BANISTERIA

A JOURNAL DEVOTED TO THE NATURAL HISTORY OF VIRGINIA

Charles O. Handley, Jr.
(1924-2000)

A remembrance and partial bibliography of one of the most outstanding natural historians in Virginia history is presented on pages 51-54 of this issue

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Number 16, 2000

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Species Composition and Biotic Condition of the Fish Community of Indian Creek, Tazewell County, Virginia

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INTRODUCTION

The Clinch River drainage of southwestern Virginia contains the greatest number of fish species in the Commonwealth. A total of 76 native and 15 introduced species are known from the Virginia portion of the Clinch River (Jenkins & Burkhead, 1994). Systematic fish surveys of the Clinch River did not occur until the 1960s by Wollitz (1965) and Masnik (1974). After these surveys, many mainstem reaches and tributaries were sampled to delimit species distributions (Jenkins & Burkhead, 1994). The purpose of recent fish sampling has been to examine the health of aquatic resources through the use of bioassessment studies (Angermeier & Smogor, 1993; J. Tuberville pers. comm.). Although most tributaries have received some level of fish sampling, resource managers still lack sufficient information to predict species composition or the ability to assess the overall health of smaller streams based on the fish community.

Indian Creek, a small montane stream in the headwaters of the upper Clinch River, has received moderate sampling effort. Between 1971 and 1972, Masnik (1974) developed an initial fish species list by surveying four sites on seven different occasions. Jenkins & Burkhead (1994) surveyed two sites near Masnik's original sampling stations in 1987. Angermeier & Smogor (1993) sampled one station during 1990 and 1991 for a bioassessment study. These collections documented 35 fish species, and based on the fish community, rated the quality of its waters as "good." However, it was not until the discovery of several species of rare and endangered mussels that additional survey effort was focused on Indian Creek (Winston & Neves, 1997).

Soon after endangered mussels were found, a deep coal mine was proposed in the headwaters of Indian Creek. The mine required construction of haul roads, spoil and waste rock storage, and a deep mine access area adjacent to the North Branch of Indian Creek. The Virginia Department of Game and Inland Fisheries and the U.S. Fish and Wildlife Service recommended measures to minimize potential impacts. Sediment control structures, off-site storage of chemicals, and a biomonitoring plan to evaluate mining impacts on water quality were proposed and incorporated into the mining permit. A comprehensive fish survey was initiated because much of Indian Creek had not been surveyed for fishes and because rare species had been documented in the stream. The objectives of this study were to determine the distribution and composition of fishes, and to develop a baseline reference of stream health before installation of a new mine in Indian Creek.

MATERIALS AND METHODS

Study Area

Indian Creek flows southwest for 20 km before entering the Clinch River at Cedar Bluff, Tazewell County, Virginia (Fig. 1). The stream descends from 707 m above sea level at the headwaters to 599 m at the mouth, with an average

total gradient of 5.4 m/km. Indian Creek watershed covers 8,702 ha and spans two physiographic provinces. The headwaters drain the Appalachian Plateau escarpment and the Ridge and Valley province underlies the remaining catchment area. The watershed is dominated by deciduous forest with agriculture along portions of the floodplain and residential areas primarily near its confluence with the Clinch River. Both active and abandoned deep coal mines are present in the headwaters and tributaries of Indian Creek (Fig. 1).

Fish Sampling

We sampled seven stations along Indian Creek at base-flow conditions during 18-24 September 1996 (Fig.1). The sampling period was selected to avoid the brooding period of federally protected mussel species. Stations were selected to represent a longitudinal distribution from the upper to lower reaches of Indian Creek. Secondary considerations were accessibility and sampling effective-ness. We intentionally placed our uppermost site (station 7) directly below the proposed mine site (Fig. 1). Because no fish were found above the proposed mine site, no station was selected upstream of this point. The lowermost site (station 1) on Indian Creek was placed 1 km from the mouth to avoid interaction with the species-rich Clinch River. Average distance between sites was 3.1 km; exact locations are defined in Table 1. We visually estimated stream width (m) during initial inspection. We then multiplied estimated stream width by 20 to determine the total length of the sampling unit. In this manner, one meander wavelength containing several riffle, run, and pool habitats was included at each station (Leopold et al., 1964). A minimum sample length of 100 m was chosen for channel widths estimated to be less than 5 m. Sampling lengths ranged from 100 m at stations near the headwaters to 180 m at station 1 near the mouth.

We collected fishes in one upstream pass at each station using gas-powered backpack electroshockers (Smith-Root, Vancouver, Washington). The four lower sites were surveyed using two backpack electroshockers to cover the greater creek width. Crew sizes varied from two to five individuals, and sampling effort (meters sampled) was recorded at each station. A block net was placed at the upstream end of the station, unless a natural barrier existed. We attempted to net all electroshocked fish. Fishes were identified to species, enumerated, examined for external anomalies (e.g., tumors, diseases) and hybridization, and released alive at the site of capture. Unidentified specimens were preserved in 10% buffered formalin and identified by Dr. Robert E. Jenkins of Roanoke College, Salem, Virginia.

Physical Habitat

Physical habitat measurements at each fish sampling station are summarized in Table 2. After the fish samples were processed, we measured stream width (m) at 10 equally-spaced intervals along the length of the sampling unit. These values were then used to obtain average stream width (m). At each stream width measurement site, we also recorded water depth and substrate type along a cross-section at 0.25, 0.50, and 0.75 intervals of the stream width. Calculation for average depth was according to Platts et al. (1983). Substrate particle size was classified using a modified Wentworth scale (Cummins, 1962).

Dominant/subdominant substrate type was determined by summation of the substrate classification types and selecting those that were the first and second most numerous. Flow (m^3/sec) was calculated from velocity (m/sec) [Marsh-McBirney velocity meter], depth (m), and distance from bank (m) measurements at a single cross-section within a sampling unit (Platts et al., 1983). The length of each habitat unit (pool, riffle, run) was measured longitudinally as defined in Rosgen (1996). Within the boundaries of each sampling station, we visually estimated embeddedness, which measures sedimentation by determining the proportion of fine particles (e.g., silt and sand) surrounding larger particles (e.g., gravel, pebble, cobble and boulder) (Platts et al., 1983). Presence of riparian vegetation and surrounding land use were noted at each station.

Biotic Condition

The index of biotic integrity (IBI) applies ecological-based metrics to fish community data at each station to assess the overall environmental quality of a stream (Karr, 1981). The IBI is sensitive to physical habitat degradation (e.g., siltation, mining impacts, and municipal sewage) (Karr et al., 1986). Twelve metrics are used that incorporate native fish species composition, trophic structure, abundance, and condition (Table 3). We used the IBI first developed by Karr (1981), and later modified by the Tennessee Department of Health and Environmental Conservation (1996) for use in the Tennessee River drainage to calculate the IBI for Indian Creek. Because scoring criteria for metrics vary among regions, a criterion specifically developed for the Tennessee River drainage should be directly comparable to Indian Creek.

Most metrics are easy to interpret, but a brief explanation may provide helpful background information to some readers. Intolerant fishes are those species that cannot survive or reproduce in streams that are

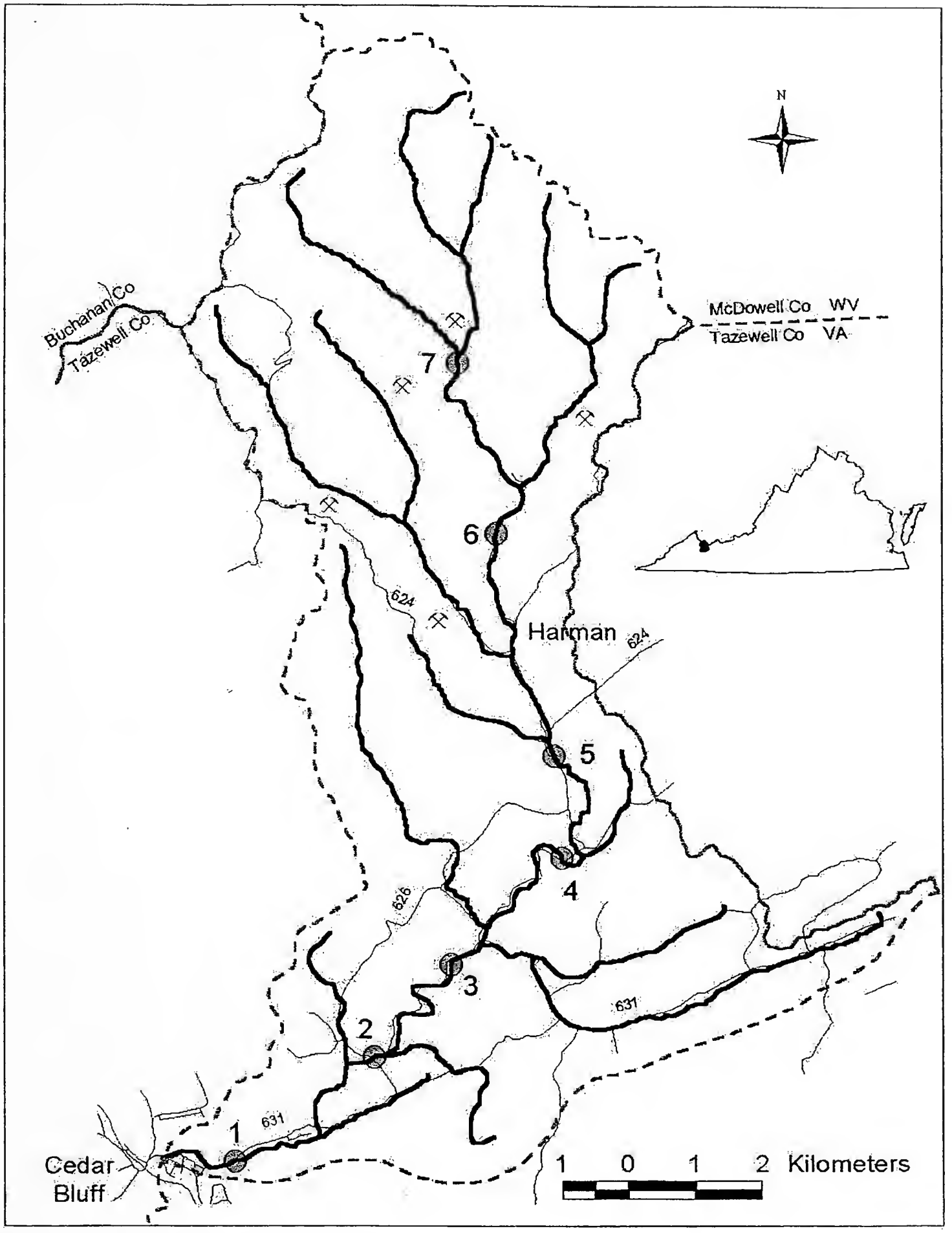

Fig. 1. Map of Indian Creek watershed, Tazewell County, Virginia. Each of the seven sampling stations is represented as circles. Proposed mine site is directly above station 7. Dashed line on the bottom of the map represents the approximate boundary between Indian Creek and mainstem Clinch River.

Table 1. Sampling stations on Indian Creek, Tazewell County, Virginia.

Site	River km above confluence	Nearby landmarks	Quadrangle	Sample date	Sample length (m)	Latitude/ Longitude	Basin area (ha)
1	0.8	From downstream side of Co. Rt. 631 bridge at Cedar Bluff to 50 m upstream above railroad bridge	Richlands	19 September 1996	180	37°05.16 N 81°45.32 W	8,624.7
2	4.4	From downstream side of Co. Rt. 626 bridge alongside Co. Rt. 630	Pounding Mill	19 September 1996	120	37°06.09 N 81°43.51 W	7,795.9
3	7.0	Alongside Co. Rt. 630 approximately 50 m downstream of railroad bridge	Pounding Mill	24 September 1996	100	37°06.54 N 81°43.05 W	7,303.8
4	10.1	Alongside Co. Rt. 627, 5 m above box culvert	Amonate	24 September 1996	100	37°07.46 N 81°41.58 W	4,972.8
5	13.2	50 m above Co. Rt. 627 bridge approximately 0.5 km from Co. Rt. 624 intersection	Amonate	20 September 1996	100	37°08.36 N 81°42.03 W	4,169.9
6	16.2	Approximately 0.75 km below confluence with Jackson Fork alongside Co. Rt. 628	Amonate	18 September 1996	100	37°10.23 N 81°42.40 W	2,590
7	19.7	100 m below confluence of South and North Branches alongside Co. Rt. 628	Amonate	18 September 1996	100	37°11.50 N 81°43.03 W	932.4

Table 2. Physical habitat characteristics of seven sites sampled on Indian Creek, Tazewell County, Virginia, September 18-24, 1996.

