairs are directed forward. The placement and function of these vibrissae is not entirely understood in mammals but undoubtedly relates to collecting information on their closest environment, where their senses of touch and smell likely become more important than vision.

REMARKS

The reasons for the isolation of *Synaptomys cooperi* populations being sufficiently long for them to have diverged to become subspecies remain enigmatic, although the speculation that persistence and divergence are related to consistent or reliable water sources, whether springs (in Kansas and Nebraska) or swamps (in Virginia and New Jersey), is plausible. Equally in need of explanation is how *S. c. gossii*, the Midwest subspecies, became adapted to life in the mesic-to-xeric grasslands of Kansas and Illinois, where thriving populations have been studied extensively. Further, the Midwest subspecies seems to be readily trappable, in

contrast to the isolated population in New Jersey, where Connor (1959) caught only 48 Southern Bog Lemmings in his four-year field study using Sherman traps. Linzey (1984) ceased trapping in western Virginia after one year in favor using dropping boards, and Rose & Stankavich (2008) observed the characteristic green feces in southeastern Virginia for nearly a year before the first lemming was trapped.

In conclusion, except for its smaller size, *Synaptomys cooperi helaletes,* the Southern Bog Lemming of southeastern Virginia, is typical in many ways to the other subspecies that have been studied in other regions. In the absence of its apparently competitive superior, the Meadow Vole, it can reach densities as high as 14 per hectare. Found mostly in damp habitats dominated by grasses and sedges, its distribution is patchy but when present, it often is one of the 2-3 most numerous species taken in pitfall traps at a site. Often difficult to catch in live traps, its presence can be detected because of its habit of depositing distinctive green feces in latrines along runways. Formerly believed to be restricted to the Great Dismal Swamp of southeastern Virginia, the distribution of *S. c. helaletes* now extends westward to include locations in western Sussex and Surry counties.

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Microhabitat of the Chainback Darter, *Percina nevisense* (Actinopterygii: Percidae), in the Upper Roanoke River in Salem, Virginia

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ABSTRACT

Microhabitat for Chainback Darter (*Percina nevisense*) was quantified from April 2016 to September 2017 using snorkeling observations and measurement of depth, current velocity, and substrate size. Mean depth of observation was 60.5 cm (SD = 16.7), mean current velocity at observation points was 0.17 meters per second (SD = 0.12), and mean substrate size was 8.1 cm (SD = 11.4). None of these variables differed statistically between adults and subadults. Depth, current velocity, and substrate size were also measured at 30 evenly spaced spots within the study site during October 2016. None of the means for measured parameters of occupied points were significantly different from available habitat. However, the variances of occupied and available habitat for October 2016 were statistically different for depth and velocity, but not substrate size. All three measured variables were not uniform among months. These analyses suggest that *P. nevisense* occupy specific habitats and those habitats change from month to month with a shift to deeper and faster water over finer substrates during March to May during the likely spawning season.

Keywords: current velocity, depth, snorkeling, substrate.

INTRODUCTION

While numerous characteristics of the biology of the Shield Darter, *Percina peltata* (Stauffer), have been described (New, 1966; Loos & Woolcott, 1969; Gray & Stauffer, 2001; Schmidt & Daniels, 2004), little is known of the biology of its sister species the Chainback Darter, *Percina nevisense* (Cope) (Actinopterygii: Percidae) as recognized by Goodin et al. (1998). Preliminary evaluation of morphological data (Raney & Suttkus, unpublished) suggests cryptic diversity may still exist within *P. nevisense* as currently recognized with specimens in the upper Roanoke River representing an undescribed taxon. Higher mean values for several meristic characters of Roanoke River specimens examined by Mayden & Page (1979) add supporting evidence to this hypothesized cryptic diversity. Further examination of this possible cryptic diversity is simultaneously made more difficult and important by the increased rarity of the species in the upper Roanoke River. Jenkins & Burkhead (1994) noted a decline in abundance in the upper Roanoke River throughout their surveys leading to an absence in their collections after 1976.

Despite the plethora of potential research projects investigating this charismatic species, recent efforts to collect specimens for study have not yielded enough individuals to provide meaningful data to help elucidate life history or systematics questions. In an effort to be more efficient with collection efforts and continue study of this species, we examined their microhabitat within a known population in the upper Roanoke River in Salem, Virginia.

MATERIALS AND METHODS

We made snorkeling observations of a known population of *P. nevisense* in the Roanoke River in Salem, Virginia (37° 16' 57.46" N, 80° 04' 01.75" W) each month from April 2016 to September 2017. We placed a numbered fluorescent green washer on the substrate at each point of first observation of *P. nevisense*, recorded the number of individuals, and estimated age class as adults (>80 mm SL), subadults (40-80 mm SL), or juveniles (<40 mm SL). Depth of water at each observation point was recorded with a

meter stick as was the diameter of five representative rocks within 10 cm of the washer. We recorded current velocity approximately 5 cm above each washer with a FloWatch FW450 flowmeter in meters per second (m/s). Some months produced no observations and data due to high water levels, turbidity or absence of *P. nevisense.* To compare our data at observation points to available habitat, we collected the same data at 30 evenly spaced points within the study site in October 2016.

We used T-tests to test for differences in habitat between adults and subadults. Observation data from October 2016 were compared to available habitat data using T-tests and Bonett's tests to determine if occupied habitat differed from available habitat. We compared observation data from different months using a one-way Analysis of Variance to test for changes in habitat throughout the year. All statistical analyses were conducted in Mini-Tab 18 with alpha = 0.05.

RESULTS

We made a total of 266 observations of *P. nevisense* totaling 388 individuals including 364 adults, 23 subadults, and one juvenile. The mean number of individuals per observation was 1.46 (SD = 0.95) and the highest number of individuals at a single observation point was eight. For all observation points, mean depth was 60.5 cm (SD = 16.7), substrate diameter was 8.1 cm (SD = 11.4), and water velocity was 0.17 m/s (SD = 0.12). There were no differences between adults and subadults for any of the habitat variables (depth P = 0.219, substrate diameter P = 0.236, velocity P = 0.286). In comparisons of October 2016 observation data and available habitat data, there were no significant differences in mean water velocity (P = 0.109), depth (P = 0.905), or substrate size (P = 0.631). However, using Bonett's test for differences in variance, occupied habitat had a lower variance than available habitat for October 2016 for depth (P = 0.002) and velocity (P = 0.044), but variances were not different for substrate size (P = 0.142).

Occupied habitat variables were not uniform among months (depth P < 0.001, velocity P < 0.001, substrate size P = 0.001) (Figs. 1-3). Mean depth of observation points was greatest in May (83.2 cm, SD = 13.4) and lowest in July (48.9 cm, SD = 6.1). Mean current velocity was also greatest in May (0.275 m/s, SD = 0.116) and lowest in November (0.080 m/s, SD = 0.084). Substrate size was greatest in November (13.8 cm, SD = 12.55). The lowest mean substrate size was for March (5.5 cm, SD = 6.50).

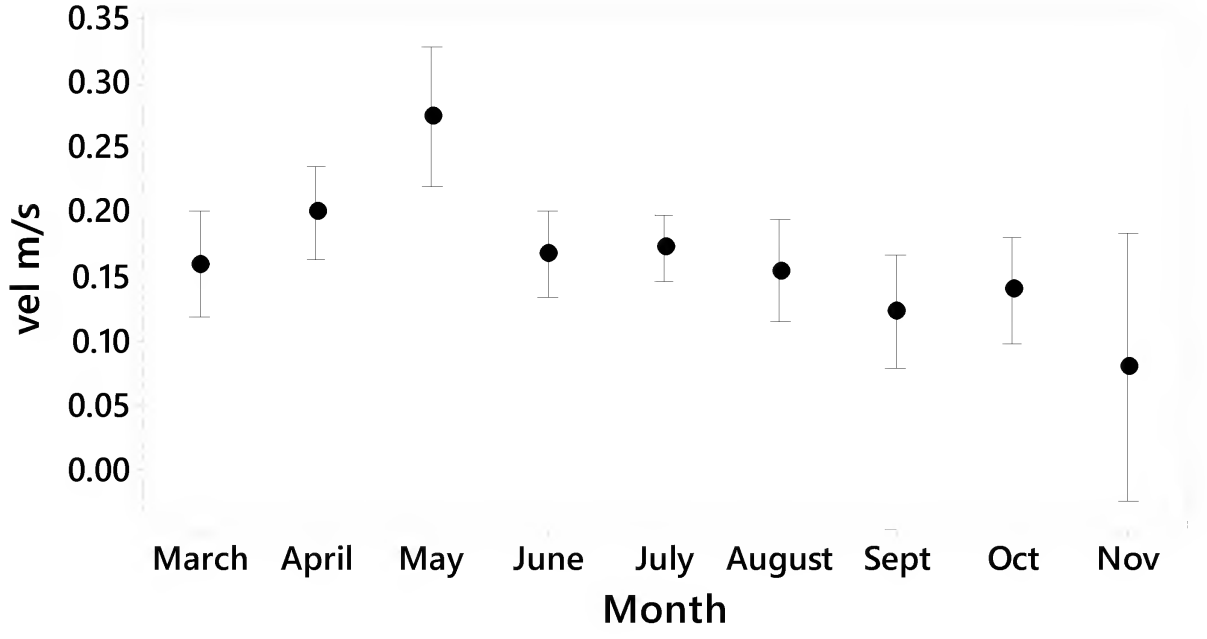

Fig. 1. Interval plot of current velocity (m/s) for monthly observation points of *Percina nevisense* in the upper Roanoke River, Virginia. Sample sizes for current velocity by month are: March (n = 15), April (n = 50), May (n = 20), June (n =41), July (n = 40), August (n = 40), October (n = 20), November (n = 5).

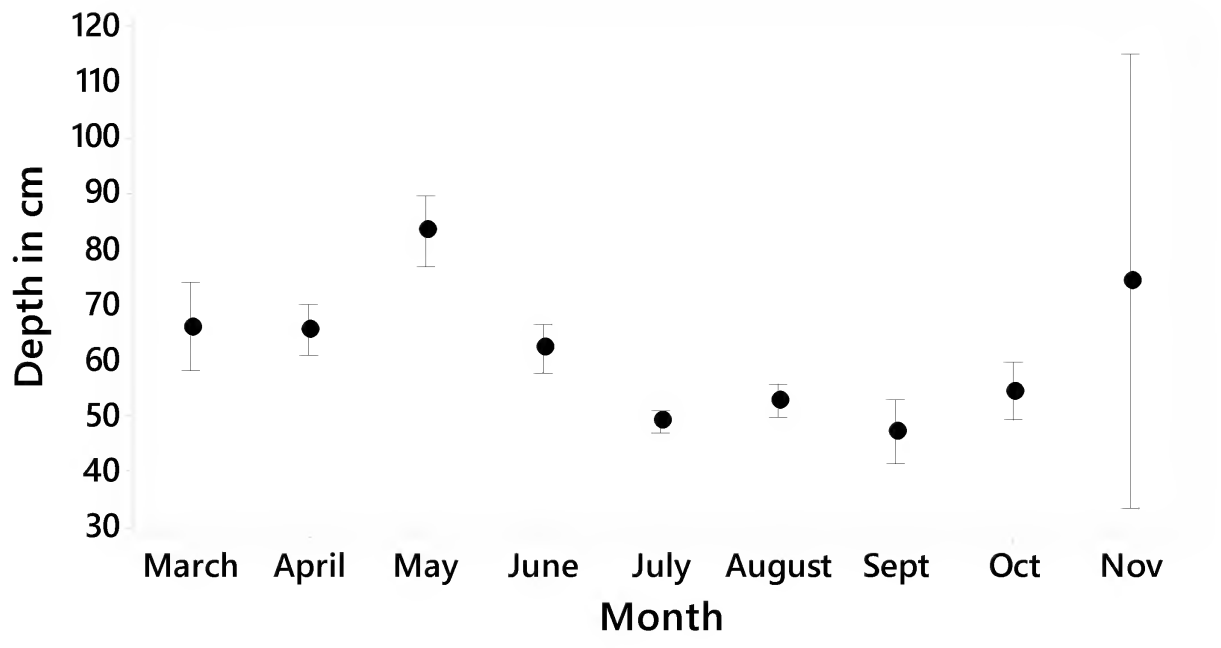

Fig. 2. Interval plot of depth (cm) for monthly observation points of *Percina nevisense* in the upper Roanoke River, Virginia. Sample sizes for depth by month are: March (n = 15), April (n = 50), May (n = 20), June (n = 41), July (n = 40), August (n = 40), October (n = 20), November (n = 5).

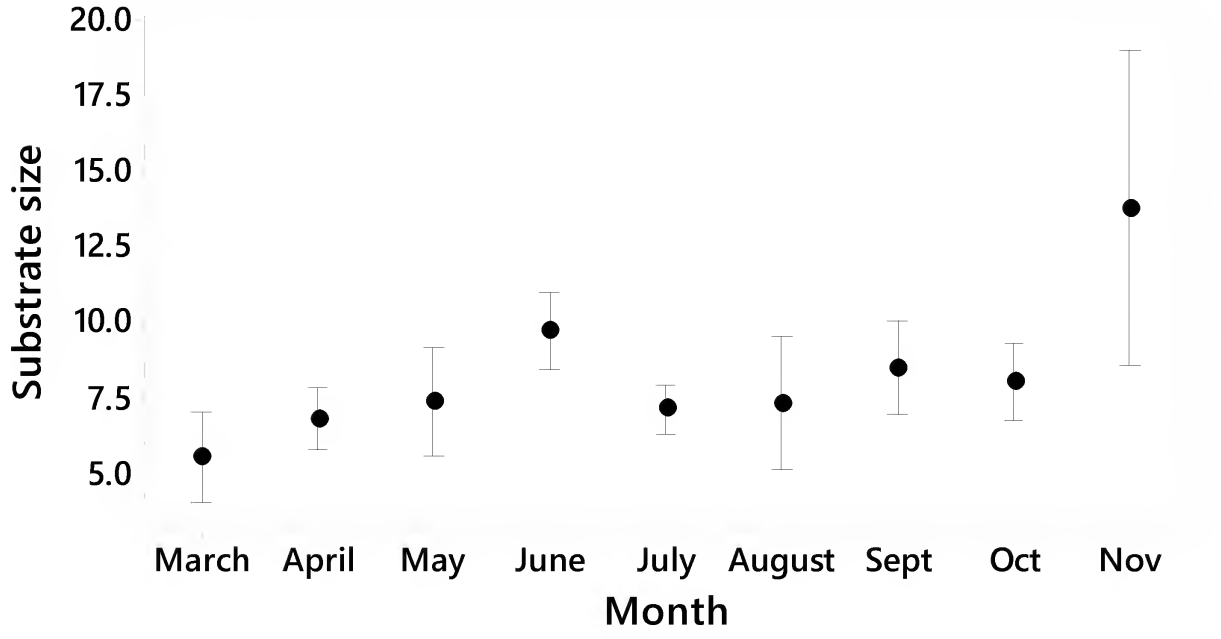

Fig. 3. Interval plot of substrate diameter (cm) for monthly observation points of *Percina nevisense* in the upper Roanoke River, Virginia. Sample sizes for substrate diameter by month are: March (n = 75), April (n = 250), May (n = 100), June (n = 405), July (n = 200), August (n = 200), October (n = 100), November (n = 25).

DISCUSSION

Our data suggest there is no difference between adults and subadults of *P. nevisense* in measured habitat variables. As only one juvenile specimen was observed during this study, little can be inferred about their specific habitat from our data. However, this dearth of data on juvenile *P. nevisense* habitat suggests there are likely differences from those of adults and subadults as has been documented for other species of darter. Rosenberger & Angermeier, (2003) found juvenile Roanoke Logperch, *Percina rex,* to inhabit slower, shallower waters than adults, and floodplains have been demonstrated to be important habitat for larval darters (Turner, et al. 1994). If juvenile *P. nevisense* were restricted largely to very shallow, slow moving backwaters, our observations would have likely missed them due to the difficulty snorkeling in those habitats.

While the mean values of current velocity, depth, and substrate size of our observation points were not statistically different than available habitat, differences in variance for two of the three measured variables suggest *P. nevisense* occupy more specific habitats than simply those available. The shallowest and deepest waters both appear to be largely avoided by *P. nevisense* because only five specimens were observed in water deeper than 100 cm, and only one specimen was observed in water shallower than 25 cm. The fastest and slowest currents also appear to be largely avoided by *P. nevisense*; only two specimens were observed in water flowing faster than 0.4 m/s, and only 41 specimens were observed in current that did not register on our flow meter, with all but 10 of these coming in summer and fall when instream flows were lower than in spring. *Percina nevisense* observed in October 2016 did not appear to have a preference for substrate size because occupied and available habitats were not statistically different. Habitat specificity for other darters within the upper Roanoke River is well documented with *Percina roanoka* occupying swifter current than *Etheostoma flabellare* in both natural and lab observations (Matthews et al., 1982; Matthews, 1985). Rosenberger & Angermeier (2003) also documented a preference for riffle and run habitats over gravel substrate for *Percina rex* in the upper Roanoke River. A greater understanding of the systematics and ecology of these darters has accompanied the documentation of their preferred microhabitat. Documentation of the apparent preference for water depth approximately 60 cm in moderate current may lead to more effective capture and observation of *P. nevisense* in future studies.

Differences in observation data from month to month also suggest the utilized habitat changes throughout the year with generally deeper, faster water over finer substrates occupied in spring, and shallower, slower water over larger substrates occupied in summer and fall (Figs. 1-3). While the biology of *P. nevisense* is largely unknown, *P. peltata* spawns in April and May in New York as water temperatures approach 10° C (New, 1966). Comparable water temperatures occur earlier in the spring in Virginia and ripe specimens were reported from late March to early June by Loos & Woolcott (1969) in the James River drainage. If *P. nevisense* has similarly timed spawning, our data suggest they are spawning in deeper, faster water, over finer substrates than they inhabit during summer and fall and is consistent with descriptions of *P. peltata* burying eggs in gravel to sandy substrates (New, 1966; Loos & Woolcott, 1969). Anecdotal descriptions by New (1966) suggest spawning habitat is not different from habitat occupied year round for *P. peltata*, but our data suggest *P. nevisense* spawn in at least slightly different habitat than is occupied through summer and fall.

As depth and current velocity at nearly every point in a stream are directly related to discharge, we evaluated the hypothesis that the precipitous decline in these values from May to June for observational data was due to changes in water levels in the Roanoke River between these months. However, our examination of daily streamflow data just upstream of our study site in the Roanoke River at Glenvar as recorded by the United States Geological Survey (https://waterdata.usgs.gov/va/nwis/current/?type=flow) led us to reject variation in streamflow as an explanation for differences in our data from May to June. Approximate flow during our May observations (17 and 19 May 2016) was 180 ft^3/s, and June observations (16 June 2016 and 12, 15, and 27 June 2017) occurred with flows ranging from 120 to 200 ft^3/s.

The findings of this study are intended to be a first step in learning more about *Percina nevisense*. A better understanding of microhabitat preference and seasonal changes in microhabitat will allow for more efficient observation and collection of specimens that can elucidate questions of ecology and systematics.

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Eight Ground Beetles (Coleoptera: Carabidae) New to Virginia, with Additional Records for West Virginia and Maryland

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ABSTRACT

Eight ground beetle species, including *Trechus quadristriatus* (Schrank), *Elaphropus dolosus* (LeConte), *Brachinus americanus* (LeConte), *Pterostichus tenuis* (Casey), *Cyclotrachelus convivus* (LeConte), *Agonum mutatum* (Gemminger & Harold), *Somotrichus unifasciatus* (Dejean), and *Cymindis elegans* LeConte, are reported from Virginia for the first time, and one species, *Clinidium apertum allegheniensis* Bell & Bell, is removed from the state list. Two species are reported as new state records for Maryland (*Harpalus katiae* Battoni) and West Virginia (*Clinidium apertum allegheniensis* Bell & Bell).

Keywords: adventive species, Gaudineer Knob Scenic Area, Laurel Fork Recreation Area, new state records, red spruce, sphagnum.

INTRODUCTION

The ground beetles of Virginia (Carabidae) have been the subject of several papers published in this journal as part of ongoing efforts to document the group's diversity in the Commonwealth. The most recent new state record was reported in Steury & Messer (2015), who cite a total of 544 species and subspecies as occurring in Virginia. The current paper brings the total to 551, satisfying a prediction made by the late Richard L. Hoffman in 2006: "An eventual total of 550 resident Virginia carabids now seems plausible, and another decade of intensive fieldwork may see that figure realized" (Hoffman et al., 2006). Of the eight taxa recorded as new here, four are the result of personal collecting efforts by me and/or Arthur V. Evans, while the other half were obtained through sampling carried out by staff of the Virginia Department of Conservation and Recreation's Division of Natural Heritage (VDNH). The latter records were discovered in the collection of the Virginia Museum of Natural History, which continues to serve as an indispensable resource for documenting Virginia's biodiversity.

The sequence and nomenclature of the taxa listed below follows that of Bousquet (2012), except the tribe Rhysodini, which Bousquet treats as a separate family. The sources used for identification are cited after each species' listing; interested readers are encouraged to refer to those sources for more information. Images of each species are available online at BugGuide (www.bugguide.net; Accessed 2 April 2018).

Specimens cited are in the collection of the Virginia Museum of Natural History (VMNH, Martinsville, VA) unless otherwise noted. Other collections cited in this paper are the Carnegie Museum of Natural History (CMNH, Pittsburgh, Pennsylvania), National Museum of Natural History, Smithsonian Institution (NMNH, Washington, DC), and the personal collections of myself (CWHC, Front Royal, VA) and Arthur V. Evans (AVEC, Richmond, VA).

SPECIES ACCOUNTS

RHYSODINI

Clinidium apertum allegheniense Bell & Bell
(Identification resource: Bell & Bell, 1985)

This subspecies is known from several old specimens collected in Pennsylvania and Mount Mitchell in the Black Mountains of North Carolina (Bell & Bell, 1985). Roble & Hoffman (2012) reported the subspecies from Virginia for the first time, based on single specimens from Cumberland and Henry counties. While examining *Clinidium* in the VMNH collection in 2017, I realized that these two specimens were misidentified. The

individual from Cumberland County is a female *C. baldufi*, and the one from Henry County is a female *C. sculptile*. These determinations are supported by the presence in the VMNH collection of correctly-identified males of the same species, from the exact same collecting events.

Clinidium species are very similar to one another dorsally. The existing keys to species rely almost entirely on ventral characters. However, *C. apertum* has a unique dorsal character that no other species currently known from Virginia has: the basal impressions of the pronotum are broadly open posteriorly (Fig. 1). Bell & Bell (1985) state that this character alone will separate *C. apertum* from all other eastern U.S. species except *C. valentinei* (not yet known from Virginia) and "some specimens of *rosenbergi*". They did not elaborate on the latter, and all the individuals of *C. rosenbergi* in the VMNH and CMNH collections have basal impressions that are closed.

As there are currently no specimens of *Clinidium apertum allegheniense* known from Virginia, the species is here **removed** from the state list. However, it can be added to the state list for West Virginia, based on the following specimens:

Fig. 1. Forebody of *Clinidium apertum allegheniense.*

NEW STATE RECORD, WEST VIRGINIA: *Pocahontas Co.*: [Monongahela National Forest], Gaudineer Knob Scenic Area. 5 August 1986, M. C. Thomas (11, CMNH); Gaudineer Knob Scenic Area, N 38.624, W -79.844. 1260 m. 29 June 2017. R. E. Acciavatti, R. L. Davidson, and C. W. Harden. Under bark, virgin spruce/hardwoods (6, CWHC; 5, CMNH).

The Gaudineer Knob Scenic Area is a small parcel of virgin red spruce (*Picea rubens*) and northern hardwood forest located in the Monongahela National Forest near Durbin. The 2017 collection cited above was carried out to confirm the continued presence of the species, after the belated discovery (by Davidson) of the specimens collected there 30 years earlier. Our success in finding the species was swift (the third log checked), and the series of 11 individuals was collected in just a couple hours of searching. All of the specimens were under the bark of fallen red spruce trees that had decayed to the point that the bark lifted off easily in large chunks. No other species of *Clinidium* were encountered at the site.

Due to its proximity and ecological similarity to Gaudineer Knob, the best place in Virginia to seek *C. apertum* might be the Laurel Fork Recreation Area in the George Washington National Forest in Highland County (see records for *Pterostichus tenuis* and *Agonum mutatum* below).

TRECHINI

Trechus quadristriatus (Schrank)
NEW STATE RECORD
(Identification resource: Bousquet et al., 1984)

Augusta Co.: [George Washington National Forest], Maple Flats, N 37.9788, W -78.9919. 480 m. 9 June 2017, C. W. Harden. Active at night, margin of sinkhole pond (1). *Botetourt Co.*: [Jefferson National Forest], west of Blackhorse Gap, N 37.4270, W -79.7589. 600 m. 11 June 2017, C. W. Harden. Sifted from litter near small stream (1).

This is a European species that was apparently introduced to the Great Lakes region some time before 1965, and it has gradually been collected from more southern locales since then. Bousquet (2012) lists the species from Maryland and West Virginia, so its occurrence here is not unexpected.

The *Trechus* that are native to Virginia and the southern Appalachians are all incapable of flight and exist only in moist, cool microhabitats. Larochelle & Larivière (2003) report *T. quadristriatus* from anthropogenic habitats such as gardens and field edges, which is typical of an introduced species. However, the habitat

cited above for Botetourt County was a shaded rocky stream in a relatively mature forest, similar to ideal native *Trechus* habitat.

BEMBIDIINI

Elaphropus dolosus (LeConte)
NEW STATE RECORD
(Identification resource: Lindroth, 1966)

Sussex Co.: Swamp, Rte 608, 4 mi SE Sussex, 15 September 1998. UV trap, R. L. Hoffman (1); Chub Sandhill Natural Area Preserve, 11 May 2000, C. S. Hobson, VDNH survey, UV (1).

Elaphropus species are difficult to identify, but *E. dolosus* can be easily distinguished by its markedly narrow body (especially the pronotum), which is also flatter and proportionately more elongate than that of other species in our area. Additionally, the antennae are entirely pale, as is most of the dorsal body surface (the center of the elytra is sometimes darker), and the elytra have only one distinct stria each. The species has not been reported from North Carolina, but its occurrence in Sussex County, not far from the state line, suggests it very likely occurs in that state as well.

BRACHININI

Brachinus americanus (LeConte)
NEW STATE RECORD
(Identification resource: Erwin, 1970)

Appomattox Co.: Holliday Lake State Park, Lakeshore Trail, N 37.34, W -78.63, 14 April 2017, C. W. Harden & L. M. Thompson, headlamp searching at night (1, CWHC). *Cumberland Co.*: 2 km SW of Columbia, clearcut North, 1 May 1990, J. C. Mitchell (1); same location and collector but hardwoods North, 19 October 1989 (1), 16 June 1990 (2), 1 July 1990 (1), 16 July 1990 (1), 1 August 1990 (5), 16 September 1990 (3), 30 September 1990 (3); same collector but 7 km SW of Columbia, hardwoods South, 17 March 1990 (2); same collector but 5.5 km SW of Columbia, clearcut South, 12 March 1990 (1), 17 March 1990 (1); same collector and location but pinewoods, 1 August 1990 (1). *York Co.*: Grafton Ponds, 9 November 1990 (1), 26 November 1990 (1), 21 March 1991 (2), 4 April 1991 (1), 1 May 1991 (1), VDNH survey, K. A. Buhlmann. *Radford City*: 19 May 1960, E. Gooding (1).

This bombardier beetle has obviously been known from Virginia for many years, and its unreported status until now is likely due only to oversight. *Brachinus* are notoriously difficult to identify, but of the 12 species known from Virginia, *B. americanus* is the only one with strongly-sloped shoulders of the elytra. The species is incapable of flight, and most of the known Virginia specimens were collected during long-term pitfall trap surveys. The specimen from Holliday Lake State Park was found actively running on a dirt trail just after sunset, along with two individuals of the much more common *B. fumans* (Fabricius). The habitat was a forest edge of mostly oak and pine, fronted by a moist grassy lake edge and not far from a developed picnic area. Descriptions of the Cumberland County sites can be found in Hoffman et al. (2012).

PTEROSTICHINI

Pterostichus tenuis (Casey)
NEW STATE RECORD
(Identification resource: Bousquet & Pilon, 1983)

Highland Co.: [George Washington National Forest] Locust Springs Recreation Area [*sic*], wet sphagnum meadow along Buck Run trail, 1000 m, 30 June 2017, C. W. Harden, treading sphagnum (2, VMNH; 12, CWHC).

The accurate title of the area cited above is the Laurel Fork Recreation Area; "Locust Springs" refers more to the maintained picnic area where parking is available. The misnomer is printed on the specimen labels, and repeated here to avoid possible confusion. Laurel Fork is a unique and biologically important area, with extensive red spruce and northern hardwood forests that are home to a more boreal flora and fauna than is typical of Virginia. See Roble (1999) and Roble et al. (2009) for detailed descriptions of the area.

Davidson (1988) discovered the preference of *P. tenuis* for *Sphagnum* mats and reported the species from Maryland and West Virginia. There may not be many other places in Virginia where this species occurs because it seems to favor cold boggy habitats. The very similar species *P. luctuosus* (Dejean) is widespread in Virginia, and found in a variety of wet habitats, usually occurring on silty mud substrates. In addition to the 14 *P. tenuis* collected in *Sphagnum* at Laurel Fork, four *P. luctuosus* were found. These, along with several other interesting beetles and *Agonum mutatum* (see below), were collected by treading the moss mats into the water and waiting for the submerged insects to float to the surface.

Cyclotrachelus convivus (LeConte)
NEW STATE RECORD
(Identification resource: Freitag, 1969)

Wise Co.: Powell Mountain Karst Preserve, Franklin Cave, pitfall traps, 1-30 July 2009, [VDNH survey], A. C. Chazal, C. S. Hobson (4), 20 August-23 September 2009, C. Hobson, W. Orndorff, S. Roble (2, AVEC; 1, CWHC); Solomon's Seal Cave, pitfall traps, 6-28 April 2009, C. S. Hobson, A. V. Evans (1, VMNH; 1, CWHC), 13-27 May 2009, C. S. Hobson, J. F. Townsend (1, AVEC), 10 June-1 July 2009 (3, AVEC), 9 July-20 August 2009, C. Hobson, R. Reynolds, S. Roble (1, CWHC); Cedar Ridge, pitfall traps, 13-29 May 2009, C. S. Hobson, J. F. Townsend (1), 9-11 June 2009, A. C. Chazal, C. S. Hobson (1), 29 June-2 July 2009, C. S. Hobson, J. F. Townsend (2) 29-30 July 2009, A. C. Chazal (1), 29 July-20 August 2009, C. S. Hobson (1, NMNH; 2, AVEC), 20 August-23 September 2009, C. Hobson, W. Orndorff, S. Roble (1, AVEC; 1, CWHC).