Variable	1	2	3	4	5	6	7
Average stream width (m)	10.5	6.76	6.45	6.60	6.27	4.8	5.5
Average stream depth (m)	0.30	0.20	0.16	0.13	0.12	0.12	0.16
Flow (m^3/sec)	0.12	0.15	0.06	0.05	0.05	0.02	0.01
Pool (%)	47	52	28	38	37	65	85
Riffle (%)	40	33	24	11	29	14	10
Run (%)	13	15	48	51	34	21	5
Embeddedness (%)[a]	30	50	30	35	40	40	90
Dominant substrate type	Bedrock	Bedrock	Cobble	Bedrock	Cobble	Boulder	Silt
Subdominant substrate type	Sand	Cobble	Gravel	Gravel	Boulder	Cobble	Cobble

[a] Visually estimated

significantly altered physically, chemically, or biologically. For example, an intolerant species such as the speckled darter (*Etheostoma stigmaeum*) is generally not found in heavily silted or highly eutrophic streams. In contrast, a tolerant species such as the white sucker (*Catostomus commersoni*) can be abundant in disturbed streams. Metrics are based on observed condition of an assessed site compared to an unimpaired stream within the same drainage, physiographic region, or both (Angermeier & Smogor, 1993). Because the number of species tends to increase with increased drainage area, metrics 1 through 5 were adjusted to account for the drainage area above a sampling station (Table 4). For station 7, which had a drainage area < 1,295 ha (5 mi^2), we used alternative headwater metrics for 2, 3, 4, 5, and 11 that account for the naturally low fish diversity found in high-elevation, headwater streams. These metrics include "number of riffle species," "number of pool species," "percentage composition by two most dominant species," and "percentage of fish as simple lithophilic spawners." Each metric is scored as 1-poor, 3-intermediate, or 5-high. Individual metric scores were then totaled to produce an overall IBI score for the site that was placed into one of the following integrity classes: 60-58 (Excellent), 52-48 (Good), 44-40 (Fair), 34-28 (Poor), and 22-12 (Very poor).

RESULTS

Species Composition and Distribution

A total of 1,970 individuals representing 33 species and 6 families was collected (Table 5). Cyprinidae and Percidae were the most speciose families with 15 species and 8 species, respectively. The most common species were the central stoneroller (*Campostoma anomalum*), Tennessee shiner (*Notropis leuciodus*), and northern hogsucker (*Hypentelium nigricans*). Fantail darter (*Etheostoma flabellare*) was the only species found at all stations. The rosyside dace (*Clinostomus funduloides*) was collected only at headwater stations 6 and 7, while spotfin shiner (*Cyprinella spiloptera*), banded darter (*Etheostoma zonale*), wounded darter (*Etheostoma vulneratum*), and bluegill (*Lepomis macrochirus*) were collected only near the mouth at station 1. Species richness ranged from 5 at station 7 to 25 at station 1. Stations 3 and 5 had the greatest fish abundance. Nearly 50% of fishes captured at station 5 were central stonerollers (*Campostoma anomalum*).

Biotic Condition

The IBI scores ranged from 48 (station 1) to 36 (stations 5 and 7) (Table 6). The native status and ecological condition of species collected is listed in Table 7. All collected species were considered native except redbreast sunfish (*Lepomis auritus*) and brown trout (*Salmo trutta*). Stations 2, 3, 4, and 6 scored "fair," station 1 scored "good," and stations 5 and 7 scored "fair/poor." Metrics for station 7 scored low for "number of riffle species," "number of intolerant species," and "percentage of piscivores" designating the integrity class between "fair" and "poor." In contrast, metrics for station 1 scored high for "number of species," "number of darters," "number of suckers," "number of intolerants," "percentage of tolerants," and "percentage of piscivores."

The metrics "number of species," "percentage of tolerants," and "percentage of specialized insectivores" scored moderate to high for all stations. Metrics for "number of sunfish species," "percentage of omnivores," and "catch rate" generally scored moderate or low for all stations except station 7, which scored high for "percentage of omnivores." The metrics "percentage of hybrids" and "percentage of anomalies" scored high at all sites indicating

Table 3. List of metrics used in calculating Index of Biotic Integrity for stations sampled on Indian Creek, Tazewell County, Virginia. Metrics are based on those developed by Karr (1981) and modified by the Tennessee Department of Health and Environmental Conservation (1996) for the Tennessee River drainage.

Metrics	Score 1	3	5
1. Number of native species	Expectations for metrics 1-5 vary with drainage area (See Table 4)		
2. Number of native darter species or Number of riffle species (headwater streams)			
3. Number of native sunfish (less *Micropterus* spp.) or Number of pool species (headwater streams)			
4. Number of native sucker species or Percentage composition by two most dominant species (headwater streams)			
5. Number of intolerant species or Number of headwater intolerant species (headwater streams)			
6. Percentage of tolerant species	> 20	20-10	< 10
7. Percentage of fish as omnivores and stoneroller species	> 30	30-15	< 15
8. Percentage of fish as specialized insectivores	< 25	25-50	> 50
9. Percentage of fish as piscivores	< 2	2-5	> 5
10. Catch rate (average number/300 ft^2 [28.7 m^2] or 5 minutes of boat shocking)*	< 16	16-32	> 32
11. Percentage of fish as hybrids or Percentage of fish as simple lithophilic spawners (headwater streams)	> 1	1-Tr**	0
12. Percentage of fish with disease, tumors, fin damage, and other anomalies	> 5	5-2	< 2

*Metric and criteria modified by the Tennessee Valley Authority
**Tr = value between 0 and 1%

Table 4. Scoring criteria of each sample station as a function of drainage area for species richness metrics used to assess biotic integrity in Indian Creek, Tazewell County, Virginia. HW streams = alternate metric used for headwater streams.

Metric	Site	1	3	5
Number of native fish species	1	< 12	12-22	> 22
	2	< 11	11-21	> 21
	3	< 11	11-21	> 21
	4	< 10	10-19	> 19
	5	< 10	10-18	> 18
	6	< 8	8-15	> 15
	7	< 5	5-9	> 9
Number of native darter species	1	< 3	3-4	> 4
	2	< 3	3-4	> 4
	3	< 3	3-4	> 4
	4	< 3	3-4	> 4
	5	< 2	2-3	> 3
	6	< 2	2-3	> 3
Number of riffle species (HW streams)	7	< 2	2	> 2
Number of native sunfish species	1	< 2	2	> 2
	2	< 2	2	> 2
	3	< 2	2	> 2
	4	< 2	2	> 2
	5	< 2	2	> 2
	6	< 2	2	> 2
Number of pool species (HW streams)	7	< 4	4-7	> 7
Number of native sucker species	1	< 2	2	> 2
	2	< 2	2	> 2
	3	< 2	2	> 2
	4	< 2	2	> 2
	5	< 2	2	> 2
	6	< 2	2	> 2
Percentage of two most dominant species (HW streams)	7	> 84	70-84	< 70
Number of intolerant species	1	< 2	2-3	> 3
	2	< 2	2-3	> 3
	3	< 2	2-3	> 3
	4	< 2	2-3	> 3
	5	< 2	2-3	> 3
	6	< 2	2	> 2
Number of headwater intolerant species (HW streams)	7	< 2	2-3	> 3

Table 5. Distribution and abundance of fishes collected in Indian Creek, Tazewell County, Virginia, September 1996.

Common name	Scientific name	Station 1	2	3	4	5	6	7	Total
Rosyside dace	*Clinostomus funduloides*	-	-	-	-	-	4	1	5
Blacknose dace	*Rhinichthys atratulus*	-	-	24	5	61	10	13	113
Central stoneroller	*Campostoma anomalum*	82	117	88	71	217	11	-	586
Creek chub	*Semotilus atromaculatus*	-	-	-	2	-	7	5	14
River chub	*Nocomis micropogon*	12	7	15	-	2	-	-	36
Bigeye chub	*Hybopsis amblops*	8	9	9	32	7	-	-	65
Whitetail shiner	*Cyprinella galactura*	16	7	4	16	-	-	-	43
Spotfin shiner	*Cyprinella spiloptera*	1	-	-	-	-	-	-	1
Warpaint shiner	*Luxilus coccogenis*	4	21	69	1	-	-	-	95
Striped shiner	*Luxilus chrysocephalus*	10	11	25	23	3	2	-	74
Mountain shiner	*Lythrurus lirus*	-	-	3	-	-	-	-	3
Tennessee shiner	*Notropis leuciodus*	7	19	73	1	53	-	-	153
Telescope shiner	*Notropis telescopus*	2	4	29	53	-	22	-	110
Sawfin shiner	*Notropis* sp.	1	1	-	3	-	-	-	5
Mirror shiner	*Notropis spectrunculus*	-	4	-	14	1	2	-	21
Bluntnose minnow	*Pimephales notatus*	12	5	35	26	18	16	-	112
Northern hogsucker	*Hypentelium nigricans*	45	13	14	26	18	2	-	118
Black redhorse	*Moxostoma duquesnei*	6	8	-	2	-	-	-	16
White sucker	*Catostomus commersoni*	1	-	-	3	-	11	4	19
Brown trout	*Salmo trutta*	-	-	-	-	-	1	-	1
Banded sculpin	*Cottus carolinae*	2	11	-	-	-	-	-	13
Rock bass	*Ambloplites rupestris*	20	11	12	10	8	10	-	71
Smallmouth bass	*Micropterus dolomieu*	9	3	2	2	4	2	-	22
Redbreast sunfish	*Lepomis auritus*	15	3	1	1	-	2	-	22
Bluegill	*Lepomis macrochirus*	3	-	-	-	-	-	-	3
Blotchside logperch	*Percina burtoni*	-	-	-	1	-	-	-	1
Greenside darter	*Etheostoma blennioides*	26	6	7	5	3	-	-	47
Banded darter	*Etheostoma zonale*	2	-	-	-	-	-	-	2
Snubnose darter	*Etheostoma simoterum*	10	3	7	11	28	10	-	69
Speckled darter	*Etheostoma stigmaeum*	3	-	10	3	1	2	-	19
Redline darter	*Etheostoma rufilineatum*	-	8	19	6	3	-	-	36
Wounded darter	*Etheostoma vulneratum*	3	-	-	-	-	-	-	3
Fantail darter	*Etheostoma flabellare*	2	3	6	9	29	19	4	72
Number of specimens		302	274	452	326	456	133	27	1970
Species richness		25	21	20	24	16	17	5	33

Table 6. Index of biotic integrity scores on stations sampled on Indian Creek, Tazewell County, Virginia. Metrics based on those developed by Karr (1981) and modified by the Tennessee Department of Health and Environmental Conservation (1996) for the Tennessee River drainage.

	Station						
Metrics	1	2	3	4	5	6	7
Number of native species	5	3	3	5	3	3	3
Number of native darter species	5	3	5	5	5	3	1*
Number of native sunfish species (less *Micropterus* spp.)	3	1	1	1	1	1	3*
Number of native sucker species	5	3	1	5	1	3	5*
Number of intolerant species	5	5	5	5	3	5	1*
Percentage of tolerant species	5	5	5	3	5	3	3
Percentage of individual fishes as omnivores and stonerollers	1	1	3	1	1	3	5
Percentage of individual fishes as specialized insectivores	3	3	5	5	3	5	3
Percentage of individual fishes as piscivores	5	5	3	1	3	5	1
Catch rate	1	1	3	1	1	1	1
Percentage of individual fishes as hybrids	5	5	5	5	5	5	5*
Percentage of individual fishes with disease, tumors, fin damage, and other anomalies	5	5	5	5	5	5	5
IBI total score	48	40	44	42	36	42	36
Integrity class	Good	Fair	Fair	Fair	Fair/ Poor	Fair	Fair/ Poor

*Calculated with metric for headwater streams

Table 7. Fish species collected in Indian Creek, Tazewell County, Virginia, with designations for native species, trophic guild, family group, and tolerance for the Tennessee River drainage. (HW Intolerant = Headwater Intolerant, used for stations with a drainage area < 1,295 ha [5 mi^2]. Spec. Insectivore = specialized insectivore). Native status and ecological information are presented by Pflieger (1975), Smith (1979), Lee et al. (1980), Etnier & Starnes (1993), and Jenkins & Burkhead (1994).