This species is nearly indistinguishable externally from *Cyclotrachelus sigillatus*, which is a very common and widespread species in Virginia. *Cyclotrachelus convivus* tends to be duller and with less rounded sides to the pronotum and elytra (notably in males), but both species show much variation, thus examination of the male reproductive organ (aedeagus) is necessary for confident identification. Usually the very tip of the organ is sufficient to confirm the species, and fortunately the tip is often exposed in preserved specimens.

All species of *Cyclotrachelus* are incapable of flight and many have relatively small and localized distributions that are strongly influenced by geographic barriers such as mountain ranges and large rivers. Freitag (1969, fig. 131) illustrates the distributions of *C. convivus* and *C. sigillatus*, showing the two species largely separated by the Appalachian Mountains, with *C. convivus* to the west. He reports eastern Tennessee and southwestern Pennsylvania as the two known areas of range overlap, stating that the species seem to be allopatric otherwise. Another area of overlap has since been observed in and near Morgantown, West Virginia (Davidson, *in litt.*). Davidson has observed that although both species occur at Morgantown and Powdermill Nature Reserve (Westmoreland County, Pennsylvania), the two seem to never share the same microhabitat.

Fine-tuning the distribution of the two species in Virginia through dedicated collecting would be an interesting project to undertake. The occurrence of *C. convivus* in the Cumberland Mountains physiographic province is not surprising given Freitag's map, and it is probably unlikely that it occurs east of the Tennessee Valley in Virginia. The case is more complicated with *C. sigillatus*. The nearest documented occurrences of *C. sigillatus* to *C. convivus* in Virginia are Washington County (1 km E of Mendota) and Dickenson County (Breaks Interstate Park). The aedeagi of males from both sites were examined and confirmed as *C. sigillatus*. The Breaks record is notably disjunct from the rest of the species' known range and its occurrence there should be verified by further collecting.

HARPALINI

Harpalus katiae Battoni
NEW STATE RECORD, MARYLAND: *Caroline Co.*: Idylwild Natural Area, 24 June 2017, W. J. Hubick, found dead on trail in sandy area (1, CMNH).
(Identification resource: Will, 1997)

The discovery of *H. katiae* on the Delmarva Peninsula in Maryland extends its known range over 180 km north of the Virginia records in Hoffman & Roble (2000), and beyond the projected range of the species presented in Will (1997, Fig. 1). The specimen is a male and was confirmed by examination of the aedeagus.

PLATYNINI

Agonum mutatum (Gemminger and Harold)
NEW STATE RECORD
(Identification resource: Lindroth, 1966)

Highland Co.: [George Washington National Forest], Locust Springs Recreation Area [*sic*, see under *Pterostichus tenuis* above], wet sphagnum meadow along Buck Run trail, 1000 m, 30 June 2017, C. W. Harden, treading sphagnum (2, VMNH; 20, CWHC).

Like *Pterostichus tenuis* (see above), *A. mutatum* is associated with *Sphagnum* mats, and the two are often found together (Davidson, 1988). *Agonum mutatum* has a much larger range than *P. tenuis*, occurring across the continent in the north and as far south as eastern South Carolina in the east (Bousquet, 2012). It is likely that that the species has been collected before in Virginia and has gone unrecognized due to the difficulty of separating the *melanarium*-group species of *Agonum*. The only other member of this group found at the Laurel Fork area during my visit was *A. fidele* Casey, one specimen of which flew to a blacklight sheet set at the edge of the *Sphagnum* meadow that night. No *A. mutatum* were attracted to the light, and no other *Agonum* were collected in the *Sphagnum*.

LEBIINI

Somotrichus unifasciatus (Dejean)
NEW STATE RECORD
(Identification resource: Ball & Bousquet, 2000)

Powhatan Co.: Powhatan State Park, vicinity of Canoe-in Camp, N 37.6792, W -77.7459, 26-27 June 2014, A. V. Evans, UV light trap (1, AVEC).

Somotrichus unifasciatus is an adventive species in North America, where it is believed to have been introduced several times by human transport. It has been reported from several southeastern states, including North Carolina. The species is distinctive, with dense vestiture and a striking orange-black color pattern. With *Trechus quadristriatus*, it raises the number of non-native carabids known from Virginia to 15.

Cymindis elegans LeConte
NEW STATE RECORD
(Identification resource: Lindroth, 1969)

Sussex Co.: Chub Sandhill Natural Area Preserve, 18 October 2002, S. Erdle, DCR-DNH (1).

Known from most of the mid-Atlantic states including the District of Columbia and North Carolina, this species was to be expected in Virginia. The presence of only a single specimen suggests that the preferred habitat of the species has not been sufficiently searched. Larochelle & Larivière (2003) report the species from sand hills and "dry, sandy, almost bare soil", of which there is plenty at Chub Sandhill. Label data from collections suggests that the species is most active at colder times of the year, which could also account for the lack of other specimens.

DISCUSSION

The total number of ground beetles known from Virginia has now surpassed 550, and this number will undoubtedly continue to increase. The important regional collection of the Virginia Museum of Natural History will surely continue to supply many of these records, as the extensive backlog of unsorted specimens is explored and identified. However, a thorough understanding of Virginia's ground beetles will depend on the interest and dedication of individuals, as well as the continued support for programs such as the Virginia Division of Natural Heritage, without which our knowledge of Virginia's natural history would be far more incomplete.

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Annotated Checklist of Some Fungivorous Beetles (Coleoptera: Anamorphidae, Biphyllidae, Derodontidae, Endomychidae, Erotylidae, and Tetratomidae) of the George Washington Memorial Parkway

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ABSTRACT

Seven collection methods were utilized at a national park site in northern Virginia to capture fungivorous beetles in the families Anamorphidae, Biphyllidae, Derodontidae, Endomychidae, Erotylidae, and Tetratomidae. Forty species and one subspecies were documented, including five new state records (*Hallomenus scapularis* Melsheimer, *Microsternus ulkei* [Crotch], *Triplax frontalis* Horn, *Tritoma erythrocephala* Lacordaire, and *Tritoma mimetica* [Crotch]). More than half of the Commonwealth's expected fauna was documented from the park. Malaise traps were the most productive capture method. Periods of adult activity, based on dates of capture, are given for each species. Relative abundance is noted for each species based on the number of captures.

Keywords: Arlington County, Fairfax County, fungus beetles, national park, new state records, Virginia.

INTRODUCTION

Fungi and Coleoptera are among the most diverse heterotrophic organisms in the world with an equally diverse array of commensal and mutualistic fungus–beetle relations as well as combative interactions including entomopathogenic fungi (Kukor & Martin, 1987) and fungivorous beetles (Schigel, 2012). Fungivory is characteristic of many families of Coleoptera. The fungal mycelia are most frequently consumed by beetles together with the woody substrata (Schigel, 2012); however, fruit bodies and spores are also consumed (Schigel, 2008). Fungivorous beetles are not always easy to find in nature, and collecting them requires an arsenal of methods for efficient documentation (Schigel, 2008). This study utilized seven collection methods to assess the fauna of six fungivorous beetle families from a national park site in northern Virginia.

STUDY SITES

The study sites include lands managed by the National Park Service as units of the George Washington Memorial Parkway (GWMP) in Virginia (Fairfax and Arlington counties). Park sites that received inventory effort included: in Fairfax County, Dyke Marsh Wildlife Preserve, Fort Marcy, Great Falls Park, Little Hunting Creek, and Turkey Run Park, and in Arlington County, Arlington Woods (at Arlington House). This area covers approximately 927 ha. A map of these sites is provided in Steury (2011). Great Falls and Turkey Run parks and Fort Marcy fall within the Piedmont physiographic province while all other collection sites are on the Coastal Plain. Most sites are situated along the shore of the Potomac River, and Great Falls and Turkey Run Parks border the Potomac River Gorge, an area with a long history of biodiversity studies (Brown, 2008). Most of the study sites are dominated by maturing, second growth, primarily upland, deciduous woodlands with a band of floodplain forest along the Potomac River. More open, herbaceous dominated habitats can be found along the river shores and in the marsh habitats at Dyke Marsh. The vascular flora of the GWMP is diverse, with more than 1,313 taxa recorded, 1,020 from Great Falls Park alone (Steury et al., 2008; Steury, 2011).

MATERIALS AND METHODS

Specimens were collected during a 19-year period

(1998-2017) using a variety of sporadic survey efforts targeting arthropods, including: Malaise traps, Lindgren funnels, blacklight (UV) bucket traps, blacklight shone on sheets, leaf litter samples processed in Berlese funnels, beating sheets, and hand picking (including examination of fungi in the field). Six Townes style Malaise traps (Townes, 1962) were set at Dyke Marsh, April 1998-December 1999, three each at Great Falls and Turkey Run parks (March 2006-November 2009), and four at Little Hunting Creek (March-November 2017). Traps at Dyke Marsh were set each year in the same locations in open, tidal, freshwater marsh dominated by *Typha angustifolia* L., floodplain forest dominated by red and silver maple (*Acer rubrum* L. and *A. saccharinum* L.) and tulip poplar (*Liriodendron tulipifera* L.), and at the marsh/forest ecotone. In Great Falls Park, a trap was set in each of three habitats: quarry site (dry, upland, mixed deciduous/coniferous forest), swamp (dominated by red maple), and floodplain forest (dominated by oaks [*Quercus* sp.], and tulip poplar). In Turkey Run Park, one trap was set in upland forest dominated by oaks and tulip poplar and two traps in floodplain forest along the Potomac River (dominated by oaks, basswood [*Tilia americana* L.], and sycamore [*Platanus occidentalis* L.]). At Little Hunting Creek, four traps were set in upland forest dominated by an ericaceous understory and a canopy of oaks, hickory (*Carya* sp.), American beech (*Fagus grandifolia* Ehrh.), and some Virginia pine (*Pinus virginiana* Mill.).

Additional collections of species from these six families of beetles were also made by sporadically using other collecting methods, including running pitfall traps set at Dyke Marsh (five years) and at Little Hunting Creek and Great Falls and Turkey Run parks (three years); Lindgren funnel and blacklight (UV) bucket traps set at Dyke Marsh, Great Falls Park, Little Hunting Creek, and Turkey Run Park (two years); blacklight shone on sheets at Great Falls and Turkey Run parks (three years); leaf litter from Arlington Woods, Dyke Marsh, Fort Marcy, Great Falls Park, and Turkey Run Park, processed in Berlese funnels (two years); beating sheets (three years); and collecting by hand (including examination of fungi in the field) at all sites, over seven years. Locations, habitat descriptions, and collection methods are summarized in Table 1. Collectors included C. Acosta, E. Barrows, J. Brown, C. Davis, A. Evans, J. Fisher, S. Lingafelter, D. Mead, E. Oberg, M. Skvarla, D. Smith, W. Steiner, B. Steury, J. Swearingen, and C. Wirth. State record determinations are based on reviews of Boyle (1956), Ciegler (2014b), Downie & Arnett (1996), Evans (2008), Lawrence (1989), and Shockley et al. (1999). Specimens were determined by Arthur V. Evans or Brent W. Steury. Specimens were pinned, labeled, and deposited in the collections maintained at the George Washington Memorial Parkway (GWMP), Turkey Run Park Headquarters in McLean, Virginia.

RESULTS AND DISCUSSION

Forty species and one subspecies were documented from GWMP in six families of fungivorous beetles (Anamorphidae, Biphyllidae, Derodontidae, Endomychidae, Erotylidae, and Tetratomidae). This is more than half of the expected fauna of Virginia (see list of species for number of species expected in Virginia from each family), emphasizing the importance of parks as havens for biodiversity near urban areas. Management decisions to not remove, or chip, downed woody debris, and to leave standing, non-hazardous, dead trees has undoubtedly provided an abundance of substrates for fungal growth, and food and shelter for beetles that feed on these fungi. Recently, the amount of standing and downed dead wood in GWMP has greatly increased due to the death of large ash trees (*Fraxinus americana* L., *F. pennsylvanica* Marshall, and *F. profunda* [Bush] Bush) infected by emerald ash borer (*Agrilus planipennis* Fairmaire), a non-native buprestid beetle. Although this loss is detrimental to arthropods that feed exclusively on ash (Gandhi & Herms, 2010), it will undoubtedly increase habitat and food sources for fungi, and the beetles associated with them.

Five species (*Hallomenus scapularis*, *Microsternus ulkei*, *Triplax frontalis*, *Tritoma erythrocephala*, and *Tritoma mimetica*) are documented in the literature for the first time from Virginia. Thirty-four species and one subspecies documented from Great Falls and Turkey Run parks are recorded for the first time from the Potomac River Gorge (Brown, 2008). Only three species (*Triplax flavicollis*, *Tritoma biguttata biguttata*, and *Tritoma humeralis*) were found to be abundant within the study area. In comparison, the other 38 taxa were rarely encountered despite 19 years of survey effort. Great Falls Park was the most species-rich site with 28 species, followed by Turkey Run Park (27 taxa), Little Hunting Creek (14), and Dyke Marsh (12). Malaise traps were the most successful capture method (37 taxa), followed by hand picking (12), Berlese funnels (6), Lindgren funnels (4), and UV bucket traps (3).

LIST OF SPECIES

The number of specimens in the collection at GWMP is indicated in parentheses after each taxon. Taxa too common for all specimens to be kept are listed as abundant. Sites, habitats, and collection methods are given following the abbreviations listed in Table 1. Other locations and habitats within sites are indicated when necessary. The periods of adult activity are based on

Table 1. Summary of locations, latitude and longitude, habitats sampled, and trap types used during this study. Additionally, all sites were sampled by hand picking, including examination of fungi in the field (hp) and beating sheets (bs).

Location	Latitude and Longitude	Habitats Sampled	Trap Types
Arlington County			
Arlington Woods (AW)	N 38.883, W -77.074	Upland, deciduous forest (uf)	Berlese funnels (bf)
Fairfax County			
Dyke Marsh Wildlife Preserve (DM)	N 38 .772, W -77.050	Tidal, freshwater marsh (tm); floodplain, deciduous forest (ff); marsh/forest ecotone (ec)	Berlese funnels; blacklight (UV) bucket traps (uv); Lindgren funnels (lf); pitfall traps (pt); Townes style Malaise traps (mt)
Fort Marcy (FM)	N 38.937, W -77.125	Upland, deciduous forest	Berlese funnels
Great Falls Park (GF)	N 38.985, W -77.246	Upland, mixed deciduous/ coniferous forest (qu); deciduous swamp (sf); floodplain, deciduous forest	Berlese funnels; blacklight shone on sheets (bl); blacklight bucket traps; Lindgren funnels; pitfall traps; Townes style Malaise traps
Little Hunting Creek (LH)	N 38.717, W -77.078	Upland, deciduous forest with some pine (dp)	Blacklight bucket traps; Lindgren funnels; pitfall traps; Townes style Malaise traps
Turkey Run Park (TR)	N 38.965, W -77.156	Upland, deciduous forest; floodplain, deciduous forest	Berlese funnels; blacklight shone on sheets; blacklight bucket traps; Lindgren funnels; pitfall traps; Townes style Malaise traps

dates when live individuals have been documented in the park. Dates separated by a hyphen indicate that the taxon was documented on at least one day during each month within this continuum of months, whereas dates separated by a comma represent individual observation dates. For traps set over multiple weeks, the first day of the set is used as the earliest date and the last day of the set as the latest date. Taxa newly recorded for the Potomac River Gorge are marked by an asterisk.