Species name	Native	Trophic guild	Family group	Tolerance
Clinostomus funduloides	Yes	Spec. Insectivore	Cyprinidae	Intolerant
Rhinichthys atratulus	Yes	Spec. Insectivore	Cyprinidae	----
Campostoma anomalum	Yes	Herbivore	Cyprinidae	----
Semotilus atromaculatus	Yes	Insectivore	Cyprinidae	Tolerant
Nocomis micropogon	Yes	Omnivore	Cyprinidae	----
Hybopsis amblops	Yes	Spec. Insectivore	Cyprinidae	HW Intolerant
Cyprinella galactura	Yes	Insectivore	Cyrpinidae	----
Cyprinella spiloptera	Yes	Insectivore	Cyprinidae	Tolerant
Luxilus coccogenis	Yes	Spec. Insectivore	Cyprinidae	HW Intolerant
Luxilus chrysocephalus	Yes	Omnivore	Cyprinidae	Tolerant
Lythrurus lirus	Yes	Spec. Insectivore	Cyprinidae	HW Intolerant
Notropis leuciodus	Yes	Spec. Insectivore	Cyprinidae	HW Intolerant
Notropis telescopus	Yes	Spec. Insectivore	Cyprinidae	Intolerant
Notropis sp.	Yes	Spec. Insectivore	Cyprinidae	HW Intolerant
Notropis spectrunculus	Yes	Spec. Insectivore	Cyprinidae	----
Pimephales notatus	Yes	Omnivore	Cyprinidae	----
Hypentelium nigricans	Yes	Insectivore	Catostomidae	HW Intolerant
Moxostoma duquesnei	Yes	Insectivore	Catostomidae	Intolerant
Catostomus commersoni	Yes	Omnivore	Catostomidae	Tolerant
Salmo trutta	No	Piscivore	Salmonidae	----
Cottus carolinae	Yes	Insectivore	Cottidae	----
Ambloplites rupestris	Yes	Piscivore	Centrarchidae	Intolerant
Micropterus dolomieu	Yes	Piscivore	Centrarchidae	----
Lepomis auritus	No	Insectivore	Centrarchidae	----
Lepomis macrochirus	Yes	Insectivore	Centrarchidae	----
Percina burtoni	Yes	Spec. Insectivore	Percidae	----
Etheostoma blennioides	Yes	Spec. Insectivore	Percidae	----
Etheostoma zonale	Yes	Spec.Insectivore	Percidae	----
Etheostoma simoterum	Yes	Spec. Insectivore	Percidae	----
Etheostoma stigmaeum	Yes	Spec. Insectivore	Percidae	Intolerant
Etheostoma rufilineatum	Yes	Spec. Insectivore	Percidae	----
Etheostoma vulneratum	Yes	Spec. Insectivore	Percidae	----
Etheostoma flabellare	Yes	Spec. Insectivore	Percidae	Intolerant

a low incidence of hybridization and anomalies. We found that <1% of fishes had blackspot, a nonlethal trematode infection that appears as dark specks on the fins and body (Post, 1987).

DISCUSSION

Indian Creek, containing 35 indigenous species, has one of the most diverse fish communities in the Clinch River drainage. Among Clinch River tributaries in Virginia, Indian Creek ranks third behind Little River with 42 species and Copper Creek with 63 species (Jenkins & Burkhead, 1994). Most species collected in our survey were the same as those in earlier sampling efforts by Masnik (1974), Angermeier & Smogor (1993), and Jenkins & Burkhead (1994). However, species not collected by us include gizzard shad (*Dorosoma cepedianum*) and mountain brook lamprey (*Ichthyomyzon greeleyi*) (Masnik, 1974); golden redhorse (*Moxostoma erythrurum*) (Angermeier & Smogor, 1993); and Clinch sculpin (*Cottus* sp.) and largemouth bass (*Micropterus salmoides*) (Jenkins & Burkhead, 1994). Our collections of blotchside logperch (*Percina burtoni*), wounded darter (*Etheostoma vulneratum*), and rosyside dace (*Clinostomus funduloides*) represent additions to the species known from Indian Creek.

Non-native species from Indian Creek include rainbow trout (*Onchoryncus mykiss*), (Jenkins & Burkhead, 1994), redbreast sunfish (*Lepomis auritus*) (Angermeier & Smogor, 1993), and brown trout (*Salmo trutta*) (this study). Because the Virginia Department of Game and Inland Fisheries has never stocked Indian Creek or permitted stocking by private citizens, the presence of salmonids is probably the result of illegal stocking, escapees from privately-owned ponds, or recruits from nearby streams. Our sampling indicates that redbreast sunfish are now well established throughout Indian Creek. Redbreast sunfish have been widespread in the upper Tennessee drainage since 1975 (Jenkins & Burkhead, 1994). The first record of this species in Indian Creek was reported in Angermeier & Smogor (1993). Of the two *Lepomis* species native to the upper Tennessee drainage, the longeared sunfish (*L. megalotis*) and bluegill (*L. macrochirus*), we only collected the latter.

Several rare fishes occur in Indian Creek. The mirror shiner (*Notropis spectrunculus*) has special concern status in Virginia and is known from only a few tributaries in the Powell, Clinch, and Holston rivers in Virginia (Jenkins & Burkhead, 1994). Masnik (1974) reported mirror shiners in most of his samples from Indian Creek, but Jenkins & Burkhead (1994) later reidentified several of his specimens as sawfin shiners (*Notropis* sp.). Our collection of mirror shiner and those of Angermeier & Smogor (1993) indicate that this species continues to persist in Indian Creek. The blotchside logperch (*P. burtoni*) is endemic to the upper Tennessee drainage and listed in Virginia as a species of special concern. It is known from a few sections of the North Fork Holston and Clinch rivers and tributaries (Jenkins & Burkhead, 1994). The presence of a blotchside logperch in a small system like Indian Creek is unusual for a species that typically populates medium to large streams and small rivers. Our record represents the furthest documented upstream collection of this species in the Clinch River drainage.

Our biotic assessment indicates that Indian Creek is in "fair" condition with portions "good" near the mouth and "fair/poor" at the headwaters. Sources of degradation at the headwaters are likely due to siltation caused by poorly maintained access roads that parallel and cross the creek, as well as the lack of riparian vegetation. High siltation levels have a negative effect on riffle, darter, and intolerant species that require clean substrate to reproduce and feed. Central stonerollers are herbivorous fish that were abundant at stations 1 to 5. This occurrence level decreased scoring for the metric "percentage of fishes as omnivores and stonerollers." Nutrient enrich-ment due to agriculture, and the opening of streamside canopy to sunlight may increase stoneroller numbers by providing an abundance of an algal food source.

Previously, Angermeier & Smogor (1993) assessed Indian Creek as "good" in 1991 and 1992. They surveyed one site that was nearest to our station 3. Our score of 44 was lower than their score of 50 in 1991 and 54 in 1992. Although Karr et al. (1986) indicate that total IBI scores should differ four points before a change in site quality can exist, we believe that these differences can be explained by sampling methods, metric descriptions, and scoring. For example, Angermeier & Smogor (1993) sampled a 500 m section and used a more efficient electric seine compared to our 100 m section and backpack shockers. Their metrics tended to score higher for "percentage of tolerant species" and "percentage of piscivores." Additionally, their metric "number of native sunfish species" included smallmouth bass whereas our metric excluded *Micropterus* sp. Because we found smallmouth bass (*Micropterus dolomieu*) at all stations except the headwaters, our exclusion of this species lowered our metric score. Finally, the numerical range of each integrity classes (i.e., excellent, fair, poor) in Angermeier & Smogor (1993) tended to be two and four points lower than that of our classification. The result of this scoring would be higher classification for their sites even if our sites had the same final IBI score.

The importance of tributaries to the overall health of the Clinch River fauna cannot be overemphasized. Resource managers have recognized tributaries as important refugia during catastrophic events and a source of recolonization thereafter in the Clinch River. In 1967 and 1973, fly ash

accidents from the APCO plant in Carbo, Virginia killed thousands of fish for over 126 rkm. Fish populations in Copper Creek are thought to be responsible for re-establishment of many species in the Clinch River (Jenkins & Burkhead, 1994). Tributaries also serve as nursery areas for early life stages of many fish species and source populations of endangered mussels (Winston & Neves, 1997). Protecting water quality in tributaries like Indian Creek is critical to maintaining the biological health of the Clinch River.

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A Floristic Survey of Appomattox Court House National Historical Park, Appomattox County, Virginia

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INTRODUCTION

Appomattox Court House National Historical Park encompasses approximately 688 ha of rolling Central Piedmont terrain in Appomattox County, Virginia. According to Godfrey's (1980) field guide, the Central Piedmont is comprised of "... cropland and ... herding enterprises, but is principally a forested landscape." Most forests here are post-agricultural and seral. Godfrey (1980) characterizes these as "pine, mixed pine-deciduous, or maturing deciduous woodlots." This is an accurate description of the landscape within the Park, as some fields are cropland and some are pasture, but more area is forested today than was forested in approximately 1917 (Gemborys & Lund, 1992) and likely more than at the time of the surrender of the Confederate Army over 130 years ago. According to Montgomery (1992), wooded areas have been encouraged on the boundaries in an effort to block out modern life. Other conspicuous features of the Park are three roadways, Virginia Route 24 and county routes 627 and 656, and Plain Run Branch and Scotts Branch that join to form the Appomattox River within the Park boundaries.

The present study addresses a need of the National Park Service, and of Appomattox Court House National Historical Park, in particular, expressed in the *Partners in Research* (1989): "Many of these Mid-Atlantic Regional parks face complex environmental, visitor-use, and cultural resource management problems, such as rapid declines in native wildlife populations, significant vegetation changes..." The publication continues in discussing the need for appropriate documentation of natural resources. The main purpose of this paper is to document the vascular flora of the Park. Such a flora offers opportunities to monitor vegetation response to management and to assess a probable ethnobotanical role in the present composition. Additionally, a floristic survey fills gaps in our knowledge of plant distributions and can help direct biological diversity conservation efforts.

MATERIALS AND METHODS

From 1990 through 1996, on scattered days throughout the growing seasons, vascular plant specimens were collected from several sites within the Park. An unpublished thesis, submitted to Virginia Polytechnic Institute and State University by Hamilton (1985), was used as a guide to the park boundaries and forested areas, with forest compartment numbers from the thesis serving as designations for most of the collection sites. Also, a map obtained from the Park with pasture and croplands marked was useful in assessing recent land-use history. Plant communities investigated included: grazed upland mixed woodlot, pasture, unfenced meadow that is sporadically mowed, open and shaded roadside, mixed forest and trail edge, periodically-mowed power-line right-of-way, hedge-row, crop land, and river's edge. Specimens were collected from the sites, field notes were made to aid identification, and the specimens were pressed for later identification or verification.

After a plant was identified or verified from the pressed specimen, the taxon was added to the list. In addition, the following information is being recorded for each specimen in a database: specimen number, scientific name, authority, family, common name (if one exists), specific location within the park, collector, identifier or verifier, habitat, date collected, origin, and ethnobotanical significance. (The recording of this information continues for the species listed in this paper.) The information is on file in the Hampden-Sydney College Biology Department, and a hard copy of the species list is available at the Park. Voucher specimens have been filed at Hampden-Sydney College, as the Park has no appropriate facility for housing herbarium specimens. The list of the species identified as occurring within the Park is on file with the Virginia Department of Conservation and Recreation, Division of Natural Heritage. Nomenclature and designation of native or exotic status are according to *Atlas of the Virginia Flora III* (Harvill et al., 1992), except in a few instances where Fernald (1950) and Hitchcock (1971) were used. In this paper, families, genera, and species are given for each specimen. An asterisk at the binomial denotes county record species.

RESULTS AND DISCUSSION

Appendix 1 includes all known vascular plant taxa recorded for the Park. The list includes 327 species from 72 families. There are 52 new county records, determined by the absence of Appomattox County designations for those taxa in Harvill et al. (1992). These county records fill gaps in our knowledge of Virginia phytogeography, and suggest that the Central Piedmont has been under-botanized. One taxon, *Asclepias purpurascens* L., included here is on the state's rare plant list (Killeffer, 1999). It should be noted that this milkweed species is one of the new county records.

Any flora is dynamic, with species entering and leaving depending on conditions. The exotic component of this flora is 19 to 20 %. This is close to the upper estimation of exotic flora for the state, as the Virginia Division of Natural Heritage estimates the state's flora is between 15 to 20+ % non-native, depending on which non-natives are considered part of the established flora (Virginia Department of Conservation and Recreation, Division of Natural Heritage, unpublished data). The maintenance of fields, pastures, rights-of-way, lawns, and early successional thickets will likely perpetuate the exotic component of the flora, as well as many of the native grasses and forbs which depend on such conditions. If the land management regime of the Park is significantly changed in the future, shifts in the composition of the flora are to be expected. With the present flora serving as a baseline, these future shifts in composition might then be detected, and the ecological effects of various land management practices more fully understood.

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Appendix 1

FLORA OF APPOMATTOX COURT HOUSE NATIONAL HISTORICAL PARK

* denotes new county record (Harvill et al., 1992)

Lycopodiaceae
Lycopodium digitatum A. Braun

Ophioglossaceae
Botrychium virginianum (L.) Swartz

Aspidiaceae
Athyrium aspleniodes (Michaux) A. A. Eaton
Onoclea sensibilis L.
Polystichum acrostichoides (Michaux) Schott

Pinaceae
Pinus echinata Miller
Pinus virginiana Miller
Tsuga canadensis (L.) Carr

Cupressaceae
Juniperus virginiana L.

Alismataceae
Alisma subcordatum Raf.

Poaceae
Andropogon virginicus L.
Aristida dichotoma Michaux
Arthraxon hispidus (Thunb.) Makino var. *cryptatherus* (Hackel) Honda
Avena sativa L.
Bromus japonicus Thunb. (*B. arvensis* L.)
Dichanthelium boscii (Poiret) G. & C.
* *Dichanthelium clandestinum* (L.) Gould
Dichanthelium commutatum (Schultes) Gould
Dichantelium dichotomum (L.) Gould
* *Dichanthelium scoparium* (Lam.) Gould
Elymus riparius Wiegand
Eragrostis spectabilis (Pursh) Steudel
Festuca elatior L.
Glyceria striata (Lam.) Hitchcock
Hystrix patula Moench

Poaceae (continued)
Microstegium vimineum (Trinius) A. Camus
Panicum anceps Michaux
* *Paspalum floridanum* Michaux
* *Paspalum laeve* Michaux
Phleum pratense L.
Poa compressa L.
* *Setaria faberii* W. Hermann
* *Setaria lutescens* (Weigel) Hubb. (*S. glauca* (L.) Beauvois)
Sorghum halepense (L.) Persoon
Sorghastrum nutans (L.) Nash
Tridens flavus (L.) Hitchcock
Tripsacum dactyloides (L.) L.

Cyperaceae
* *Carex caroliniana* Schweinitz
* *Carex cephalophora* Willdenow
Carex crinita Lam.
Carex frankii Kunth
* *Carex laevivaginata* (Kukenthal) Mackenzie
* *Carex laxiflora* Lam.
Carex lurida Wahlenberg
Carex pensylvanica Lam.
Carex scoparia Willdenow
Carex squarrosa L.
* *Carex swanii* (Fernald) Mackenzie
Cyperus ovularis (Michaux) Torrey
* *Cyperus pseudovegetus* Steudel
* *Cyperus retrofractus* (L.) Torrey
* *Eleocharis obtusa* (Willdenow) Schultes
Eleocharis tenuis (Willdenow) Schultes
Scirpus atrovirens Willdenow
* *Scirpus validus* Vahl
* *Scleria pauciflora* Willdenow

Araceae
Arisaema triphyllum (L.) Schott

Commelinaceae
* *Commelina communis* L.

Juncaceae
Juncus dichotomus Ell.
Juncus effusus L.
Juncus tenuis Willdenow

Liliaceae
Allium vineale L.
Hemerocallis fulva (L.) L.
Muscari racemosum (L.) Miller
Polygonatum biflorum (Walter) Ell.
Smilacina racemosa (L.) Desf.
Smilax glauca Walter
Smilax rotundifolia L.
Uvularia perfoliata L.

Amaryllidaceae
Hypoxis hirsuta (L.) Coville

Iridaceae
Sisyrinchium angustifolium Miller

Orchidaceae
Goodyera pubescens (Willdenow) R. Brown
Spiranthes gracilis (Bigelow) Beck
Spiranthes grayi Ames

Juglandaceae
Carya glabra (Miller) Sweet
Carya ovalis (Wang) Sargent
* *Carya ovata* (Miller) K. Koch
Carya tomentosa (Poiret) Nuttall
Juglans nigra L.

Betulaceae
Carpinus caroliniana Walter
Alnus serrulata (Aiton) Willdenow

Fagaceae
Fagus grandifolia Ehrhart
Quercus alba L.
Quercus falcata Michaux
Quercus marilandica Muenchh
Quercus prinus L.
Quercus phellos L.
Quercus stellata Wang.

Ulmaceae
Ulmus americana L.

Moraceae
Morus rubra L.

Urticaceae
Boehmeria cylindrica (L.) Swartz
* *Urtica dioica* L.

Aristolochiaceae
* *Aristolochia serpentaria* L.

Polygonaceae
Polygonum cespitosum Blume
Polygonum persicaria L.
Polygonum sagittatum L.
Rumex acetosella L.
Rumex crispus L.
Rumex patientia L.

Phytolaccaceae
Phytolacca americana L.

Caryophyllaceae
Cerastium fontanum Baumg.
Cerastium glomeratum Thuillier
Dianthus armeria L. (Aiton) Willdenow
Silene antirrhina L.
Stellaria media (L.) Cyrillo

Ranunculaceae
Anemone virginiana L.
Clematis ochroleuca Aiton
Ranunculus bulbosus L.
Thalictrum pubescens Pursh

Berberidaceae
Podophyllum peltatum L.

Lauraceae
Sassafras albidum (Nuttall) Nees

Brassicaceae
Barbarea vulgaris R. Brown
Brassica rapa L.
Cardamine hirsuta L.
Lepidium campestre (L.) R. Brown
* *Teesdalia nudicaulis* (L.) R. Brown

Platanaceae
Platanus occidentalis L.

Rosaceae
Agrimonia parviflora Aiton
Duchesnia indica (Andrz.) Focke
Fragaria virginiana Duchesne
Geum canadense Jacquin
* *Potentilla canadensis* L.
Potentilla recta L.

Rosaceae (continued)
Prunus serotina Ehrhart
Rosa carolina L.
* *Rosa palustris* Marshall
* *Rubus allegheniensis* Porter
Rubus occidentalis L.

Linaceae
* *Linum virginianum* L.

Fabaceae
Albizia julibrissin Durazzini
Amphicarpa bracteata (L.) Fernald
Baptisia tinctoria (L.) R. Brown
Cassia fasciculata Michaux
Cassia nictitans L.
Cercis canadensis L.
Coronilla varia L.
Desmodium canescens (L.) DC.
Desmodium glutinosum (Willdenow) Wood
* *Desmodium laevigatum* (Nuttall) DC.
* *Desmodium marilandicum* (L.) DC.
Desmodium nudiflorum (L.) DC.
* *Desmodium obtusum* (Willdenow) DC.
* *Desmodium paniculatum* (L.) DC.
Desmodium rotundifolium DC.
Desmodium viridiflorum (L.) DC.
Gleditsia triacanthos L.
Lespedeza cuneata (Dumont) G. Don
* *Lespedeza intermedia* (Watson) Britton
Lespedeza procumbens Michaux
* *Lespedeza repens* (L.) Barton
Lespedeza stipulacea Maxim.
Lespedeza virginica (L.) Britton
Melilotus alba Desr.
Robinia pseudo-acacia L.
Strophostyles umbellata (Willdenow) Britton
Stylosanthes biflora (L.) BSP.
Tephrosia virginiana (L.) Persoon
Trifolium arvense L.
Trifolium campestre Schreber
Trifolium dubium Sibthorp
Trifolium pratense L.
Trifolium repens L.
Vicia caroliniana Walter
Vicia dasycarpa Tenore
Vicia sativa L. (*V. angustifolia* L.)
Vicia villosa Roth

Oxalidaceae
Oxalis dillenii L.
Oxalis stricta L.

Geraniaceae
* *Geranium dissectum* L.

Simaroubaceae
Ailanthus altissima (Miller) Swingle

Polygalaceae
Polygala verticillata L.

Euphorbiaceae
Acalypha rhomboidea Raf.
Euphorbia corollata L.
Euphorbia cyparissias L.
Euphorbia maculata L.

Anacardiaceae
Rhus copallina L.
Rhus glabra L.

Aquifoliaceae
Ilex opaca Aiton

Celastraceae
Euonymus americanus L.

Aceraceae
Acer negundo L.
Acer rubrum L.

Balsaminaceae
Impatiens capensis Meerb.

Rhamnaceae
Ceanothus americanus L.

Vitaceae
Parthenocissus quinquefolia (L.) Planchon
Vitis labrusca L.
* *Vitis rotundifolia* Michaux

Hypericaceae
Hypericum gentianoides (L.) BSP.
Hypericum hypericoides (L.) Crantz
Hypericum mutilum L.
Hypericum punctatum Lam.

Cistaceae
* *Helianthemum canadense* (L.) Michaux
Lechea sp.

Violaceae
Viola palmata L.
Viola papilionacea Pursh
Viola rafinesquii Greene

Lythraceae
Cuphea viscosissima Jacquin

Onagraceae
Ludwigia alternifolia L.
Ludwigia palustris (L.) Elliott
Oenothera fruticosa L. ssp. *glauca* (Michaux) Straley

Apiaceae
Daucus carota L.
Sanicula canadensis L.
Thaspium trifoliatum (L.) Gray

Nyssaceae
Nyssa sylvatica Marshall

Cornaceae
Cornus florida L.

Ericaceae
Chimaphila maculata (L.) Pursh
Vaccinium pallidum Aiton
Vaccinium stamineum L.

Primulaceae
* *Anagallis arvensis* L.
Lysimachia ciliata L.

Oleaceae
Fraxinus americana L.
* *Fraxinus pennsylvanica* Marshall
Ligustrum sp.

Gentianaceae
Sabatia angularis (L.) Pursh

Apocynaceae
Apocynum cannabinum L.

Asclepiadaceae
Asclepias amplexicaulis Smith
* *Asclepias purpurascens* L.
Ascelpias syriaca L.
Asclepias tuberosa L.
Asclepias viridiflora Raf.
Cynanchum laeve (Michaux) Persoon

Convolvulaceae
Calystegia sepium (L.) R. Brown
Convolvulus arvensis L.
* *Ipomoea hederacea* (L.) Jacquin
Ipomoea pandurata (L.) G. F. W. Meyer
Ipomoea purpurea (L.) Roth

Boraginaceae
Lithospermum arvense L.
* *Myosotis macrosperma* Engelm.

Verbenaceae
Verbena simplex Lehmann
Verbena urticifolia L.

Phrymaceae
Phryma leptostachya L.

Lamiaceae
Hedeoma pulegioides (L.) Persoon
Lamium amplexicaule K.
Lycopus americanus Barton
Lycopus virginicus L.
Perilla frutescens (L.) Britton
Prunella vulgaris L.
Pycnanthemum sp.
Pycnanthemum incanum (L.) Michaux
Pycnanthemum tenuifolium Schrader
Salvia lyrata L.
Satureja vulgaris (L.) Fritsch
Scutellaria elliptica Muhl.
Scutellaria integrifolia L.

Solanaceae
Solanum carolinense L.

Scrophulariaceae
Agalinis fasciculata (Elliott) Raf.
* *Agalinis tenuifolia* (Vahl) Raf.
Aureolaria virginica (L.) Pennell
Mimulus ringens L.
Paulownia tomentosa (Thunberg) Steudel
Verbascum blattaria L.
Veronica hederaefolia L.
* *Veronica officinalis* L.

Acanthaceae
Ruellia caroliniensis (Walter) Steudel

Plantaginaceae
Plantago aristata Michaux
Plantago lanceolata L.
Plantago rugelii Duchnesne

Rubiaceae
Cephalanthus occidentalis L.
* *Diodia virginiana* L.
Galium circaezans Michaux
Galium pilosum Aiton
* *Galium parisiense* L.
Galium tinctorium L.

Rubiaceae (continued)
* *Galium triflorum* Michaux
Houstonia pusilla Schoefp.
Houstonia purpurea L.

Caprifoliaceae
Lonicera japonica Thunberg
Sambucus canadensis L.
Symphoricarpos orbiculatus Moench
Viburnum sp.

Campanulaceae
Lobelia inflata L.
Lobelia siphilitica L.
Specularia perfoliata (L.) A. DC.