Anamorphidae (False Handsome Fungus Beetles)

This family was split from Endomychidae by Robertson et al. (2015). Two species have been documented from Virginia (Shockley et al., 1999), one of which was found in GWMP. Species in this family are generally quite small, some less than 1 mm, and thus easily overlooked.

**Clemmus minor* (Crotch) – (1); TR ff; 18 Aug-4 Sep; mt.

Biphyllidae (False Skin Beetles)

Two species occur in eastern North America, both of which have been documented in Virginia. One of these species was found in GWMP. These beetles feed on fungal spores (Downie & Arnett, 1996).

Diplocoelus brunneus LeConte – (1); LH dp; 19 Sep-10 Oct; mt.

Derodontidae (Tooth-necked Fungus Beetles)

Four species in two genera are expected in Virginia, one of which, *Laricobius nigrinus* Fender, has been introduced as a biological control agent for the hemlock woolly adelgid (*Adelges tsugae* [Annand]). *Laricobius rubidus* LeConte reaches its southern known limit in Washington, DC, but has not yet been recorded from Virginia (Lawrence, 1989). *Laricobius* are not fungivores, but instead feed on adelgids (Hemiptera:

Adelgidae) that feed on conifers. *Derodontus* feed on fruiting bodies of Basidiomycotic fungi. Two species are documented from GWMP.

**Derodontus esotericus* Lawrence – (26); DM ec, GF sf, TR ff; 22 May-1 Jul, 19 Sep-5 Dec; mt.

**Derodontus maculatus* (Melsheimer) (Fig. 1) – (4); GF sf, TR ff; 22 Oct-17 Nov; mt. Always captured in association with *D. esotericus*.

Endomychidae (Handsome Fungus Beetles)

Ten species have been documented in Virginia (Shockley et al., 1999), of which seven are recorded from GWMP. *Holoparamecus* contains five species, three of which are cosmopolitan, but none has been found in Virginia. One of these, *H. caularum* Aubé, has been documented only in the eastern United States from Florida and Michigan. The other two have been recorded near Virginia, *H. depressus* Curtis (Georgia and New York) and *H. singularis* (Beck) (New York). A fourth species, *H. ragusae* Reitter, occurs in Pennsylvania (Shockley et al., 1999).

**Aphorista vittata* (Fabricius) – (3); GF sf and rocky outcrop above Sandy Landing, TR Leiter Mansion ruins; 15 Apr-10 May, 16-30 Jul; bf, hp, mt.

**Endomychus biguttatus* Say – (16); DM ec, GF sf, TR uf and ff; 1 May-21 Oct, 15 Dec; hp (under bark of large fallen *Liriodendron tulipifera* L. [Magnoliales: Magnoliaceae], on fungus), mt.

**Mycetina perpulchra* (Newman) – (7); GF sf, LH dp, TR ff; 23 Apr-26 Jul; mt.

**Phymaphora pulchella* Newman – (2); GF sf; 18 Mar-30 Apr; mt.

**Rhanidea unicolor* (Ziegler) – (8); AW uf, DM ec, GF qu and Difficult Run, LH dp; 10 Apr-18 May; bf, lf, pf, mt.

**Stenotarsus blatchleyi* Walton – (12); DM ff, GF sf, LH dp, TR ff; 19 Jun-14 Aug; mt.

This species was not included for the northeastern United States by Downie & Arnett (1996.). It reaches its northern extreme in Virginia and has not been documented in North Carolina (Shockley et al., 1999).

Fig. 1. *Derodontus maculatus* (Melsheimer); Collection data: Virginia, Fairfax Co., Great Falls Park, swamp, Malaise trap, 22 October - 11 November 2008, B. Steury & D. Smith. Top, dorsal habitus. Bottom, close-up of the head and pronotum of the same specimen.

Stenotarsus hispidus (Herbst) – (1); LH dp; 20-30 Jun; mt.

Erotylidae (Pleasing Fungus Beetles)

There are 57 potential species in South Carolina (Ciegler, 2014a). Downie & Arnett (1996) report 36 species in northeastern North America and Evans (2014) reports 40 in the eastern United States. Twenty species and one subspecies have been documented from GWMP.

Acropteroxys gracilis (Newman) – (3); DM tm and ec; 28 May-8 Aug; mt.

**Ischyrus quadripunctatus* (Olivier) – (19); GF ff, TR ff and uf; 10 Apr-4 Sep; mt, uv.

Languria angustata (Beauvois) – (3); DM tm; 16 Jun-8 Aug; mt.

Languria mozardi Latreille – (1); FM uf; 15 Apr; bf.

Loberus impressus LeConte – (8); DM tm; 11 Apr-1 Aug; mt.

**Megalodacne fasciata* (Fabricius) – (2); TR uf, LH dp; 11 Jun-30 Jul; hp (shelf fungus on stump), mt.

**Megalodacne heros* (Say) – (4); GF uf; 24 Jun-6 Jul; hp (on fungus), uv.

Microsternus ulkei* (Crotch) – (2); TR ff, GF sf; 10 Apr-21 Jun; mt. **NEW STATE RECORD.

This species has a narrow range in North America extending from Illinois (Goodrich, 1994) and Tennessee eastward to Pennsylvania and North Carolina (Downie & Arnett, 1996). It appears to have a relict distribution, being the only Nearctic representative of a widely distributed genus. It is not common where it occurs (Boyle, 1956). It has been documented on shelf fungi in the family Hymenochaetacea (Goodrich, 1994).

**Toramus pulchellus* (LeConte) – (8); AW uf, GF ff; 15 Apr, 23 Jun-6 Aug; bf, bl, uv.

**Triplax festiva* Lacordaire – (5); AW uf, LH dp, GF sf; Apr 10-30, 3 Jun-15 Oct; bf, lf, mt.

**Triplax flavicollis* Lacordaire – (abundant); DM ec, GF qu, TR uf; 17 May-17 Nov; hp (under bark and on fungus), mt.

A Malaise trap set in floodplain forest in Turkey Run Park from 22 October-17 November 2008 contained 63 *T. flavicollis* and 2 *T. thoracica*.

Triplax frontalis* Horn – (3); AW uf, GF qu; 10-30 Apr; bf, mt. **NEW STATE RECORD.

This beetle occurs from Nebraska and Texas eastward to Georgia and Pennsylvania (Boyle, 1956; Downie & Arnett, 1996).

**Triplax thoracica* (Say) – (5); DM ec, TR ff; 7-21 Jul, 5 Oct-17 Nov; mt.

**Tritoma biguttata biguttata* (Say) – (abundant); LH dp, GF qu, TR ff; 21 May-10 Oct; hp (in gills of yellowish-orange *Russula* sp. [Russulales: Russulaceae; near *R. ochroleucoides* Kauffm]), mt.

**Tritoma biguttata affinis* Lacordaire – (8); LH dp, TR ff; 5 Aug-10 Oct; mt.

This subspecies is reported by Evans (2014) as not occurring on the East Coast north of southern North Carolina, however Downie & Arnett (1996) list records from as far north as Pennsylvania.

Tritoma erythrocephala* Lacordaire – (2); LH dp, TR ff; 7-21 Jun, 19 Sep-10 Oct; mt. **NEW STATE RECORD.

This beetle was expected in Virginia because it was documented previously in many states from Texas and Kansas eastward to New York and Florida (Downie & Arnett, 1996).

**Tritoma humeralis* Fabricius – (abundant); DM ff, LH dp, GF sf, TR ff; 21 May-10 Oct; pf, mt.

A Malaise trap set from 19 September-10 October 2017 at Little Hunting Creek contained 88 *T. humeralis*, 34 *T. b. biguttata*, 7 *T. b. affinis*, and 1 *T. erythrocephala*.

Tritoma mimetica* (Crotch) – (4); GF ff and qu, TR ff; 23 May-30 Jun; mt. **NEW STATE RECORD.

Virginia is well within the range of this species, which has been documented from Texas and Kansas eastward to Quebec and Florida (Downie & Arnett, 1996).

**Tritoma pulchra* Say – (6); GF ff, TR ff; 1 May-26 Jul; mt.

**Tritoma sanguinipennis* (Say) – (10); LH dp, GF sf and qu, TR ff; 10 Apr -30 Jul; mt.

**Tritoma unicolor* Say – (4); GF sf; 19-30 Jun; mt.

Tetratomidae (Polypore Fungus Beetles)

This family was split from the Melandryidae (false darkling beetles) by Nikitsky (1998). Evans (2014) reported 17 species in the eastern United States and 12 species are reported for South Carolina (Ciegler, 2014b). Nine species have been documented at GWMP.

**Eustrophopsis bicolor* (Fabricius) – (4); DM ec and ff, TR ff, GF ff; 19-28 Apr, 30 Jun-13 Jul, 11-27 Sep, 15 Dec; hp (under bark of dead standing *Carya tomentosa* [Lam.] Nutt) (Fagales: Juglandaceae), mt.

**Eustrophus tomentosus* Say – (4); GF riverside prairie and uf, TR uf; 15 Jan, 14 Apr; hp (under bark and under loose bark of dead standing *Quercus coccinea* Münchh. [Fagales: Fagaceae]).

Hallomenus scapularis* Melsheimer (Figs. 2-3) – (4); TR uf; 5 Sep-21 Oct; mt. **NEW STATE RECORD.

Pale form (perhaps subteneral) *Hallomenus scapularis* (Fig. 2) is very similar to descriptions of *H. debilis* LeConte. These two species overlap in range

Fig. 2. *Hallomenus scapularis* Melsheimer (pale form); Collection data: Virginia, Fairfax Co., Turkey Run Park, gulch, Malaise trap, 5 September-21 October 2009, B. Steury & D. Smith. Length 4.0 mm. The slightly paler humeral angles can be seen even in pale form specimens.

Fig. 3. *Hallomenus scapularis* Melsheimer (typical form). Same collection data as Fig. 2.

and body length. They are separated in keys (Downie & Arnett, 1996; Ciegler, 2014b) based on dorsal coloration rather than anatomical features. The two can reportedly be separated by the extent of the basal punctures on the pronotum; "small depressions" in *H. debilis* and "large, deep impressions" in *H. scapularis* (Ciegler, 2014b). These four specimens were captured in the same Malaise trap, but only one was of the pale form.

**Holostrophus bifasciatus* (Say) – (16); DM ec, LH dp, GF sf, TR uf; 10 Apr-20 Jul; pf, mt.

**Penthe obliquata* (Fabricius) – (5); GF sf, TR ff; 16 Jun-17 Aug; hp (under bark), lf, mt.

**Penthe pimelia* (Fabricius) – (7); LH dp, GF sf and uf, TR ff and uf; 10 Apr-24 Aug; hp, lf, pf, mt.

**Pisenus humeralis* (Kirby) – (1); TR ff; 22 Oct-17 Nov; mt.

**Synstrophus repandus* (Horn) – (15); GF riverside prairie, TR uf and ff; 14 Apr, 24 Jun-21 Jul; bs, hp (under bark), mt.

Two specimens are of the brown form, the remainder are of the more typical black form.

**Tetratoma tessellata* (Melsheimer) – (1); GF ff; 21 May-18 Jun; mt.

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Banisteria, Number 50, pages 29-31

Four Longhorned Beetles (Coleoptera: Cerambycidae) New to Virginia and Additional New Park Records (Coleoptera: Anthicidae, Buprestidae, Cantharidae, Carabidae, Cerambycidae, Chrysomelidae) for the George Washington Memorial Parkway

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ABSTRACT

New park records are provided for six families of Coleoptera. Four species of Cerambycidae are recorded for the first time from Virginia. An updated count of Cerambycidae and Chrysomelidae is given for the Potomac River Gorge, an area that has been surveyed for beetles for more than 100 years.

Keywords: Fairfax County, Malaise trap, national park, new state records.

Continued sorting of Malaise trap samples obtained from national park sites within the George Washington Memorial Parkway (Dyke Marsh Wildlife Preserve, Great Falls Park, Turkey Run Park, and Little Hunting Creek) and recent hand picking has produced new beetle records for the park and for Virginia. All specimens are deposited at the Turkey Run Park Headquarters of the George Washington Memorial Parkway (GWMP) in McLean, Virginia. These new records are summarized below.

Anthicidae (Ant-like Flower Beetles)

The following record increases the number of ant-like flower beetles documented from the park to 13 species (Steury et al., 2013; Steury, 2017).

Malporus formicarius (LaFerté-Sénectère) – Fairfax Co.: Turkey Run Park, near river, 10-30 April 2009, D. Smith (1).

Buprestidae (Metallic Wood-boring Beetles)

These records increase the total number of metallic wood-boring beetles known from the park to 29 species (Steury et al., 2012; Steury & Messer, 2015; Steury, 2017).

Agrilus arcuatus (Say) – Fairfax Co.: Little Hunting Creek, 19 May-2 June 2017, B. Steury, C. Davis, & C. Acosta (2).

Chrysobothris chlorocephala Gory – Fairfax Co.: Collingwood Picnic Area, found dead in parking lot, 20 August 2017, B. Steury & H. M. Steury (1).

Cantharidae (Soldier Beetles)

This record increases the number of soldier beetles documented from the park to 38 species (Steury et al., 2018).

Malthodes werneri Fender – Fairfax Co.: Little Hunting Creek, 1-14 June 2018, B. Steury & C. Davis (1). Fender (1951) reported this species from the District of Columbia, Maryland, and West Virginia, but not Virginia. Pelletier & Hébert (2014) include a record from near the state line between Virginia and West Virginia.

Carabidae (Ground Beetles)

These records increase the tally of ground beetles documented from the park to 199 species (Steury et al., 2014, Steury & Messer, 2014, 2015; Steury, 2017).

Bembidion confusum Hayward – Fairfax Co.: Turkey Run Park, sand bar with silt cakes in Potomac River at mouth of Dead Run, 8 May 2017, B. Steury (1); same but 13 June 2017 (4).

Trichotichnus vulpeculus (Say) – Fairfax Co.: Great Falls Park, quarry, 5 September-21 October 2009, D. Smith (2); Turkey Run Park, in building in spider web, 2 October 2017, B. Steury (1).

Cerambycidae (Longhorned Beetles)

These records increase the number of longhorned beetles known from the Potomac River Gorge (POGO), an area that has been surveyed for beetles for more than 100 years (Evans, 2008; Staines, 2008a), to 102 species (Steury & MacRae, 2014), and increase the park total to 91 species (Steury & MacRae, 2014; Steury, 2017). State record determinations are based on published literature records maintained in the database of Ted MacRae (T. C. MacRae, in litt., 2017). Voucher specimen records from the Virginia Museum of Natural History (VMNH), located in Martinsville, Virginia, (and possibly Virginia Polytechnic Institute and State University [VTEC], in Blacksburg) that were compiled by the late Richard Hoffman for his uncompleted atlas of Virginia Cerambycidae project, are given for each species reported as new to Virginia.

Methia necydalea (Fabricius) – Fairfax Co.: Dyke Marsh Wildlife Preserve, 6-16 June 1998, E.M. Barrows (1); Little Hunting Creek, 2-20 June 2017, B. Steury, C. Davis, & C. Acosta (6). **NEW STATE RECORD.** Richard Hoffman had records from the cities of Norfolk and Virginia Beach.