Asteraceae
Achillea millefolium L.
* *Ageratina altissima* (L.) K. & R.
Ambrosia artemisiifolia L.
Ambrosia trifida L.
Aster divaricatus L.
Aster dumosus L.
Aster pilosus Willdenow
Bidens bipinnata L.
Bidens frondosa L.
Centaurea maculosa Lam.
Chrysanthemum leucanthemum L.
Cichorium intybus L.
* *Cirsium arvense* (L.) Scopoli
Cirsium discolor (Willdenow) Spengel
Coreopsis verticillata L.
Eclipta alba (L.) Hasskarl
Elephantopus carolinianus Raeusch
Erigeron annuus (L.) Persoon
Erigeron canadensis L.
* *Erigeron philadelphicus* L.

Asteraceae (continued)
Erigeron strigosus Muhl. ex Willdenow
Eupatorium coelestinum L.
Eupatorium fistulosum Barratt
Eupatorium godfreyanum Cronq.
Eupatorium hyssopifolium L.
Gnaphalium purpureum L.
Gnaphalium obtusifolium L.
* *Helianthus strumosus* L.
Heterotheca mariana (L.) Shinners
Hieracium caespitosum Dumort
Hieracium pilosella L.
* *Hieracium scabrum* Michaux
Hieracium venosum L.
Krigia virginica (L.) Willdenow
* *Kuhnia eupatorioides* L.
Lactuca saligna L.
Liatris squarrosa (L.) Michaux
Mikania scandens (L.) Willdenow
Parthenium integrifolium L.
Pyrrhopappus carolinianus (Walter) DC.
Rudbeckia hirta L.
Senecio anonymus Wood
Sericocarpus asteroides (L.) BSP.
Silphium trifoliatum L.
Solidago canadensis L.
Solidago juncea Aiton
Solidago nemoralis Aiton
* *Solidago rugosa* Miller
Solidago sp.
Solidago speciosa Nuttall
Taraxacum erythrospermum Andrz. ex Besser
* *Verbesina alternifolia* (L.) Britton ex Kearney
Verbesina occidentalis (L.) Walter
Vernonia glauca (L.) Willdenow
Vernonia noveboracensis (L.) Michaux

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Notes on Amphibians and Reptiles in Riparian and Upland Habitats on Fort A. P. Hill, Virginia

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INTRODUCTION

Riparian habitats are used extensively by amphibians and reptiles in North America (Rudolph & Dickson, 1990; Pauley et al., 2000) and act as dispersal corridors for some species (Harris, 1984; Naiman et al., 1993). Most of the research conducted on the ecology of these groups in riparian ecosystems has occurred in the Midwest (Burbrink et al., 1998) and the Pacific Northwest (e.g., Brode & Bury, 1984; McComb et al., 1993; Gomez & Anthony, 1996). Comparatively little has been conducted in eastern North America. Pauley et al. (2000) found only three studies that evaluated differences in herpetofaunal assemblages between riparian and upland habitats in the East. These studies suggest that riparian habitats are important components in conservation and management of amphibian and reptile diversity in regional landscapes.

The purpose of our study was to compare amphibian and reptile assemblages between riparian and adjacent upland habitats in a forested ecosystem in the Upper Coastal Plain of Virginia. We hypothesized that herpetofaunal species richness and relative abundance would be higher in riparian habitats. Because a diverse array of forested habitats, a network of streams, and topographic relief occur on Fort A.P. Hill, this kind of study was deemed feasible in the upper Coastal Plain.

MATERIALS AND METHODS

Fort A. P. Hill, Caroline County, Virginia, is a 30,329 ha military training installation located in the Coastal Plain physiographic province. Descriptions of the environment and habitats of this installation are in Mitchell & Roble (1998), Bellows (1999), and Bellows & Mitchell (2000).

We selected fourteen sites for study - 7 in riparian habitats and 7 in upland habitats. Riparian sites were located on the floodplains of seven different streams. Each of the 7 upland sites was located 150-250 m from the adjacent riparian site. Two of the pairs of sites were located in the Mattaponi River watershed and the remainder were located in the Rappahannock River watershed. The latter offered greater topographic relief than the former. Bellows & Mitchell (2000) provided qualitative descriptions of the 14 study sites in their report on small mammals in these habitats on Fort A.P. Hill.

We assessed habitat variables by a line-intercept method using eight equally spaced 25 m transects that radiated from the center of each study site. Variables were recorded at one-meter intervals (total each site = 200) and included presence or absence of downed woody debris (DWD). Diameter of DWD encountered in transects was measured to the nearest cm. Percent canopy closure was estimated visually over each transect point by viewing the canopy through a cardboard tube (4.5 cm diameter, 11.5 cm length).

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We used drift fences with pitfall traps to sample amphibians in an area approximately 30 m in diameter within each study site. We constructed three pitfall arrays approximately 120° apart and 15 m from the center of each study site (see Figure 1 in Bellows et al., 1999). We made drift fences with black fiber silt fencing 61 cm high and one m in length, and used plastic 3.8-l buckets (18 cm diameter x 19 cm height) for the center pitfalls. We used plastic 2-l soda bottles with the tops cut off (11 cm diameter x 20 cm height) for the peripheral pitfalls; one 2-l bottle was placed on each side of the distal end of all three drift fences. There was a total of seven pitfalls per array.

We conducted 12 four-day trapping sessions every 12-16 days from 9 April through 12 October 1998 and a mid-winter trapping session from 21 to 24 January 1999 for a total of 5,854 trap nights. Flooded pitfall traps were considered non-functional and were subtracted from the total effort. We released all captured individuals following identification in the field.

Site Descriptions

Overstory trees in riparian sites consisted primarily of hardwoods (e.g., red maple [*Acer rubrum*], sycamore [*Platanus occidentalis*], American beech [*Fagus grandifolia*]). Loblolly pine (*Pinus taeda*) was the only gymnosperm observed and only in low numbers. Understory trees were represented by saplings of overstory species and, for example, American holly (*Ilex opaca*) and flowering dogwood (*Cornus florida*). Frequency of DWD in riparian sites varied from 8.5% to 21.0% and mean diameter of DWD varied from 4.5 cm to 20.6 cm. Mean canopy closure varied from 72.8% to 85.7%.

Overstory trees in upland sites included white oak (*Quercus alba*), southern red oak (*Q. falcata*), pignut hickory (*Carya glabra*), tuliptree (*Liriodendron tulipifera*), loblolly pine, and Virginia pine (*P. virginiana*). Understory trees were similar to those in riparian sites. Frequency of DWD was 8.5-13.0% and mean diameter of DWD was 5.1- 24.0 cm. Mean canopy closure varied from 54.7% to 85.0%.

Neither average DWD occurrence frequencies (t-test = 1.78, P = 0.0997) nor mean diameters of DWD (t = 0.111, P = 0.9136) were significantly different between riparian and upland habitats. Mean canopy closure was not significantly different between the two habitat types (t = 0.443, P = 0.666).

RESULTS AND DISCUSSION

A total of six species of frogs and five species of salamanders was captured; 30 individuals total (Table 1). There were twice as many species of frogs caught in riparian habitats as upland habitats and about twice as many individuals. Five species of salamanders were captured in riparian habitats compared to three species in upland habitats. Numbers of individuals captured were nearly equal (9 in riparian sites, 12 in upland sites). Average amphibian species richness per riparian site was 1.6 ± 1.9 (0-5) and average species richness per upland site was 1.0 ± 1.2 (0-3). Average number of captures (2.1) was identical between sites. Similarity of capture rates among sites may have been a function of their close proximity, well within the home ranges and dispersal distances of many of the species captured (Pauley et al., 2000).

One eastern box turtle (*Terrapene carolina*), one eastern mud turtle (*Kinosternon subrubrum*), and one black racer (*Coluber constrictor*) not captured in traps were also observed in riparian habitats. Two box turtles were observed in one upland site. Two five-lined skinks (*Eumeces fasciatus*) were captured in a single riparian site and one eastern worm snake (*Carphophis*

Table 1. Amphibian and reptile captures in riparian and upland habitats April 1998 to January 1999 on Fort A.P. Hill, Virginia.

Species	Riparian	Upland	Total
Frogs			
Bufo americanus	0	2	2
Bufo fowleri	2	0	2
Rana clamitans	2	0	2
Rana palustris	1	0	1
Rana sylvatica	1	0	1
Scaphiopus holbrookii	0	1	1
Number of frog species	4	2	6
Salamanders			
Ambystoma opacum	4	1	5
Eurycea guttolineata	1	0	1
Notophthalmus viridescens	1	1	2
Plethodon cinereus	2	10	12
Plethodon cylindraceus	1	0	1
No. of salamander species	5	3	5
Total number of captures	15	15	30
Total amphibian species	9	5	11

amoenus) was captured in an upland habitat. Overall herpetofaunal species diversity was low compared to the known species richness of Fort A.P. Hill (Mitchell & Roble, 1998) and the Coastal Plain of Virginia (Mitchell & Reay, 1999).

The low numbers of amphibians and reptiles captured in this study was likely a function of the size of the drift fences and pitfall traps and the drought that occurred during 1998. Large pitfall traps (e.g., 19 1 buckets) with large drift fences capture many more terrestrial amphibians and reptiles than small pitfalls like those used in this study (Mitchell et al., 1993, 1997). Rainfall amounts were at drought levels in 1998, averaging 17% below normal for the trapping period (Bellows & Mitchell, 2000). Amphibians and reptiles are active and disperse much more readily during rainfall events than when surface conditions are dry (Stebbins & Cohen, 1995; JCM unpublished). There were few opportunities to disperse during our study year, especially in late spring and summer months. Thus, a combination of factors contributed to the low sample sizes.

Although riparian habitats should offer moist microhabitats on a more consistent basis than upland sites, our hypothesis that herpetofaunal species richness and relative abundance would be higher in this habitat type than in upland habitats was not supported by our results. This result is similar to that for small mammals in these habitats (Bellows & Mitchell, 2000). They concluded with larger sample sizes that both upland and riparian habitats were important to the small mammal fauna on Fort A.P. Hill. Elucidation of amphibian and reptile distributions between riparian and upland habitats in the upper Coastal Plain of Virginia requires more effective sampling methods than that used here. Such methods used in non-drought conditions may yield different results. However, the relatively low topographic relief in this area may not provide sufficient microgeographic variation in habitats to segregate amphibian and reptile species or populations. Other environmental variables, such as forest cover type and proximity of wetlands, may be more important in determining distribution patterns of these vertebrates on Fort A.P. Hill.

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Amphibian and Reptile Diversity of a Threatened Natural Area in Central Virginia

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INTRODUCTION

The political boundaries of Virginia encompass a wide variety of habitats that support rich vertebrate faunas. Some of these habitats have been studied thoroughly (e.g., Dismal Swamp, Shenandoah Valley sinkhole ponds, Shenandoah National Park), but others have been studied only marginally or not at all. Despite the fact that biological investigations of Virginia started in the late 1600s with the unpublished works of John Banister (Ewan & Ewan, 1970) and have continued to the present, there are numerous areas of the state that have not received our attention. Many of these are currently threatened with destruction due to ever-expanding urban sprawl. Many of the rich local faunas present in historical and relatively recent times are likely to disappear in the near future. Thus, the results of natural history investigations of such diverse natural areas are worthy of publication.

A parcel of land formerly owned by the Commonwealth of Virginia in eastern Henrico County called the Elko Tract is one such diverse natural area. It has been partially inventoried by Natural Heritage Program (now Division of Natural Heritage, Virginia Department of Conservation and Recreation) personnel (Virginia Natural Heritage Program, 1989). This tract is currently threatened by industrial development by the county. Because the Elko Tract harbors uncommon natural communities and a rich diversity of plants and animals, natural history reports on various taxonomic groups would be valuable and should be placed on public record. Herein, I report on an investigation of the amphibians and reptiles in one portion of the Elko Tract, and demonstrate that one sampling technique can yield considerable insight into the species richness of the area.

MATERIALS AND METHODS

Study Area

The Elko Tract is a 972 ha area formerly owned by the Commonwealth of Virginia. All but 42 acres were sold to Henrico County by then Governor G. Allen for $1.00. The study site was located in the eastern portion of the county between White Oak Swamp (a tributary of the Chickahominy River) and Portugee Road. This tract lies immediately to the west of the community of Elko, located at the junction of VA Route 156 and the C&O railroad. The tract was comprised of the following habitat types at the time of the survey: clearcut, upland pine forest, upland mixed pine and hardwoods forest, upland hardwood forest, and swamp forest (Virginia Natural Heritage Program, 1989). Wetlands in the area consist of an acidic seepage swamp and a bottomland hardwood forest. The swamp supports a dense mat of sphagnum, numerous herbs and shrubs, and a variety of broadleaved wetland trees (including *Nyssa sylvatica*, *Acer rubrum*, *Fraxinus pennsylvanica*, and *Magnolia virginiana*). The bottomland hardwoods are dominated by *Quercus lyrata*, *Q. michauxii*, *N. sylvatica*, and *Ulmus americana*.