Neoclytus scutellaris (Oliver) – Fairfax Co.: Little Hunting Creek, 2-20 June 2017, B. Steury, C. Davis, & C. Acosta (1). **NEW STATE RECORD.** Richard Hoffman had records from Charlotte, Craig, Fairfax, Frederick, King and Queen, Nelson, Northumberland, Prince William, and Roanoke counties and the cities of Chesapeake, Norfolk, and Virginia Beach.

Oberea deficiens Casey – Fairfax Co.: Little Hunting Creek, 1-14 June 2018, B. Steury & C. Davis (1).

Obrium rubidum LeConte – Fairfax Co.: Turkey Run Park gulch, 1-20 May 2009, D. Smith (2). New POGO Record**; NEW STATE RECORD.** Richard Hoffman was aware of a record from Montgomery County.

Psyrassa pertenuis (Casey) - Fairfax Co.: Little Hunting Creek, 1-14 June 2018, B. Steury & C. Davis (1).

Purpuricenus paraxillaris MacRae – Fairfax Co.: Collingwood Picnic Area, 18 June 2018, B. Steury (1). This species was only recently described (MacRae, 2000, 2009).

Sarosesthes fulminans (Fabricius) – Fairfax Co.: Little Hunting Creek, 5-19 May 2017, B. Steury, C. Davis, & C. Acosta (1).

Stenocorus cylindricollis (Say) – Fairfax Co.: Little Hunting Creek, 19 May-2 June 2017, B. Steury, C. Davis, & C. Acosta (1); same but 2-20 June 2017 (2). Two specimens are of the form with a dark head, pronotum, basal antennal segments, and legs. The other specimen is of the form with a reddish head, pronotum, basal antennal segments, and femora.

Sternidius alpha (Say) – Fairfax Co.: Little Hunting Creek, 23 April-15 May 2017, B. Steury, C. Davis, & C. Acosta (2); same but 2-20 June 2017 (1).

Typocerus lugubris (Say) – Fairfax Co.: Great Falls Park swamp, 15-29 June 2006, D. Smith (1); same but 21 May-18 June 2009 (1); Great Falls Park quarry 19-30 June 2009, D. Smith (4); Little Hunting Creek, 2-20 June 2017, B. Steury, C. Davis, & C. Acosta (1). **NEW STATE RECORD.** Richard Hoffman had records from Amherst, Augusta, Dickenson, Fairfax, Franklin, Giles, Halifax, Henrico, Louisa, Lunenburg, Montgomery, Nelson, Page, Roanoke, Rockingham, Spotsylvania, Tazewell, and Warren counties and the City of Richmond.

Chrysomelidae (Leaf Beetles)

The following records increase the number of leaf beetles known from the park to 110 species (Cavey et al., 2013; Steury et al., 2014; Steury, 2017) and those known from the Potomac River Gorge to 189 (Evans, 2008; Staines, 2008b).

Bassareus formosus (Melsheimer) – Fairfax Co.: Turkey Run Park, 7-21 June 2006, D. Smith (1). New POGO Record.

Epitrix fasciata Blatchley – City of Alexandria: Jones Point Park community gardens, feeding on *Solanum melongena* L., 22 May 2018, B. Steury (6).

Pachyonychus paradoxus (Melsheimer) – Fairfax Co.: Little Hunting Creek, 2-20 June 2017, B. Steury, C. Davis, & C. Acosta (1).

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Shorter Contributions

Banisteria, Number 50, pages 32-33

Two Significant Cases of Insects Biting Humans

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ABSTRACT

Bites of humans by the squirrel flea, *Orchopeas howardi*, have rarely been recorded. An occurrence is documented from Maryland that resulted in a case of dermatitis in a boy. The Azalea Plant Bug, *Rhinocapsus vanduzeei*, is a fairly well known biter of humans. A painful bite is recorded from Virginia and the distribution of the bug in Virginia is described.

Keywords: Azalea Plant Bug, flea, Heteroptera, *Orchopeas howardi*, Maryland, Siphonaptera, Virginia.

On 26 January 1990, a 10-year old boy presented with symptoms of a severe flea bite allergy at the Georgetown University Hospital in Washington, D.C. Two fleas taken from the boy's body were brought to the clinic by his mother. In the absence of anyone at the hospital able to identify the fleas they were brought to me. I identified them as two females of *Orchopeas howardi* (Baker, 1895), a common species of ceratophyllid flea on arboreal squirrels in eastern North America (Traub et al., 1983) including Maryland (Eckerlin, 2011). The specimens were mounted to slides and are kept as number M-Hs[1]-90 in my collection.

In a follow-up telephone conversation with the boy's mother I learned that Eastern Gray Squirrels, *Sciurus carolinensis* Gmelin, 1788, were living in the crawl space above the apartment in Silver Spring, Montgomery County, Maryland where the boy lived. Apparently, fleas from the squirrels were dropping through the ceiling into the apartment below. The young boy had experienced many bites and had developed a flea bite allergy.

What is interesting about this case is the rarity of reports of *O. howardi* biting humans. The only published report of which I am aware is that of Benton (1980), who noted an outbreak of this flea species at a mink farm in Virginia in which "Persons handling the mink were seriously affected." Lewis (2000) states that "on more than one occasion this species has been found on humans, though usually singly". Corpus & Corpus (1991) stated that flea outbreaks with *Ctenocephalides felis* (Bouché, 1835), the cat flea, are rarely reported in the literature although entomologists were aware of many anecdotal accounts. I am aware of anecdotal accounts of humans bitten by squirrel fleas (possibly *O. howardi)* related to me by people in Connecticut, New Jersey, and Virginia, but no flea specimens were provided.

What is significant about this case is that *Orchopeas howardi* has been found infected with the rickettsial organism, *Rickettsia prowazekii*, which is the causative agent of sylvatic epidemic typhus. Southern Flying Squirrels, *Glaucomys volans* (Linnaeus, 1758), are reservoir hosts for this rickettsial organism and *O. howardi* has been found to be infected with *R. prowazekii* (Durden & Hinkle, 2009). Human cases with sylvatic epidemic typhus have been reported in Georgia, Tennessee, Pennsylvania, and Massachusetts (McDade et al., 1980) and North Carolina, Virginia, and West Virginia (Duma et al., 1981). The Virginia cases were from residents in the counties of Halifax and Lee, and the City of Richmond. Additional human cases of sylvatic epidemic typhus have been reported from the states of Arkansas, California, Indiana, Maryland, and New York (McDade, 1987). Detailed information on the nature of sylvatic epidemic typhus disease is given by Reynolds et al. (2003) based on two additional cases from Georgia and West Virginia. What the role is of *O. howardi* in the maintenance and transmission of sylvatic epidemic typhus is as yet unknown. Thus, it is significant to note that *O. howardi* does indeed bite and feed on humans.

Another example of insects biting humans and inflicting painful bites occurred in Virginia. Shortly after planting two varieties of azalea bushes in front of their home in Annandale, Fairfax County, VA, the couple living there began to experience numerous painful bites from insects they called "redheads". Specimens were submitted to me and were identified by Thomas Henry of the United States Department of Agriculture (ARS, SEL) as *Rhinocapsus vanduzeei* Uhler, 1890, the Azalea Plant Bug (Order Hemiptera: Family Miridae).

The year following the planting of the azalea bushes, bites from the mirid bug were experienced beginning in May and continuing through July. The bite was described by one of the homeowners as a sharp, immediate pain resulting in a reddened wheal at the bite site. For several days later, the bite would itch and beginning on day 3 through day 6 would weep clear fluid. The bite site was dry by day 7 and still red until day 10. The bite of *R. vanduzeei* is described by

Wheeler & Herring (1979) as "painful", "a chigger-like welt".

The Azalea Plant Bug is common on a number of plant species, primarily members of the Ericaceae, and there are some records of its occurrence in Virginia. The Virginia Museum of Natural History has in its collection specimens of *R. vanduzeei* from the following counties: Caroline, Chesterfield, Floyd, Greensville, Henry, Isle of Wight, Wythe, and the City of Richmond. All specimens were collected between May and July. Two specimens from Martinsville in Henry County were noted by the collector as "biting". At the National Museum of Natural History, Smithsonian Institution, there are Virginia records from the counties of Arlington and Albemarle. There is an additional record from the City of Alexandria (Bug Guide, 2018). Specimens in my possession from Annandale have been deposited into the VMNH collection and are the first record from Fairfax County.

There are two species of very similar appearing azalea plant bugs in eastern North America which occur from southern Canada to the Gulf States (Henry & Wheeler, 1988). Knight (1923) discerned the two species in a key as follows: *Rhinocapsus rubricans* (Provancher, 1887) has the second segment of the antenna all black while *R. vanduzeei* has the second antennal segment bicolored yellow and black.

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Banisteria, Number 50, pages 34-35

The Current Status of *Cicindela limbalis* Klug in Virginia

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ABSTRACT

We report the discovery of a population of the tiger beetle *Cicindela limbalis* from a powerline in Frederick County, Virginia. We found only two old records of single specimens from Fairfax and Page counties and consider this species rare in the state. A peak count of about 40 adults was recorded during three site visits.

Keywords: rare species, tiger beetle.

Cicindela splendida Hentz, *C. limbalis* Klug, and *C. denverensis* Casey are very closely related tiger beetle species, and although there is uncertainty about their taxonomic status, most workers consider them to be distinct species (e.g., Bousquet, 2012; Pearson et al., 2015). Their ranges overlap in parts of the Midwest, and in some areas all three species and their hybrids may occur (Brust et al., 2012). While *C. splendida* is widespread in the western two-thirds of Virginia, *C. limbalis* is known from only four old and dubious records, and was considered to be extirpated or perhaps viable populations never being present in Virginia and other southeastern coastal states (Knisley & Schultz, 1997; Pearson et al., 2015). The second author has collected it near Romney, West Virginia, less than 50 km west of the Virginia state line. Adding to the uncertainty of its status in Virginia was the discovery of a large population in Botetourt County with 85 sampled individuals identified as *C. splendida* (elytra reddish/purple and dorsum of head and pronotum green) and 14 identified as *C. limbalis* (elytra, pronotum, and head reddish/purple) using the key in Pearson et al. (2015). In their recent study, Brust et al. (2012) determined the color of the proepisternum was red/purplish in *C. limbalis* and green in *C. splendida*. Using this additional character, 97 individuals of the Botetourt population were identified as *C. splendida* and only two as *C. limbalis*. The results of a mtDNA analysis of this and other populations of *C. splendida* and *C. limbalis* in Virginia and other states determined that these species could not be separated genetically (Woodcock & Knisley, 2009). The authors noted evidence that recent evolution and possibly interbreeding are factors that could make mtDNA analysis inconclusive in separating species. Consequently, Bousquet (2012) removed *C. limbalis* from the list of confirmed species known from Virginia. This note reports on a newly discovered population of *C. limbalis* in Virginia, an examination of the older *C. limbalis* specimens, and the current status of this species in Virginia.

Knisley & Schultz (1997) recorded *C. limbalis* from Fairfax, Montgomery, and Page counties and the City of Suffolk in Virginia. We could not verify the source of the records for Montgomery County and City of Suffolk but believe these are probably misidentified and actually *C. splendida* because these localities are well beyond the known historic range of *C. limbalis*. We examined single specimens for the other two Virginia records in the National Museum of Natural History. The label for the Page County record was from Skyland, 13-IX-[19]33 from the Nicolay Collection. The label for the other specimen, which we believe corresponds to the Fairfax record, is: Alex. [Alexandria] Co., 1-V-1887, E. Shoemaker. Both specimens are from northern Virginia and identified as *C. limbalis*. Although single specimens from a population may not be definitive for resolving the species' identity, these specimens suggest that *C. limbalis* was historically present in Virginia.

In the spring of 2016, a new population was found by the first author in northwestern Virginia (Frederick County), less than 2 km from the West Virginia state line. The site was the slope of an overgrown powerline with relatively dense vegetation of shrubs, small trees (pine, oak), herbaceous plants, and ground cover of moss, lichens, and scattered rocks. In this and subsequent surveys, all adults and some larvae were found within or at the edges of 6-8 small patches of bare to sparsely vegetated soil. The results of the three site visits were as follows: 15 April 2017, 15-20 *C. limbalis*, 1 *C. purpurea* Olivier; 27 April 2017, 20 *C. limbalis*, 5 *C. purpurea*, and several *C. sexguttata* Fabricius; 11 September 2017, about 40 adults of *C. limbalis* and two *Cicindelidia rufiventris* Dejean. Our examination of 46 specimens collected or observed in the field during the site visits revealed two specimens from 11 September 2017 had a green head and pronotum and reddish/purple elytra, but these and the others with a reddish/purple head and pronotum all had the red/purple proepisternum (Fig. 1). Based on these

Fig. 1. Dorsal view of two specimens of *Cicindela limbalis* Klug from Frederick County, Virginia.

findings and the current literature, we conclude that all individuals of the new population are *C. limbalis* and consequently, the species is currently extant in Virginia. While future surveys may find additional populations, it is likely that *C. limbalis* will be rare in Virginia and restricted to the northern, and especially the northwestern, part of the state. Since this new population occupied a very small portion (approximate 3 km) of the powerline surveyed with dense, encroaching vegetation, it may be threatened by loss of habitat from natural succession. We found some recently cut small trees, but the extent of vegetation control along the powerline is unknown. Vegetation reduction of the powerline cut would likely improve the status of the population. We checked the powerline to the east of the occupied area, but it was low, mesic, densely vegetated, and unsuitable habitat. The powerline continues to the west into West Virginia and may provide suitable habitat, but we surveyed only about 1-2 km west of the area occupied by the beetles. Voucher specimens will be deposited in the Virginia Museum of Natural History and Virginia Tech collections.

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Historical Contributions

First Fern Records from Virginia: John Banister's Account of 1679-1692

Joseph Ewan

Reprinted from *American Fern Journal*
Vol. 53, No. 4 (Oct. - Dec., 1963), pages 138-144

Editor's note: The following article is being reprinted, with permission of the American Fern Society, to celebrate the publication of this 50th issue of *Banisteria.* The reasons that I selected this article are:

1. It provides a brief synopsis of John Banister's life and career and informs readers that he did not live to publish his own discoveries. (Joseph and Nesta Ewan later published a full biography of Banister: Ewan, J., & N. Ewan. 1970. John Banister and his Natural History of Virginia 1678-1692. University of Illinois Press, Urbana, IL. 485 pp. They also prepared a short paper about Banister that appeared as the first article in the inaugural issue in *Banisteria*, published in 1992 to commemorate the 300th anniversary of his death.)

2. The paper reminds readers that Banister preceded Linnaeus and polynomials were used before the binomial system of nomenclature.

3. The article informs/reminds readers that Banister was both a collector and illustrator of plants.

4. Banister's written account of walking fern is included in the paper.

In an addendum to this reprint, Associate Editor Wieboldt discusses some issues associated with the list of fern species that appears on the last page of the Ewan paper, including numerous taxonomic changes and some possible misidentifications or specimens from a source beyond present day Virginia.

First Fern Records from Virginia: John Banister's Account of 1679-1692[1]

JOSEPH EWAN

Seventy-four years *before* the *Species plantarum* of Linnaeus appeared, John Banister (1654-1692) listed seventeen ferns and lycosphens from Virginia. It is natural to think that our fern binomials originated with the Great Swede when, in fact, many of the common Atlantic Coast forms were known quite precisely under earlier polynomial names to naturalists, some of whom, like Banister, died before Linnaeus was born. Like Clayton's discoveries in Virginia in the next century, Banister's pioneer observations and descriptions of ferns and flowering plants would be quite unknown had not other botanists interested themselves in his work. Gronovius published Clayton's findings; John Ray (1686-1704) and Leonard Plukenet (1691-1705), Banister's.

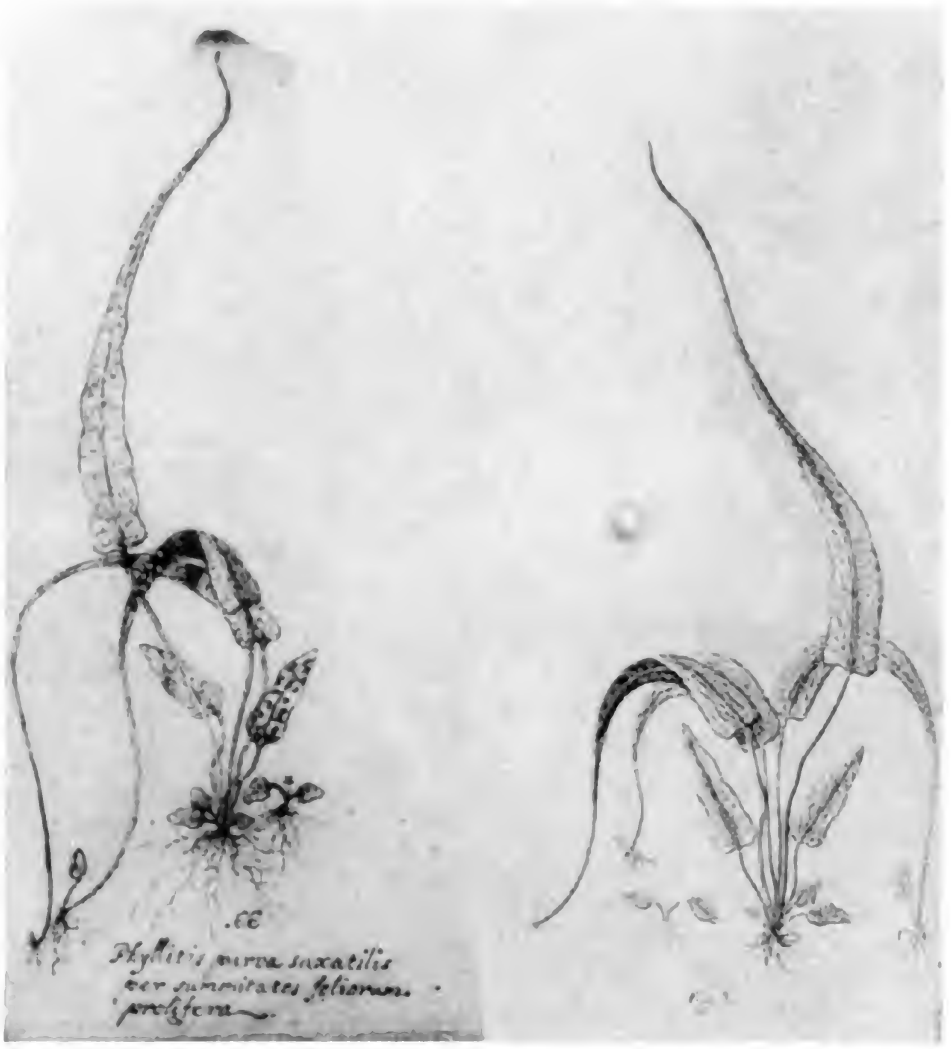
[1]Presented at the American Fern Society meeting, Stillwater, Oklahoma, 1960. Research supported by National Science Foundation, 1959-60.

Only Banister's early Catalogue was published, and his more complete account, edited by Sherard, rested in manuscript nearly three hundred years before its significance was understood.

This report describes only a small segment of a five-part manuscript recently brought to light at Oxford which is being edited for publication by Mrs. Ewan and me, including the identification of the approximately 375 plant species. In addition to the plant catalogue, the largest of five parts, the manuscript contains an account of insects, one of molluscs, another of general natural history, and an account of the Indians. In short, Banister's is the first *scientific* account for Virginia in the field of descriptive botany, entomology, and malacology. John Banister had keen powers of observation, a talent for drawing—he was self-taught—and familiarity with contemporary literature based upon an Oxford education in botany and natural philosophy. Had Banister lived beyond his thirty-eight years—he was accidently shot by a companion while on a field trip—he would certainly have profoundly altered the course of science in colonial America.

Reverend Banister arrived in Virginia about the year 1676, and evidently began at once observing, collecting, and describing in Latin phrases the plants, including the ferns, he found there. His nominal task was as clergyman to the Church of England; his frontier work was among the colonists, and perhaps among the Indians, and in the world of nature that surrounded him. In the remarkably short span of about three years he assembled a catalogue of the plants he had found, noting their relationships with European species, or suggesting possible alliances if the plants were wholly new to him. Made acutely aware of the value of preparing a graphic record, he then taught himself to draw, and fifty-three of his sixty-five drawings survive in the British Museum, the majority published, sometimes modified, and with or without acknowledgment of their source, by Plukenet (1691-1705) whose *Phytographia* was extensively used by Linnaeus in his works on American botany.

Banister wrote detailed letters on Virginia natural history



Right: Plukenet's figure of Walking Fern based on Banister's drawing published in his Phytographia and captioned "Phyllitis parva saxatilis per summitates foliorum radicosa Banist [er] Cat [alogus] Stirp [ium] Virg [ininse] . . ."

Left: Banister's original (unpublished) drawing of Walking Fern made in Virginia preserved in the British Museum (published by courtesy of the Trustees).

[The "*" just above the growing point of the plantlet relates to a matching "*" barely discernible at the tip of the upper frond. The handwriting is not Banister's, possibly Plukenet's, in spite of change of "prolifera" to "radicosa" in published version.]

to his British colleagues, Dr. Robert Morison and Bishop Compton, to John Ray, Dr. Martin Lister, and perhaps to James Petiver. Four of Banister's letters, besides the excerpts which Lister published in *Philosophical Transactions* (1693), have been traced.

We know from William Aiton's printed record of the introduction dates of American plants into English horticulture that Banister certainly sent more novelties to his homeland than any other visitor to the New World before the year 1700. In Aiton's *Hortus Kewensis* many of Banister's introductions were listed with credit to him, although more usually they were credited to Bishop Compton and Jacob Bobart, both of whom enthusiastically grew his seeds and plants from Virginia.

It is of interest and is acknowledged that this study could have made little progress if it had been undertaken before the completion of the recent works of Raven (1942) on the life and times of John Ray, of Dandy (1958) on the content of the Sloane Herbarium, of Vines and Druce on the Morisonian Herbarium (1914), and of Raymond Phineas Stearns (1953) on the contribution of James Petiver. The several librarians who have enabled us to locate and identify three different manuscript versions of Banister's Virginia natural history, first at Oxford, then the British Museum, and recently at Colonial Williamsburg, have been most helpful.

We shall not repeat here Banister's Latin for the seventeen Pteridophyta he described from Virginia; it will be published with the detailed account, but what he found and recorded are summarized here. His description of what we today call *Botrychium virginianum* was the partial basis of Linnaeus's *Osmunda virginiana,* and Banister's description and drawing of the walking fern were mentioned by Morison, Plukenet, and Petiver, and all contributed to Linnaeus's establishing the species *Asplenium rhizophyllum,* later called *Camptosorus.* Linnaeus specifically cited Virginia as the source of seventeen Pteridophyta, and Banister knew thirteen of these. In short, Banister knew the majority

of the Virginia ferns and lycosphens described by Linnaeus seventy-four years later, a not inconsiderable and little appreciated fact. The four cited by Linnaeus, but not described by Banister, are *Osmunda claytoniana,* commemorating its discoverer, John Clayton, *Pellaea atropurpurea,* and *Woodwardia areolata. Polystichum lonchitis,* noticed for Virginia by Linnaeus, must have been mistakenly associated with that colony at the time *Species plantarum* was written. Some of Banister's one-line descriptions refer to classic works by Parkinson whose reference to *Adiantum pedatum,* for example, is the basis of Banister's admitting a Virginia fern to that species; or to Gerard whose good illustration of *Botrychium virginianum* contributed to Banister's recognition of the grape fern; or to Matthiolus, or Dodonaeus—each author in fact resting his work, then as now, on the labors of others.

Incidentally, the eighteenth century of Linnaeus muddled the knowledge of Virginia ferns, and the inimitable Professor Fernald (1935) detailed the story of *Asplenium platyneuron* in this connection. Three ferns were curiously mixed by Linnaeus, and only by adopting as a clear basis the collection made by Clayton and described by Gronovius are we able to salvage the name. Had Banister's original description and drawing been published during his lifetime subsequent confusion in this and other fern typifications would have been averted.

The Reverend botanist was so fascinated by the walking fern that he wrote one of his longest surviving accounts for any Virginia species, relating its growth and habitat. Fortunately William Sherard copied this from a letter into his draft of Banister's *Catalogus* at Oxford; this detailed account of the walking fern is lacking in the *Catalogus* in Banister's own hand preserved at the British Museum (cf. Ewan, in press).

"Phyllitis parva saxatilis per summitates foliorum prolifera. In Sept. last we occasionally took a journey towards, I might have said, to the mountains, had not the Indians w^{ch} were our guides, been afraid as they pretended, but I am apt to think it was policy not fear retarded them, and that they were unwilling

to let us be acquainted with their recesses so far up in the country. In our march about 35 miles above the Falls of the James River on the southside our small path brought us to a vast rock, or rather the side of a hill, w^{ch} seem'd to be of entire stone part of w^{ch} was very thinly spread over with a swift fall of water, w^{ch} made a pleasant not loud noise, having no cragginess to interrupt its course. A little lower down this rivulet is received into a natural bason, & from thence conveighed into a small vault of craggy rocks, where with its fall it makes a Hollow sound, something like that of a kettle drum, but more like an Indian one, w^{ch} is a skin stretched over an earthen pot half full of water; it just shews its self & is again rec'd into an open Arch of rough stone, where among other Capillaries[2] grows this small but rare kind of Harts-tongue. This plant grows erect as others of the like kind, till it comes to the age of puberty and nature calls it down to propagate, & w^{n} its offsetts are strong enough to draw their own aliment it leaves them & grows up as before. This rock is crowned with not very large but well spreading trees of cypress-leav'd Savin under whose shade on beds of matted moss, we eat our dinner, & wis'd we might meet wth a place as pleasant & commodius four our repose at night. We went a day's journey & a half further & then cross'd the river w^{ch} we found prettie wide, but by reason of its declivity in many places fordable. In our way home the rich low grounds abounded with a kind of wild Baulm w^{ch} being trampled on by our horses as we rode thro it mightily refreshed us with its fragrant scent. Little else I think occur'd on this or the other side worth giving an acc(oun)tt of."

From this quotation you will see that Reverend John Banister had a genuine love of the Virginia woods and rivers, and wrote charmingly of her natural history.

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[2]Banister alludes to Maidenhair which included species both of *Adiantum* and *Asplenium*, and from which the medicinal *Syrup of Capillary* was made. *Cf.* R. C. Benedict (1957).

Any botanist who has an interest in the history of his science can hardly avoid wondering about the possible existence of other manuscripts and notebooks that may be hidden in seldom-opened storage files. Some of them, if made available and studied carefully, almost surely would provide helpful information about early exploration routes, dates, and field observations. They might hold keys to some of the riddles surrounding the application of names given to plants by early writers, but not associated clearly, with any existing specimen.–Ed.

VIRGINIA FERNS AND FERN ALLIES KNOWN TO BANISTER (1679-1692)

Lycopodium alopecuroides L.
Selaginella apoda (L.) Spring
Selaginella rupestris (L.) Spring
Botrychium virginianum (L.) Sw.
Osmunda regalis L.
Woodsia ilvensis (L.) R. Br.
Cystopteris fragilis (L.) Bernh.
Onoclea sensibilis L.
Thelypteris phegopteris (L.) Slosson
Polystichum acrostichoides (Michx.) Schott
Camptosorus rhizophyllus (L.) Link
Asplenium platyneuron (L.) Oakes
Woodwardia virginica (L.) Sm.
Adiantum pedatum L.
Adiantum capillus-veneris L.
Polypodium virginianum L.
Polypodium polypodioides (L.) Watt

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DEPARTMENT OF BOTANY, TULANE UNIVERSITY, NEW ORLEANS, LOUISIANA.

Addendum to Ewan (1963) paper
Prepared by Associate Editor Thomas Wieboldt

Inspection of the list of ferns and lycophytes in Ewan (1963) reveals several that are phytogeographically improbable and, therefore, worthy of further discussion. Montane species would not be expected to occur at or near the Fall Line where Banister lived. Ewan & Ewan (1970) wrote, "By his own statement during his years in Virginia, Banister had reached at least 66 miles into the highlands above the falls of the James River, …." and "... so far as we know, his mountain plants were given to him." (p. 89). It is clear from writings in his mollusc catalogue that he had only heard of the western mountains but not seen them himself (Ewan & Ewan, 1970: 326-327). In addition to several ferns, a number of flowering plants also listed in his Catalogus must have come from farther afield. This assumption is based on present day distributions and what we know about ecological preferences of the species, but Banister's writings mention features of the landscape in other parts of the country far beyond his own travels. It seems likely that objects of natural history made their way to him as a learned man of science.

John Banister sent several copies or parts of his *Catalogus Plantarum in Virginia observatorum* to European men of science. The now-familiar Linnaean system of classification was not yet born, and plants were described by Latin phrases rather than having names in the sense we think of them today. The entries in the Catalogus would originally have corresponded to specimens or drawings, or both. The job which Joseph and Nesta Ewan undertook was to try to find as many specimens as possible and to assign genus and species names to each.

The authors mentioned on page 141, their intention to publish a more detailed account which would include Banister's Latin polynomials. Indeed, in 1970, they included an extensively annotated version of Banister's entire Plant Catalogue (about 340 descriptive phrases) in their book, "John Banister and His Natural History of Virginia 1678-1692" (Ewan & Ewan, 1970). Comparison of the fern taxa contained therein reveals additional details about several species as well as additions to and omissions from the list published in *American Fern Journal* (Ewan, 1963). Since most of the names have changed since 1963, all 17 species are listed below with current names following in square brackets where different, along with common names (nomenclature follows the Digital Atlas of the Virginia Flora [2018]). The Plant Catalogue published by Ewan & Ewan (1970) contains two additional lycopods not included in the *American Fern Journal* article. These are appended to the end of the list.

Notes inform the reader as to changes and differences between the two accounts. The discrepancies noted help one to appreciate the enormous job it was to undertake such an endeavor. In speaking about their work, the Ewans stated, "We were also able at this time to search more systematically for unrecognized specimens that might be attributed to Banister in the Sloane Herbarium at the British Museum (Natural History). This task, although aided by Dandy's guide [reference to Sloane Herbarium, facsimile no. 91 (1958)], is unrewarding and exasperating because of the loss or unreliability of the surviving labels attached to the sheets." (Ewan & Ewan, 1970: 147). A few pages later they also mention "Virginia specimens … which had been moved to Petivar's Herbarium …." (Ibid, p. 150). No doubt, the archives of older European herbaria, and pre-Linnaean herbaria, in particular, are a challenge even for the most informed student of historical botany!