Methods

A site at the edge of the seepage swamp and the upland habitats was selected in which to establish a drift fence/pitfall array to sample terrestrial vertebrates. A single drift fence array with pitfall traps was installed on 9 August 1989. The array consisted of three 7.5 m sections of aluminum flashing set upright in the ground in an exploded "Y" configuration. Each arm of the drift fence was located about 7.5 m from the imaginary center. Plastic buckets (19 l) were buried flush with the ground at each end of each drift fence (n = 6 total). Each pitfall was inoculated with dilute formalin to quickly kill and preserve the specimens for other studies. The array was checked 15 times from 23 August 1989 to 7 July 1990. On each visit all specimens were removed from the pitfalls, counted, and placed in plastic containers for transfer to the Virginia Museum of Natural History. All of these specimens have been catalogued. I counted each of the available specimens and scored them for size and sex, where possible.

RESULTS AND DISCUSSION

A total of 27 species of amphibians and 33 species of reptiles are known to occur in the Chickahominy River watershed (Mitchell & Reay, 1999). Of these, 24 species of amphibians and 31 reptiles, some 92% of the entire watershed fauna, are likely to occur in the Elko Tract. Twenty-four species (18 amphibians, 6 reptiles) were confirmed for the small portion of the Elko Tract sampled by the drift fence/pitfall array. All of the species in this report were caught in the pitfall traps (Table 1). Additional species were apparently recorded (1 amphibian, 11 reptiles; Virginia Natural Heritage Program, 1989, p. 20) but documentation on them cannot be located. Anuran diversity was higher than the other taxonomic groups probably because of the higher species richness and large number of captures for several species (Table 2). Evenness (J) between the two groups of amphibians was higher than that for reptiles, reflecting the greater rates of capture of several species in each group (Table 2).

The known terrestrial amphibian fauna at the Elko Tract was dominated by two species of widespread anurans, *Bufo fowleri* and *Rana clamitans*. Most of the captures were of metamorphs during the summer months. Metamorphs also dominated the captures of *Bufo americanus*, *Rana catesbeiana*, and *Rana palustris*. Metamorphs of these species disperse widely from breeding sites and are frequently caught in pitfall traps in a variety of terrestrial habitats (Gibbons & Semlitsch, 1982; Mitchell et al., 1997). Adults dominated the captures of *Pseudacris crucifer* and *Pseudacris feriarum*. Other species were caught in low numbers because they were either arboreal or occurred in low population sizes in this area.

Except for the eft stage of *Notophthalmus viridescens*, which wanders widely (Gill, 1978), salamander samples largely consisted of adults. The presence of juveniles of three species (*Ambystoma*, *Pseudotriton*) indicates that breeding habitat was located nearby. The relatively large number of *Hemidactylium scutatum* suggests that the small, acidic wetland in the tract was used as a breeding site by this species.

Reptiles were represented by low numbers of several widespread species (Table 1). The adult *Sceloporus* samples were mostly males (n = 10, females n = 3). One species of skink (*Eumeces fasciatus*) and the only teiid lizard found in the East (*Cnemidophorus sexlineatus*) were represented by a single juvenile each. Adults and a juvenile of the

Table 1. Amphibians and reptiles collected in pitfall traps in the Elko Tract, Henrico County, Virginia. Juveniles include recently metamorphosed frogs.

Species	Adults	Juveniles
Frogs		
Acris crepitans	1	0
Bufo americanus	10	38
Bufo fowleri	10	91
Gastrophryne carolinensis	0	1
Hyla chrysoscelis	4	5
Pseudacris crucifer	20	0
Pseudacris feriarum	6	0
Rana catesbeiana	0	10
Rana clamitans	2	92
Rana palustris	2	22
Scaphiopus holbrookii	1	1
Salamanders		
Ambystoma opacum	1	1
Eurycea cirrigera	6	0
Hemidactylium scutatum	30	0
Notophthalmus viridescens	0	20
Plethodon cylindraceus	2	0
Pseudotriton montanus	1	6
Pseudotriton ruber	1	3
Total amphibians	97	290
Lizards		
Cnemidophorus sexlineatus	0	1
Eumeces fasciatus	0	1
Eumeces inexpectatus	2	0
Sceloporus undulatus	13	4
Snakes		
Carphophis amoenus	1	0
Storeria dekayi	1	0
Total reptiles	17	6

common southeastern five-lined skink (*E. inexpectatus*) were captured in this study. Only two species of small snakes, both represented by adults, were caught in the pitfall traps during the sampling period.

In addition to the amphibians and reptiles, the following small mammals were collected by the drift fence/pitfall technique: *Blarina brevicauda* (short-tailed shrew), *Condylura cristata* (star-nosed mole), *Cryptotis parva* (least shrew), *Microtus pennsylvanicus* (meadow vole), *Mus musculus* (house mouse), *Peromyscus leucopus* (white-footed mouse), *Reithrodontomys humulis* (eastern harvest mouse),

Table 2. Numeric assessment of the diversity of taxonomic groups of amphibians and reptiles at the Elko Tract site, Henrico County, Virginia. N_{sp} = number of species, N_{ind} = number of individuals, H' = Shannon diversity index value, H_{max} = the maximum diversity possible given the number of species, and J = evenness.

Group	N_{sp}	N_{ind}	H'	H_{max}	J
Frogs	11	316	0.750	1.041	0.720
Salamanders	7	71	0.649	0.845	0.768
Amphibians	18	387	0.937	1.255	0.746
Reptiles	6	23	0.439	0.778	0.565
All species	24	410	1.001	1.380	0.726

Sorex hoyi (pygmy shrew), *Sorex longirostris* (southeastern shrew), *Tamias striatus* (eastern chipmunk), and *Zapus hudsonius* (meadow jumping mouse) (Virginia Natural Heritage Program, 1989).

This assemblage of small mammals indicates that the area sampled was a mix of habitats supporting grassland specialists and forest generalists (Pagels et al., 1992; Bellows & Mitchell, 2000). The small mammal community at Elko Tract consists of the same species as those found in southeastern Virginia (Erdle & Pagels, 1995) and the upper Coastal Plain (Bellows et al., 1999), further supporting the conclusion that this area is rich in biodiversity and is representative of the terrestrial vertebrate fauna of central Virginia.

The single drift fence/pitfall array technique used in this study yielded insights into the rich terrestrial vertebrate community of the Elko Tract. This sampling method has been used successfully in many places around the state, e.g., southeastern Virginia (Buhlmann et al., 1994), the Virginia mountains (Mitchell et al., 1997), and central Virginia Piedmont (Pagels et al., 1992). Numbers caught in the pitfalls in Elko Tract are comparable to those obtained for several upland and wetland sites in southeastern and other parts of Virginia (Buhlmann et al., 1994; JCM unpublished data). The technique effectively samples small terrestrial vertebrates moving across the landscape. It is not reliable for capturing highly aquatic, arboreal, or large terrestrial species. Thus, the perception of the structure of the amphibian and reptile community at Elko, although comprised of a rich fauna, is incomplete. Other techniques that could have provided additional records are visual (haphazard) encounter surveys, frog call surveys, coverboard surveys, and various other means of trapping (Heyer et

al., 1994). Most of these techniques are either time-prohibitive or target fewer taxa than large-scale drift fences with pitfall traps. Multiple techniques should be used simultaneously to sample all habitat types for all possible species.

The Elko Tract harbors a high diversity of amphibians, reptiles, and small mammals due to the diversity of microhabitats associated with the uplands and wetlands of the White Oak Swamp. This wetland is part of a tributary that leads to the Chickahominy River and associated habitats, which itself contains a high diversity of amphibians and reptiles (see distribution maps in Mitchell & Reay, 1999). Although there are no state or federally listed species of amphibians and reptiles in this area, the diversity of taxa reflects the many different habitat types in this portion of eastern Henrico County. This county is experiencing a high rate of urban sprawl (personal observations) and the Elko area in particular has been targeted for industrial development. As a consequence, few tracts of land as biologically rich as the Elko Tract will remain in this area after the next couple of decades. Places such as the Elko Tract will likely suffer the same fate as other wetlands in central Virginia (e.g., Mitchell, 1996). I encourage other reports on the various taxa of areas such as the Elko Tract to assist with documenting Virginia's rich biological heritage for the public record before they disappear.

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First Virginia Records of Four European Insect Herbivores of *Phragmites australis*

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INTRODUCTION

Common reed, *Phragmites australis* (Cav.) Trin. ex Steudel, is a clonal cosmopolitan grass species with rapidly expanding populations in both freshwater and brackish North American wetlands, particularly along the Atlantic Coast (Marks et al., 1994). Recruitment from seed is generally low, and vegetative propagation and clonal expansion occur through dispersal of rhizome fragments. The extensive belowground rhizome system produces homogenous stands with up to 200 stems/m^2 that can reach 4 m in height (Haslam, 1972). Low nitrogen or phosphorous availability, high salinity, extensive tidal flooding, and anaerobic soils may limit the expansion of *P. australis* clones (Chambers, 1997). The rapid expansion of *P. australis* in North America during the past several decades has resulted in the replacement of mixed wetland plant communities by monotypic *P. australis* stands, causing detrimental impacts on native wildlife (Marks et al., 1994). This invasion is considered a threat to biodiversity in natural areas and has resulted in aggressive control attempts (Marks et al., 1994). Recommendations for *P. australis* control include the use of herbicides, mowing, disking, dredging, flooding, draining, burning, mulching, and grazing. Currently, the most widespread and successful approach appears to be the application of glyphosate late in the growing season, followed by prescribed burning or mechanical removal of dead stalks, and subsequent application of glyphosate the next year. In order to maintain areas with low *P. australis* abundance, however, re-treatments are usually necessary every 3-5 years and negative side effects on non-target plants are inevitable if non-selective herbicides are used over large areas. At present, there is no long-term, species-specific control measure.

The commitment of wetland managers to reduce *P. australis* populations in North America has increased interest in alternatives to currently used control techniques. One alternative to chemical, mechanical, and physical control is biological control, the introduction of host-specific natural enemies (usually insects, less often pathogens) from the native range of an introduced plant (Tewksbury et al., in prep.). The status of *P. australis* as native or introduced is not resolved, and it has been hypothesized that a more aggressive genotype of European origin has been introduced (Metzler & Rosza 1987; Tucker, 1990; Mikkola & Lafontaine, 1994; Besitka, 1996). This hypothesis is being evaluated using advanced genetic techniques (K. Saltonstall, pers. comm.). Regardless of its status as native, introduced, or both, control attempts continue. As part of an evaluation of the potential of developing biological control of *P. australis*, literature and field surveys for insects and pathogens associated with common reed have been conducted in North America and Europe since 1998 (Schwarzländer & Häfliger, 1999; Tewksbury et al., in prep.). In Europe, at least 151 herbivore species feed

on *P. australis*, some of which cause significant damage; about 50% of these species are considered specialist herbivores of common reed (Schwarzländer & Häfliger, 1999).

Literature (covering all of North America) and field surveys (in the northeastern United States) reveal that at least 26 herbivores attack *P. australis* in North America (Tewksbury et al., in prep.). Five of these species may be native; the rest are accidental introductions that occurred during the past several decades (Tewksbury et al., in prep.). Two species, the Yuma skipper, *Ochlodes yuma*, a species distributed throughout the western United States, and a gall midge, *Calamomyia phragmites*, are considered native and monophagous on *P. australis* (Gagné, 1989; Tewksbury et al., in prep.). The native broad-winged skipper, *Poanes viator*, has expanded its diet to include *P. australis* along the Atlantic Coast as far north as Massachusetts (Opler & Krizek, 1984; Glassberg 1999) and the species is now common in Rhode Island (Tewksbury et al., in prep.). The rhizome-feeding noctuid moth *Rhizedra lutosa* was first reported from North America in 1988 from New Jersey (McCabe & Schweitzer, 1991). It subsequently was found in the Catskill Mountains of New York in 1991 (Mikkola & Lafontaine, 1994) and by 1999 was recorded from Rhode Island, Connecticut, Massachusetts, and as far west as Ohio (Tewksbury et al., in prep.). The moth *Apamea unanimis* was first collected in 1991 near Ottawa, Canada (Mikkola & Lafontaine, 1994); larvae feed on leaves of *P. australis*, *Phalaris*, and *Glyceria*. *Apamea ophiogramma* was first reported in 1989 from British Columbia, Canada (Troubridge et al., 1992) but has since been found in New York, Vermont, Quebec, and New Brunswick (Mikkola & Lafontaine, 1994). Four European shoot flies of the genus *Lipara* (*L. lucens*, *L. rufitarsis*, *L. similis*, and *L. pullitarsis*) and the mealybug *Chaetococcus phragmitis* have been reported from the Northeast (Tewksbury et al., in prep.). Additional species such as the gall midge *Lasioptera hungarica*, a dolichopodid fly *Thrypticus* sp., the aphid *Hyalopterus pruni* and the wasp *Tetramesa phragmitis* appear widespread. The mite *Steneotarsonemus phragmitidis* was recently discovered in the Finger Lakes Region of New York and the rice grain gall midge *Giraudiella inclusa* in Massachusetts, Connecticut, New Jersey, and New York (Blossey & Eichiner, unpubl. data). These are the most commonly recognized species; a complete list of all 26 species recorded on *P. australis* can be found in Tewksbury et al. (in prep.). It is very likely that more detailed investigations and more extensive field surveys will reveal additional species associated with *P. australis* in North America.