LIST OF FERNS AND LYCOPHYTES

Lycopodium alopecuroides L. [*Lycopodiella alopecuroides* (L.) Cranfill; Foxtail Clubmoss]

Selaginella apoda (L.) Spring. [*Lycopodioides apodum* (L.) Kuntze; Meadow Spikemoss] – This species is not found in the Plant Catalogue. The absence of a Latin polynomial or other information does not allow one to explain the earlier attribution.

Selaginella rupestris (L.) Spring. [*Bryodesma rupestris* (L.) J. Sojak; Rock Spikemoss]

Botrychium virginianum (L.) Sw. [*Botrypus virginianus* (L.) Michx.; Rattlesnake Fern]

Osmunda regalis L. [*Osmunda spectabilis* Willd.; Royal Fern]

Woodsia ilvensis (L.) R. Br. - Presumably, redetermined as *Woodsia obtusa* (Spreng.) Torr. [Blunt-lobed Woodsia]. *Woodsia* obtusa is the only *Woodsia* included in Ewan & Ewan's (1970) version of the Plant Catalogue. Furthermore, *W. ilvensis*, being a montane species, would be phytogeographically improbable. The nearest population and only Piedmont occurrence is at Sugarloaf Mountain, Nelson County, considerably northwest of the area Banister is believed to have traveled.

Cystopteris fragilis (L.) Bernh. [*Cystopteris protrusa* (Weath.) Blasdell; Lowland Bladder Fern] - The Plant Catalogue further specifies var. *protrusa*, now given species status. *Cystopteris fragilis* (= var. *fragilis*) is a

northern, circumpolar species not known to occur in Virginia.

Onoclea sensibilis L. [Sensitive Fern or Bead Fern]

Thelypteris phegopteris (L.) Slosson – This species is not known to occur in Virginia and is a rare, strictly montane species in the region. The common and widespread species of eastern Virginia in this genus is now known as *Phegopteris hexagonoptera* (Michx.) Fee (formerly *Thelypteris hexagonoptera* (Michx.) Weath.) [Broad Beech Fern]. The two species are easily confused due to a striking similarity in overall form.

Polystichum acrostichoides (Michx.) Schott [Christmas Fern]

Camptosaurus rhizophyllus (L.) Link [*Asplenium rhizophyllum* L.; Walking Fern]

Asplenium platyneuron (L.) Oakes [*Asplenium platyneuron* (L.) BSP; Ebony Spleenwort] – The Plant Catalogue contains two different entries (polynomials) determined as this species, the first preceded by a question mark. Its leading term, *Lonchitis*, is shared by the two previous entries which are referable to the Christmas fern, *Polystichum acrostichoides*. The second polynomial (*Trichomanes major foliis longis auriculatis*) is more descriptive of this fern and can confidently be assigned to it.

Woodwardia virginica (L.) Sm. [Virginia Chain Fern]

Adiantum pedatum L. [Maidenhair Fern]

Adiantum capillus-veneris L. [Venus'-hair Fern or Southern Maidenhair Fern] – The only positively known occurrence of this fern in Virginia is an 1879 record from the New River in Wythe County which has never been rediscovered. There are a few Coastal Plain records from calcareous sediments in the Carolinas (Weakley, 2015), thus holding out the possibility that it once occurred in the Virginia Coastal Plain as well, most likely on Miocene shell deposits which are strongly calcareous. This intriguing possibility is given more credence by the fact that Banister was also a malacologist and is known to have collected from and discussed fossil shell deposits with Martin Lister of Yorkshire and Oxford who may have inspired his interest in collecting molluscs in Virginia (Ewan & Ewan, 1970: 309). An entry in the mollusc catalogue states, "And I myself so or thirty miles up in ye freshes have seen on ye land between high and low-water mark a bed of scallop shells grown into a rock ...." (Ibid, p. 323). Such habitat may well have supported Venus'-hair fern.

Polypodium virginianum L. [Common Polypody Fern]

Polypodium polypodioides (L.) Watt [*Pleopeltis polypodioides* (L.) Andr. & Windham ssp. *michauxiana* (Weath.) Andr.; Resurrection Fern] – The entry in the Plant Catalogue adds var. *michauxianum* Weath. which distinguishes the subspecies known from temperate North America.

Lycopodium complanatum L. [*Diphasiastrum digitatum* (Dill. ex A. Braun) Holub; Common Running-cedar]

Lycopodium obscurum L. [*Dendrolycopodium obscurum* (L.) A. Haines; Common Ground-pine]

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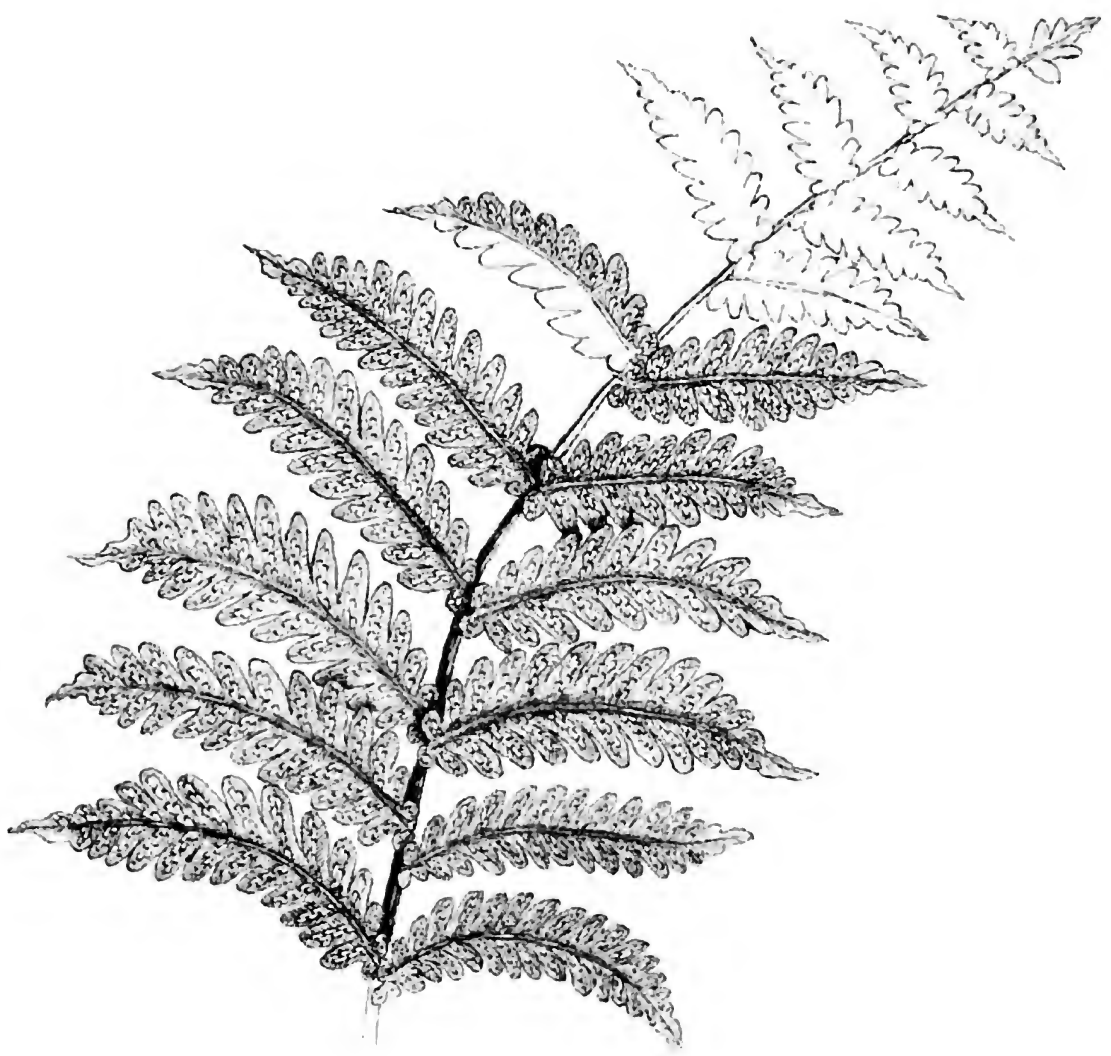

Virginia Chain Fern
Woodwardia virginica (L.) Sm.

Original drawing by John Banister, sent to Bishop D. H. Compton in 1689.
Figure 35 in folio in Sir Hans Sloane's MS 4002 in the British Museum.
Photocopy courtesy of Joseph and Nesta Ewan.

Miscellanea

Summary of 2018 Members' Meeting

The first Scientific Meeting of the Virginia Natural History Society was held on Saturday October 13, 2018, at the Virginia Museum of Natural History (VMNH) in Martinsville. This was the first official gathering of the Society since the September 2009 symposium (also held at VMNH) entitled "Historical Explorations into Virginia's Natural History." The 30 attendees included 11 students. At least 10 colleges and universities were represented, as were two state agencies, the National Museum of Natural History, and other naturalists. The program consisted of the eleven talks and seven posters listed below, followed by a brief business meeting and tours of the museum's research collections.

ORAL PRESENTATIONS (* = presenter)

History of the Virginia Natural History Society: the first 25 years. Steve Roble, *Banisteria* Editor and Virginia Department of Conservation and Recreation, Division of Natural Heritage

Specimen vouchers, natural history collections, and holistic collecting. Ralph P. Eckerlin, National Museum of Natural History, Smithsonian Institution

Natural history collections at Emory and Henry College. Jake Bova*, George Argyros, Jerry Bresowar, Christopher Fielitz, and Laura Hainsworth, Emory and Henry College

Ants of Virginia. Kal Ivanov, Virginia Museum of Natural History

Beetles of Virginia. Arthur V. Evans, Virginia Museum of Natural History

Inventory and conservation assessment of the dragonfly and damselfly (Odonata) faunas of Virginia. Steve Roble, Virginia Department of Conservation and Recreation, Division of Natural Heritage

Systematics of the colorful cyanide-producing millipedes (Polydesmida, Xystodesmidae). Paul E. Marek*, Jackson Means, and Derek Hennen, Virginia Tech

Molecular phylogenetics of the twisted claw millipedes (Polydesmida: Xystodesmidae: *Nannaria*). Jackson Means*, Derek Hennen, and Paul E. Marek, Virginia Tech

Gray bat summer activity in the Clinch River watershed, Virginia. Karen Powers*, W. Mark Ford, Rick Reynolds, Wil Orndorff, Tom Malabad, Sarah Sweeten, and Margaret Short, Radford University (KP), U.S. Geological Survey (WMF), Virginia Department of Game and Inland Fisheries (RR), Virginia Department of Conservation and Recreation (WO, TM), Virginia Tech (WMF, SS), Virginia Department of Transportation (MS)

Bird-window collisions at Radford University: effects of vegetation, window area, and landscape features. Breann Mullen*, Lauren Burroughs*, and Karen Powers, Radford University

Metzergia at Solite: how a tiny liverwort changes things. DorothyBelle Poli, Roanoke College

POSTER SESSION (* = presenter)

Cretaceous macroflora in the VMNH collections. Brooke Haiar, University of Lynchburg

The effects of wetlands and forest opening size on the richness and abundance of early-successional birds. Isabel Hildesheim*, David Brown, and Katie Kelly, Roanoke College (IH), Eastern Kentucky University (DB, KK)

Tracking potential hosts of *Amblyomma maculatum* through wildlife cameras. Amanda DeVleeschower* and Holly Gaff, Old Dominion University

Comparing reptile and amphibian distribution across the Appalachian bioregion. Hannah Reed* and Matt Close, Radford University

Age classification of *Sciurus*: comparison of criteria based on bone fusion, tooth wear, and cementum annuli. Nancy D. Moncrief, Liberty Hightower*, and Kal Ivanov, Virginia Museum of Natural History

Genetic connectivity of raccoons (*Procyon lotor*) in a naturally fragmented coastal landscape: evidence from mitochondrial and microsatellite markers. Nancy D. Moncrief*, James H. Roberts, Eric M. Hallerman, Ron A. Van Den Bussche, and Raymond. D. Dueser, Virginia Museum of Natural History (RDD, NDM), Georgia Southern University (JHR), Virginia Tech (EMH), Oklahoma State University (RAVBD), University of Virginia (RDD)

Land mammals of the Virginia barrier islands. Raymond D. Dueser, John H. Porter, and Nancy D. Moncrief*, University of Virginia (RDD, JHP), Virginia Museum of Natural History (RDD, NDM, JHP)

A Brief Review of the Virginia Natural History Society's First Quarter Century

Steve Roble
Editor, *Banisteria*

Brief summaries of the first 10 and 20 years of the history of our society were published in previous issues of *Banisteria* (Mitchell & Roble, 2002; Roble, 2012), so I will not repeat most of that information here. During my keynote address at the recent members meeting, I reviewed some of this history and included additional observations.

Joe Mitchell and Richard Hoffman, cofounders and original coeditors of *Banisteria*, conceived of the journal for the purpose of publishing traditional natural history data and observations pertaining to Virginia that would not be accepted by mainstream journals (Mitchell, 1993). They devoted more than a year toward soliciting or writing papers for inclusion in the first issue and also developed the journal's format, including selection of a historical font type for the title on the front cover. The first issue of *Banisteria* was published on November 13, 1992, just in time to commemorate the 300th anniversary of the accidental death of its namesake, John Banister (ca. 1650-1692), the first university-trained naturalist to work in Virginia. Including the current issue, the society has now published 50 issues of *Banisteria* totalling 3,081 printed pages and containing 391 papers by more than 300 authors, plus several biographies, 14 obituaries, and 47 book reviews.

Shortly after the conception of *Banisteria*, the Virginia Natural History Society was formed as a means of distributing the journal (Mitchell, 1993). Significant contributors in launching the society included Michael Kosztarab (1st VNHS president, 1992-94), Barry Knisley (VP 1992-94, president 1995-96; also again in 2009-10), and Anne Lund (Secretary-Treasurer, 1992-2007). The inaugural issue of *Banisteria* includes the names of 16 patrons who contributed financially toward the publication of that issue. I would like to hereby acknowledge the six living patrons who are still current members of the society: Ralph Eckerlin, Bob Jenkins, Joe Mitchell, Jim Murray, Tom Wieboldt, and Robert Wright. At least 14 other individuals, including Drs. Kosztarab and Knisley, Barb Abraham, Allen Belden, Mike Donahue, Norm Fashing, Lynn Ferguson, Ollie Flint, Joella Killian, Don Linzey, Tom McAvoy, Dave Smith, Al Wheeler, and me, have been active members of the society since the first year of its existence. Several others have been members for more than 20 years.

In the past five years, *Banisteria* issues have included six (of 13) papers that were presented at the society's September 2009 symposium entitled "Historical Explorations into Virginia's Natural History" as well as a special issue concerning the cave invertebrate fauna of Virginia. Published contributions also included a major paper summarizing the composition and distribution of the state's Neuroptera fauna (owlflies, lacewings, antlions, and relatives). In the past three years, the number of printed pages has been lower than the 25-year average (Fig. 1). In general, submission of manuscripts by members and other authors is sporadic and unpredictable from year to year such that a backlog of accepted papers awaiting publication rarely exists.

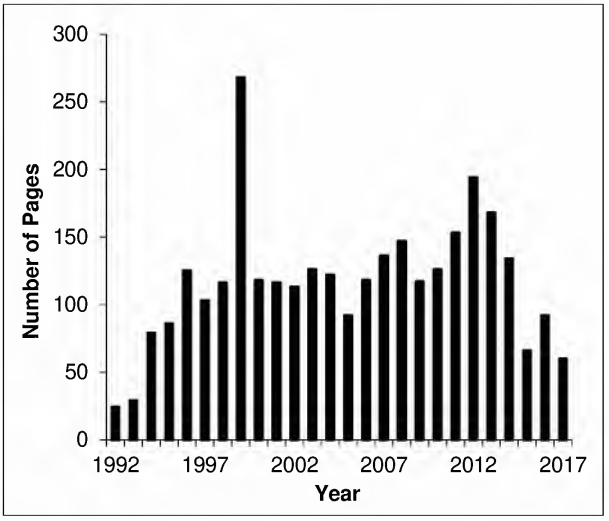

Fig. 1. Number of printed pages in *Banisteria* per year, 1992-2017.

The chronology of the society's officers since its inception is summarized in Table 1. We have had 13 presidents to date, with Barry Knisley serving two 2-year terms more than a decade apart and Dick Neves presiding for about 3.5 years after his predecessor moved out of state. Cumulatively, 35 individuals have served the society as officers, editors, and webmasters. Richard Groover and Paul Marek have also served as the first two editors of the society's occasional newsletter.

Every year or two the society seeks new candidates for the positions of councilor and vice president (automatically becomes the next president), so members who are interested in serving the society in either of those roles or in some other capacity should contact the current president.

Membership levels in the VNHS have fluctuated considerably during its brief history, reaching a peak of

Table 1. History of VNHS Officers (1992-2018).

President (and Vice-President)	
Michael Kosztarab	1992-1994
Barry Knisley	1995-1996 (VP 1992-94)
Thomas Rawinski	1997 (part; VP 1995-96)
Richard Neves	1997-2000 (VP 1997, part)
Werner Wieland	2001-2002 (VP 1999-2000)
Barbara Abraham	2003-2004 (VP 2001-2002)
Judith Winston	2005-2006 (VP 2003-2004)
Thomas McAvoy	2007-2008 (VP 2005-2006)
Barry Knisley	2009-2010 (VP 2007-2008)
Ralph Eckerlin	2011-2012 (VP 2009-2010)
Todd Fredericksen	2013-2014 (VP 2011-2012)
Michael Lachance	2015-2016 (VP 2013-2014)
Alfred Gardner	2017-2018 (VP 2015-2016)
Nancy Moncrief	(VP 2017-2018; becomes President 2019-2020)
Secretary-Treasurer	
Anne Lund	1992-2007
Bill Shear	2008-2015
Rachel Goodman	2015-2017; Treasurer 2017-2018
Paul Marek	Secretary 2017-present
Councilors	
Richard Neves	1993-1996
Thomas Rawinski	1993-1994
Carolyn Wells	1993-1994
Norman Fashing	1995-1998
Judith Winston	1996-1998
Steven Roble	1997-2000
Michael Kosztarab	1999-2000
Joella Killian	1999-2002
Thomas McAvoy	2001-2004
Paul Bedell	2001-2005
Michael Donahue	2003-2006
Arthur Evans	2005-2008
Janet Reid	2006-2009
Michael Lachance	2007-2010
Oliver Flint	2009-2012
Lisa Williams	2010-2013
Richard Groover	2011-2014
Nancy Moncrief	2013-2016
Paul Marek	2015-2017
Chris Milensky	2015-2018
Kal Ivanov	2017-present
Karen Powers	2018-present
***Banisteria* Editors**	
Richard Hoffman	1992-1999
Joseph Mitchell	1992-2007
Steven Roble	2000-present
Honorary Councilors	
Richard Hoffman	2001-2012
Michael Kosztarab	2001-present
Joseph Mitchell	2009-present
Webmaster	
Kenneth Stein	1999-2001
John White	2002-2017
Paul Marek	2017-present

Photos of attendees at past VNHS board meetings:

Dec. 1993: (left to right) Barry Knisley, Tom Rawinski, Joe Mitchell, Richard Hoffman, Anne Lund, Dick Neves, Michael Kosztarab.

Jan. 1998: (front) Joe Mitchell, Richard Hoffman, Dick Neves; (back) Steve Roble, Anne Lund, Norm Fashing, Michael Kosztarab.

Dec. 2000: (left to right) Steve Roble, Joella Killian, Anne Lund, Werner Wieland, Dick Neves, Richard Hoffman, Joe Mitchell, Michael Kosztarab.

Dec. 2002: (front) Barb Abraham, Joe Mitchell, Richard Hoffman (and dog Karla), Michael Kosztarab; (back) Anne Lund, Steve Roble, Dick Neves, Werner Wieland.

Dec. 2005: (left to right) Richard Hoffman, Anne Lund, Art Evans, Joe Mitchell, Steve Roble, Michael Kosztarab, Tom McAvoy, Judy Winston. (All photos courtesy of Michael Kosztarab)

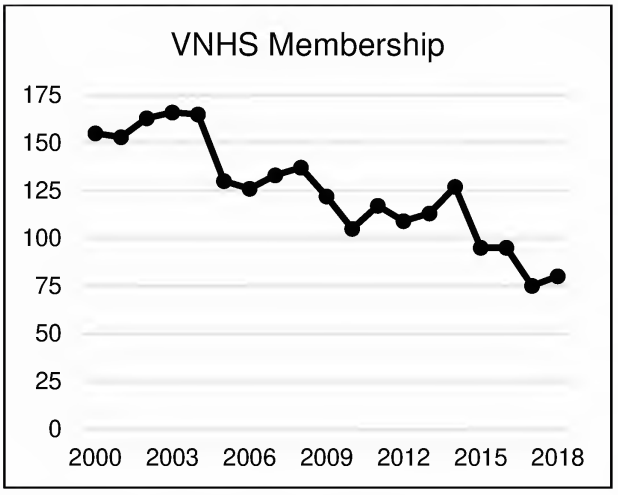

Fig. 2. Size of VNHS membership, 2000-2018.

about 165 (including 22 institutions) in 2002-2004, but it has mostly declined since then to its present level of about 80 (Fig. 2). The society is always seeking to recruit new members and striving to retain current members. Perhaps a more rigorous effort directed toward reminding lapsed members to renew their memberships should be implemented. Also, if electronic payment of dues becomes an option in the future, that may help to increase the membership retention rate.

In 2015, the society announced a new initiative whereby faculty and other society members could nominate college or high school students to receive a free, one-year membership. In subsequent years, these students can renew their membership at the low annual rate of only $5. This is a real bargain! The ultimate goal is to recruit students who will become longterm members of the society, as well as potential officers and/or *Banisteria* authors.

The future of the Virginia Natural History Society depends on both current and new members who are willing to serve as officers, editors, and webmasters, to recruit new members and help raise the profile of the society, or to volunteer to organize symposia, meetings, field trips, and other activities. The society will especially require a younger generation of new leaders and members to carry it forward in the coming decades.

Literature Cited

Mitchell, J. C. 1993. The origin of *Banisteria* and the Virginia Natural History Society. Banisteria 2: 26-27.

Mitchell, J. C., & S. M. Roble. 2002. Ten-year summary of *Banisteria* / History of VNHS officers (1992-2002). Banisteria 20: 77-78.

Roble, S. M. 2012. The Virginia Natural History Society: A brief history of the first 20 years. Banisteria 40: 109-112.

Reports

1. Treasurer's Report

As of November 1, 2018, the society has 80 members, including 12 institutions, which is unchanged from last year's membership at this time. The current bank balance is $17,945, which is up from $15,787.00 in December 2017.

Respectfully submitted,
Rachel M. Goodman, Treasurer

2. Webmaster's Report

VNHS website traffic during the first 10 months of 2018 is summarized in the following table:

Month	Visits	Pages	Files	Hits
Oct 2018	2404	3902	7205	23278
Sep 2018	2095	3012	5737	16124
Aug 2018	2044	5365	5272	20222
Jul 2018	2326	3347	5927	17916
Jun 2018	2552	3753	6196	19014
May 2018	2649	5155	6693	20087
Apr 2018	2725	3754	6570	17392
Mar 2018	2538	3589	6766	16168
Feb 2018	4678	6526	6306	17127
Jan 2018	2165	3322	6547	14347

Respectfully submitted,
Paul E. Marek, Webmaster

3. Editor's Report

I was contacted recently by staff of the Biodiversity Heritage Library as they begin the process of adding *Banisteria* to their website per our society's agreement with this organization. So far, I have provided electronic copies of about half of the *Banisteria* issues. This effort should help *Banisteria* reach a wider audience than it currently does and make the VNHS better known.

I am currently working on the second issue of *Banisteria* for 2018 and anticipate that it will be published in early 2019. More submissions are always needed for publication in the journal, so please consider submitting a paper, note, biography, or historical contribution concerning the natural history of Virginia.

Finally, I would like to thank Chris Haufler, editor of *American Fern Journal* and the board of the American Fern Society for permission to reprint the article by Joseph Ewan that appears in this issue. I would also like to thank the following people for serving as peer reviewers of *Banisteria* submissions during the past several years (* = reviewed >1 paper): Barb Abraham, Paul Angermeier, Art Bogan, Janet Ciegler, Carolyn Copenheaver, Charlie Covell, Bob Davidson, Andy Deans, Mike Donahue, Lance Durden*, Sandra Erdle, Mike Ferro, Dot Field, Gary Fleming, Todd Fredericksen, John Goodin, Gary Graves, Curt Harden, Tom Henry, Rick Hoebeke, Kal Ivanov, Jerry Jackson, Bob Jenkins, Alicia Linzey, Mark Milne, Joe Mitchell*, Nancy Moncrief*, Paul Moosman, John Pagels, Harry Pavulaan, Tim Pearce, Karen Powers, Rick Reynolds, Bob Rose*, Don Schwab*, Alicia Shenko, Dave Smith, Charlie Staines*, Brent Steury, Johnny Townsend, Todd Tupper, Al Wheeler*, and Tom Wieboldt*. Their time, effort, and valuable comments are much appreciated and have helped to maintain the quality of *Banisteria*.

Respectfully submitted,
Steve Roble, Editor, *Banisteria*

Announcements

1. Election results and new ballot

Earlier this year, Karen Powers of Radford University was elected to fill the Councilor position that runs from 2018-2021. Another election is upon us, this time for Vice President (= President-Elect) and up to two Councilors. **Please cast your votes by returning the enclosed ballot by February 1, 2019**.

2. News of past VNHS members

George W. Byers, Emeritus Professor of Entomology at the University of Kansas, passed away on January 1, 2018, at the age of 94. A faculty member at that institution since 1956, Dr. Byers had close ties to Virginia because he taught an introductory entomology course at the University of Virginia's Mountain Lake Biological Station 16 times in alternate summers between 1961 and 1992. He published two papers in *Banisteria* based on his insect collections from that area of Giles County:

Byers, G.W. 1993. Sampling soil arthropods at Mountain Lake Biological Station, Virginia, over a 32-year period. Banisteria 3: 31-32.

Byers, G.W. 2002. Summer crane flies (Tipulidae) of the Mountain Lake vicinity, Virginia. Banisteria 20: 3-30.

Dr. Byers was a veteran of World War II and the Korean War, and retired from the Army as a lieutenant colonel. He became a world renowned authority on the taxonomy and biology of craneflies (Tipulidae) and scorpionflies (Mecoptera). He is a coauthor of a paper reviewing the Mecoptera fauna of Virginia that will be published next year by the Virginia Museum of Natural History in its *Insects of Virginia* series.

3. Recent publications of regional interest

Guide to the Geology & Natural History of the Blue Ridge Mountains. Edgar W. Spencer. 2017. University of Virginia Press, Charlottesville. 388 pp.

Butterflies of Pennsylvania, A Field Guide. James L. Monroe & David M. Wright. 2017. University of Pittsburgh Press. 304 pp.

Student Member Incentive

The Virginia Natural History Society is offering **free one-year memberships** for students (high school, undergraduate, or graduate) nominated by an advisor/ teacher/mentor who is a member in good standing of the Society. This offer is available for up to 20 students each year, and nominations will be considered in the order in which they are received.

Nominators should include the following information for up to three students: name, institution, enrollment level, mailing address, e-mail address, and a short paragraph describing the student's interests in and activities related to Virginia natural history. Nominations should be sent to the Chair of the membership committee, Nancy Moncrief at nancy.moncrief@vmnh.virginia.gov.

Virginia Natural History Society

http://virginianaturalhistorysociety.com/

General Information

The Virginia Natural History Society (VNHS) was formed in 1992 to bring together persons interested in the natural history of the Commonwealth of Virginia. The VNHS defines natural history in a broad sense, from the study of plants, animals, and other organisms to the geology and ecology of the state, to the natural history of the native people who inhabit it. The goals of the VNHS are to promote research on the natural history of Virginia, educate the citizens of the Commonwealth on natural history topics, and to encourage the conservation of natural resources.

Dissemination of natural history information occurs through publication of the journal *Banisteria*, named for John Banister (1650-1692) who was the first university-trained naturalist to work in Virginia. The first issue was published in 1992, and the journal is published twice per year in spring and fall. Articles cover a wide array of subjects, and prospective authors are encouraged to submit manuscripts on any aspect of natural history in Virginia; papers may pertain to Virginia or regional archaeology, anthropology, botany, ecology, zoology, paleontology, geology, geography, or climatology. Biographies, obituaries, and historical accounts of relevance to natural history in Virginia also are welcomed. Manuscripts are peer-reviewed for suitability and edited for inclusion in the journal.

Page charges ($20/page) are waived if the sole or first author is a VNHS member. All authors must pay $75/page if they desire color printing of figures. The society's website contains detailed instructions for prospective authors and PDF reprints of all *Banisteria* articles that are more than two years old.

Memberships

The VNHS is open to anyone with an interest in natural history and welcomes participation by all members in society activities and efforts to promote education and conservation. Membership includes a subscription to *Banisteria* and invitations to periodic symposia and field events. Annual dues for members are $20 (per calendar year); library subscriptions are $40 per year. Checks or money orders should be sent to the Treasurer, who also has most back issues of *Banisteria* available for sale. The VNHS is a tax-exempt, nonprofit, society under Section 501(C)3 of the IRS. We welcome donations to support our mission in Virginia.

Virginia Natural History Society

Application for Membership

Name _____

Address_____

_____

_____

Zip Code _____

Phone _____

Email _____

Area(s) of Interest _____

ANNUAL DUES AND SUBSCRIPTIONS TO *BANISTERIA*

(memberships and subscriptions are by calendar year; subscribers/members outside the United States should add $3.00 for additional postage)

- ☐ $500.00 Life (not annual)
- ☐ $300.00 Benefactor
- ☐ $100.00 Patron
- ☐ $50.00 Supporting
- ☐ $40.00 Institutional
- ☐ $25.00 Family
- ☐ $20.00 Regular
- ☐ $5.00 Student (see below)
- ☐ I have added a contribution of $_____ to my membership dues.

The special student rate is applicable only when accompanied by the following certification signed by a faculty advisor (**students are also eligible for a 1-year free membership** if an advisor's nomination is approved by the society's Executive Committee; see nomination guidelines in *Banisteria*).

Institution _____

Advisor _____

Date_____

Make checks or money orders payable to:
Virginia Natural History Society

Send membership form and dues to:
Dr. Rachel Goodman, Treasurer
Virginia Natural History Society
Box 74
Hampden-Sydney, VA 23943

f.66

Gladiolus Bellatus
gladiato caule.