PHRAGMITES AUSTRALIS IN VIRGINIA

The Division of Natural Heritage (DNH) of the Virginia Department of Conservation and Recreation manages a statewide system of Natural Area Preserves (NAPs) dedicated for protection of rare natural communities, species, and their habitats. The DNH is concerned that *P. australis* is expanding in many coastal NAPs. *Phragmites australis* is common in Virginia, especially in the marshes of the Chesapeake Bay and its tributaries, and in the marshes of Back Bay and the Northwest and North Landing rivers in the extreme southeastern corner of the state (Fig. 1).

From 1977 to 1990, a 5-10 fold increase in percent cover of *P. australis* was documented in Back Bay, City of Virginia Beach (Priest & Dewing, 1991). This expansion is creating monospecific stands, replacing diverse marsh communities and threatening unique and rare communities, including a globally rare (Natural Heritage Network/The Nature Conservancy rank G1G2) community, the Spikerush-Olney Three-square Marsh (*Eleocharis fallax-Eleocharis rostellata-Scirpus americanus-Sagittaria lancifolia* tidally flooded marsh), at the Northwest and North Landing rivers, in the cities of Chesapeake and Virginia Beach (Fleming & Moorhead, 1998). *Phragmites australis* has been ranked A, indicating that it is a species exhibiting "the most invasive tendencies in natural areas and native plant habitats," by DNH and the Virginia Native Plant Society (1999).

Efforts to protect and restore vulnerable biological resources must include control of *P. australis*. DNH led an interagency evaluation (Clark, 1997) of the

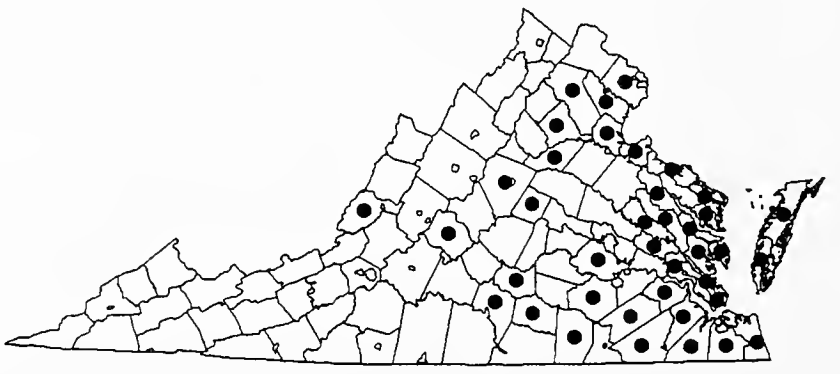

Fig. 1. Distribution of *Phragmites australis* by county in Virginia (Harvill et al., 1992).

feasibility of effectively controlling *P. australis* in southeastern Virginia using a combination of herbicide application and prescribed fire. Stands of *P. australis* were sprayed with glyphosate in early autumn for two successive years. Large stands were sprayed from helicopter and fixed-wing aircraft, while small stands were treated from the ground using hand-pumped sprayers. Many of these stands were burned between herbicide applications. The degree of control was highly variable, but most stands exhibited an intermediate level of control. Intermediate control was characterized as stands in which much of the *P. australis* was killed but which contained strips and patches of healthy *P. australis* and areas of re-sprouts. Such stands will require further monitoring and treatment to prevent subsequent *P. australis* expansion. The study determined that control of established stands of *P. australis* is expensive, labor-intensive, and not always successful. However, this treatment methodology is now commonly being used in the mid-Atlantic region as the only means to potentially slow the expansion of *P. australis*.

Current efforts within DNH involve the use of vegetation plot samples, global positioning systems (GPS), and remotely sensed imagery to map ecological communities of the wetlands of the Northwest, North Landing, and Pamunkey rivers. Delineating stands of *P. australis* provides information on distribution, areal extent, and proximity to sensitive communities to facilitate protection and management of biological resources.

Although *P. australis* is widespread in the coastal areas of Virginia, there have been no records of herbivores associated with this plant from the state. In this paper we report the discovery of four introduced European species in Virginia, known to be specialized on *P. australis,* at two field sites, 49 km (30 mi) apart (Fig. 2). Both sites were visited on 8 March 2000 and surveyed for insect herbivores.

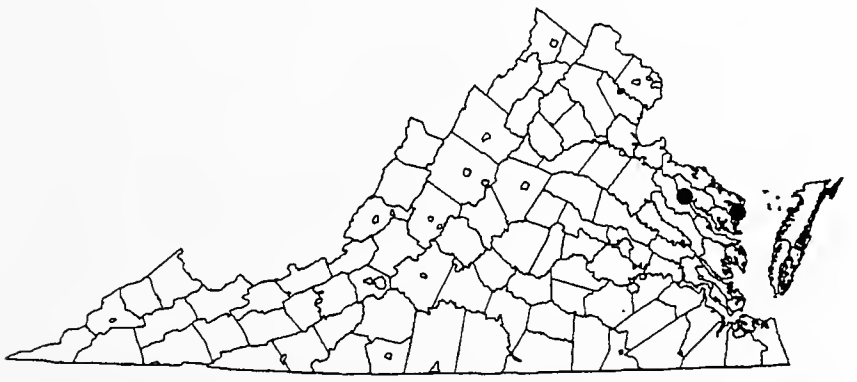

Fig. 2. Field sites visited on 8 March 2000.

FIELD SITES

The first field site was in the town of Tappahannock (Essex County), adjacent to the parking lot of a marina on the southern shore of the Rappahannock River, just west of the U. S. Route 360 bridge. *Phragmites australis* grows in a several-meter wide by approximately 100 m long, relatively dense stand (shoot height 2-4 m) between the parking lot and a shallow bay bordered by a *Spartina patens* marsh. This stand is flooded during periods of high water.

Dameron Marsh NAP, the second site, is located on the western shore of the Chesapeake Bay in Northumberland County. Saltmarsh communities occupy more than half of this 132 ha (316 acre) preserve, with the remaining area consisting of pine-hardwood forests, tidal mud flats, beaches, and fallow fields. Common reed grows on the preserve in several separate clones (total area ca. 2 ha) near the high water mark and on a fallow field. Approximate plant height ranged from 1 (fallow field) to 4 m.

METHODS

At each field site, shoots were surveyed for signs of insect attack. Stems showing signs of herbivore feeding or abnormal growth were cut at soil level and dissected at the site to search for internally feeding larvae. Additional random samples were taken and dissected at each site. At the Tappahannock site, approximately 50 randomly selected shoots were collected and dissected on site and 60 additional shoots were taken to Ithaca, New York to confirm species identification and to rear adult specimens. At Dameron Marsh NAP, visual inspection of shoots started with the fallow field followed by the examination of the older, long-established clones along the shoreline. Several visibly attacked shoots, as well as approximately 50 randomly selected shoots, were dissected on site, and a reference sample of 80 stems was taken to Ithaca to confirm species identification and to rear adults.

RESULTS

Four species (*Lipara rufitarsis, Lasioptera hungarica, Tetramesa phragmitis,* and *Chaetococcus phragmitis*) not previously recorded from Virginia were identified during this study. All four species are accidental introductions from Europe and not native to North America. An additional Diptera species discovered in the samples as larvae was reared in the laboratory to obtain adults for species identification,

but all larvae subsequently died and additional samples will be needed to determine the species. Reference specimens are deposited in the Cornell University Insect collection under Lot # 1241.

Lipara rufitarsis Loew (Diptera, Chloropidae)

The genus *Lipara* Meigen is restricted to the Palaearctic region and all 9 recognized species use *P. australis* as their sole host plant (Beschovski, 1984). The four European species *L. lucens*, *L. rufitarsis*, *L. similis*, and *L. pullitarsis* cause more or less distinct apical shoot galls, in which the mature larvae overwinter (Chvala et al., 1974). A single larva develops per shoot (de Bruyn, 1994). All four species are widely distributed throughout Europe with variable but usually low (5-10%) attack rates (Schwarzländer & Häfliger, 1999).

Sabrosky (1958) reported the first North American record of *L. lucens* in Connecticut on the basis of specimens collected in 1931. He also reported intercepting *L. similis* in New York in a shipment from the Netherlands where dry *P. australis* stems were used as packaging materials (Sabrosky, 1958). Use of *P. australis* as packaging material may be a primary mode of introduction for many other insects that overwinter in dry stems of this species. Recent regional surveys in the Northeast (Tewksbury et al., in prep.; Blossey & Eichiner, unpubl. data) reveal that *L. rufitarsis*, *L. similis*, and *L. pullitarsis* are widespread and abundant. *Lipara lucens* has not been found in North America since the initial record in 1931, suggesting that the species may not be established on this continent. Taxonomic identification of adult flies is difficult and the species recorded in 1931 may have been misidentified and might actually be *L. rufitarsis*. Recent attempts to locate the specimens have been unsuccessful (N. Muth, pers. comm). In the Northeast, attack rates of stems, particularly by *L. similis*, can approach 80% (Blossey & Eichiner, unpubl. data).

The previous southernmost record of *L. rufitarsis* was along the coast of southern New Jersey (Blossey & Eichiner, unpubl. data). The new records from Tappahannock and Dameron Marsh NAP in Virginia extend the distribution of this species several hundred kilometers south. No surveys for *P. australis* herbivores have been conducted south of Dameron Marsh NAP in Virginia, or in other southeastern states. However, the abundance of *L. rufitarsis* at Dameron Marsh NAP suggests that its occurrence in other *P. australis* stands has gone unnoticed.

Larval feeding by *L. rufitarsis* causes stunting of the 2-4 apical internodes of *P. australis* and the formation of a cigar-shaped gall at the shoot tip. Infested shoots do not flower, remain much smaller, and, characteristic of all *Lipara* attacks, show a dry leaf extending from the gall. Galls produced by *L. rufitarsis* can be distinguished from attack by other *Lipara* species using criteria of gall morphology and larval overwintering habit. *Lipara lucens* causes stunting of 10-13 internodes, and larvae penetrate the growing point to feed in a gall chamber. *Lipara rufitarsis* causes stunting of only 2-4 internodes with larvae also penetrating the growing point. *Lipara pullitarsis* causes stunting of the apical internodes and gall formation similar to *L. rufitarsis* but larvae overwinter above the growing point. *Lipara similis* causes only barely visible alterations of the shoot diameter, but infested shoots can be easily identified by the dried up apical leaves and the lack of an inflorescence. Similar to *L. pullitarsis*, *L. similis* larvae feed and overwinter above the growing point of the attacked shoots. Pupation of the larvae occurs in early spring and flies most likely emerge in May. By mid-summer attacked stems should be visible by the dry leaves extending from the shoot tip.

Lasioptera hungarica Möhn (Diptera, Cecidomyiidae)

Lasioptera hungarica is a univoltine gall midge with *P. australis* as the only recorded host plant (Skuhrava & Skuhravy, 1981). The species appears to be most common in eastern and southern Europe (Schwarzländer & Häfliger, 1999). Infested shoots show no obvious signs of damage; however, they often break in strong winds at the site of attack, suggesting a weakening of the stem tissue. Larvae overwinter in the stem and often 30-300 yellow-orange larvae can be found in a single internode. The species is easily identified by its association with a black fungal mycelium, genus *Sporothrix*, that fills the internode (Skuhrava & Skuhravy, 1981). Oviposition by females also infects the stem with fungal spores providing food for the developing larvae. A parasitic wasp (identification pending) commonly attacks the species, and birds in certain areas of the Northeast have learned to forage for larvae (Blossey et al., unpubl. data).

Lasioptera hungarica was recognized to occur in North America only in 1999 (Tewksbury et al., in prep.) but the species is widespread throughout the Northeast in Connecticut, Massachusetts, New Jersey,

and New York (Blossey & Eichiner, unpubl. data). The records from Tappahannock and Dameron Marsh NAP are the southernmost known occurrences but additional surveys in North America may document a much wider distribution of *L. hungarica*. The range of the species and the limited dispersal ability of adult gall midges indicate a long-term presence of *L. hungarica* in North America.

***Tetramesa (Gahaniola) phragmitis* Erdös**
(Hymenoptera, Eurytomidae)

Tetramesa phragmitis is a phytophagous, monophagous wasp with larvae living gregariously (2-12) inside *P. australis* stems where they also overwinter. Shoots attacked by this wasp show no visible signs of damage and presence of the species is only revealed upon dissections. Larval feeding inside the internodes is very minimal and hard to detect. It can probably be best described as a "scraping" of the interior stem with no impact on shoot growth. Krombein et al. (1979) reported *T. phragmitis* from North America. Recent surveys indicate that *T. phragmitis* is the most widespread herbivore of *P. australis* throughout North America and was also found in samples from California (Blossey & Eichiner, unpubl. data). The species is often attacked by a parasitic wasp (species identification pending) that consumes all larvae. The parasitic wasp can be identified by the presence of a long white cocoon replacing the *Tetramesa* larvae. Only a single stem was found to be attacked by *T. phragmitis* at Dameron Marsh NAP. The species was not found at the Tappahannock field site in March 2000, but a recent additional field visit in November 2000 found several stems attacked by *T. phragmitis* in a *P. australis* stand across the river (Blossey, pers. obs.).

***Chaetococcus phragmitis* Marchal**
(Homoptera, Pseudococcidae)

The legless reed mealybug, *Chaetococcus phragmitis,* has recently been found in Delaware, Maryland, New Jersey, southern New York (Kosztarab, 1996; Krause et al., 1997) and Connecticut (Blossey & Eichiner, unpubl. data), and can be quite abundant (Krause et al., 1997). The only known host plants of this mealybug are *Phragmites* and *Arundo* spp. (Kosztarab, 1996). Although *C. phragmitis* was not reported during recent surveys in Western and Central Europe (Schwarzländer & Häfliger 1999), the species is native to Western and Central Europe, Armenia, Azerbaijan, and the Mediterranean region (Kosztarab & Kozar, 1988; Ben-Dov, 1994; Hendricks & Kosztarab 1999). In Virginia, it was not found in spring 2000 at Tappahannock but was recorded recently during an additional field visit (Blossey, pers. obs.) and the species was abundant on older clones at Dameron Marsh NAP. The mealybugs feed and overwinter under leaf sheaths and North American birds such as the Black-capped Chickadee (*Poecile atricapilla*) have discovered this abundant food source (Blossey & Eichiner, unpubl. data).

DISCUSSION

Our very limited surveys of *P. australis* at Tappahannock and Dameron Marsh NAP resulted in the discovery of four species of insect herbivores new to the Virginia fauna. The mealybug and *L. rufitarsis* are fairly abundant. More extensive surveys at other sites and during the growing season are likely to record additional species. At field sites in New Jersey as many as nine different species were found in similar winter surveys (Blossey & Eichiner, unpubl. data). The regional survey conducted in the Northeast (Blossey & Eichiner, unpubl. data) revealed that the number of accidentally introduced species is highest in close vicinity to New York City, most likely the primary source of new introductions for *P. australis* herbivores. Currently, many species appear to be spreading and a number of new records can be expected in Virginia within the next few years.

The abundance of accidentally introduced insect herbivores of *P. australis* in North America requires an evaluation of a potential implementation of a biological control program and a re-assessment of currently employed control techniques. We have very little information about the impact of the accidentally introduced herbivores on this invasive plant in North America. Many of the insects recorded from *P. australis* have been studied extensively in Europe (Tscharntke 1992a, b) where they are considered pests of reed beds (Mook & van der Toorn, 1982). Generally, these studies lack information on the impact of herbivores on host plant population dynamics, so we are unable to predict their impact in North America. However, the prevalent control methods using herbicides and fire eliminate all herbivores that overwinter as adults, larvae or eggs in *P. australis* stems. This may, in fact, limit their potential to reduce the spread or decrease the abundance of *P. australis* in North America. More detailed investigations on the impact of these herbivores on *P. australis* performance

are urgently needed to assess whether a change in management recommendations aimed at preserving populations of these herbivores is needed. Investigations aimed at assessing the impact of these herbivores on native marsh vegetation may also be warranted.

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Fourteen Ground Beetles New to the Virginia Fauna (Coleoptera: Carabidae)

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INTRODUCTION

Ongoing inventory activities conducted by our respective agencies in various parts of Virginia continue to disclose numerous species of insects not previously recorded for the state. The present contribution documents Virginia records for a number of ground beetles (Carabidae), which constitute the most diverse beetle family in the state.

The comprehensive list of Nearctic carabids compiled by Bousquet & Larochelle (1993; hereinafter "B&L") accounted a total of 446 species for Virginia, some of them from collections made by André Larochelle in 1980, but many others representing new, undocumented additions made by RLH to a preliminary state list sent by Dr. Bousquet for revision. Subsequently, Davidson (1995) cited previously unpublished collection data for three species listed for Virginia by B&L, and added seven other species not previously recorded in the state, for a total of 453. Anderson et al. (1995) increased that number by five more, to 458. Two recent papers by Hoffman (1997, 1998) added a lebiine and documented four pterostichines listed in B&L, giving the current state list of 459 species.

The present addition of fourteen more carabids extends the new total to 473 and opens the prospect that a total of 500 species or more may be achieved. Previously unpublished collection data for two other species listed for Virginia in B&L are also presented herein. All material cited is in the Virginia Museum of Natural History (VMNH). The abbreviation "UV" refers to specimens captured at ultraviolet lights (= blacklights).

BEMBIDIINI

Bembidion aenulum Hayward

This very distinctive species has been recorded (B&L 1993: 125) from a number of states chiefly in the Gulf and midcontinent regions, but disjunctly for New Hampshire and Virginia. The latter entry was based on a record provided by RLH, a single specimen taken in *Louisa Co.*: South Anna River about 100 m upstream of the Co. Rte. 635 bridge (5.2 mi/8.5 km E of Oilville), on 17 March 1989, RLH (VMNH, presently misplaced). Fortunately, we are now able to add a second Virginia locality: *Brunswick Co.*: Fort Pickett Military Reservation, south side of Nottoway River, 1.2 km upstream of Shack's Hole Road bridge, on sand bar, 14 September 1999, SMR (1♀).

The specimen at hand is nearly uniform black dorsally, but head and elytra with a faint purplish infusion, and pronotum distinctly more purple. The elytral striations are marked by fine bright green punctations.

Micratopus aenescens (LeConte) New State Record

States of record listed by B&L (1993: 152) define what appears to be a lowland range extending from Connecticut to Florida and Texas, northward in the interior to Indiana and Michigan. Within this continuum, nearly all states except Virginia were cited.

Greensville Co.: Meherrin River ca. 3 mi/5 km NE of Claresville, UV, 19 August 1994, RLH (2); Fontaine

Swamp at Co. Rte. 624, UV, 14 June 1994, RLH (1). *Northampton Co.*: Savage Neck Dunes Natural Area Preserve, ca. 6 km SW of Eastville, holly forest, UV, 27 July 1999, A. C. Chazal & A. K. Foster (1). *York Co.*: ponds near Grafton, from pitfall, 27 May 1991, K. A. Buhlmann (1).

Superficially resembling species of the tachyine genus *Paratachys*, this species is distinguished readily by the complete set of elytra intervals and striae, as well as the investiture of setae on the dorsal surface of the pronotum and elytra. These setae are very short, very fine, and very pale, and are best seen in lateral profile over a white background.

AMARINI

Pseudamara arenaria (LeConte)
New State Record; New Southernmost Locality

Grayson Co.: Whitetop Mountain, pitfall site beside FS 89 at 5000 ft., 11-25 June 1993, VMNH survey (1, det. R. L. Davidson).

One of the more impressive range extensions represented in our material is afforded by the capture of this "northern" species in a pitfall array set in mixed beech-spruce woods on Whitetop Mountain. The range of *P. arenaria* extends from Nova Scotia west to Wisconsin, south to Ohio and West Virginia, so its occurrence southward at higher elevations in the Appalachians is not unexpected. Lindroth (1968: 654) described the habitat in Vermont as "forested parts of the mountains", thus similar to the collection site in Virginia, and contrary to the more agrarian biotopes favored by species of *Amara*. However, that only one specimen was taken during a 13-month trapping period suggests that the preferred local niche was not being sampled.

As Whitetop Mountain is only 4 km north of both North Carolina and Tennessee, the discovery of *P. arenaria* at Roan Mountain and/or Grandfather Mountain seems likely.

MORIONINI

Morion monilicornis (Latreille) New State Record

B&L (1993: 160) recorded this species from a basically lowland range, Maryland to Florida, west to Texas, north to South Dakota, but it has previously evaded capture in Virginia. We have only three specimens of *M. monilicornis*, two of them from a single, intensively collected site. The species is obviously not common in eastern Virginia.

Henrico Co.: Chickahominy River floodplain, 2.2 mi/3.5 km upstream from Bottoms Bridge (U.S. Rte. 60), UV, 4 July 1999, I. T. Wilson (1). *Isle of Wight Co.*: Antioch Pines Natural Area Preserve, 5 km S of Zuni, along Blackwater River, UV, 21 May 1996, SMR & RLH (2).

HARPALINI

Harpalus katiae Battoni
New State Record; New Northeasternmost Locality

Dinwiddie Co.: Fort Pickett Military Reservation, 2 km E of Birchin Lake, 6 July 2000, A. C. Chazal & S. White (1♀). *Mecklenburg Co.*: Elm Hill Wildlife Management Area (WMA), 7.5 mi/12 km SE of Boydton, 17 June-10 July 1995, VMNH survey (1♂ and 2♀♀, one of them teneral).

This widespread but uncommon sibling species of the well-known *H. caliginosus* was only recently distinguished (Battoni, 1985). A more detailed comparison of the two, including drawings, photographs, and distribution maps, was published three years ago (Will, 1997); that source readily enabled identification of several Virginia specimens as *H. katiae*.

Will's (1997) shaded map for *H. katiae* even anticipated its occurrence in southside Virginia although his northernmost locality for the species was "Hog Hill" [ca. 8.4 mi W of Maiden] in Catawba County, North Carolina. The capture at Fort Pickett, Virginia, thus extends the verified range some 220 mi/352 km to the east-northeast.

Two specimens of *H. caliginosus* were taken at nearby localities in Fort Pickett during the period 7-9 July 2000; further collecting may indicate syntopy with *H. katiae* in that area.

VMNH staff operated two adjacent pitfall lines in the Elm Hill WMA during 1994 and 1995, placed in the sandy floodplain of the Roanoke River at the head of Lake Gaston, and only a mile north of the North Carolina state line. In addition to the three specimens of *H. katiae*, a single female of *H. caliginosus* was trapped there during 10 July-1 August 1995, showing local syntopy. Other specimens were probably captured but discarded in the belief that, prior to Will's (1997) paper, only the common *H. caliginosus* occurred in Virginia. Still, even that species is rarely trapped in any numbers; usually, we would capture two or three specimens, at most, in a month-long period.

All of the 88 other specimens of the subgenus *Megapangus* in the VMNH collection, carefully re-examined with *H. katiae* in mind, proved to be typical *H. caliginosus*.

Harpalus gravis LeConte New State Record

The range of this very distinctive little harpaline was shown by Noonan (1991: map 270) as confined to

southeastern United States from Texas and Oklahoma to Florida and South Carolina, almost entirely in the Coastal Plain, but with two disjunct records for Long Island and New Jersey. We can now document the occurrence of *H. gravis* in eastern Virginia, near the center of the former lacuna.

City of Hampton: Langley Air Force Base, 19 August 1970, W. A. Allen (1♂). *City of Virginia Beach*: Oceana Naval Air Station, 26 August 1975, W. A. Allen (1♂); False Cape State Park, dunes north of cemetery, 18 August 1998, SMR et al. (2♂♂, 2♀♀).

All of the cited material was taken at blacklight traps. The activity peak in mid- to late August corresponds to Noonan's phenograph (1991: fig. 224) based on material from the southern part of the range. It is noteworthy that no specimens of *H. gravis* were taken at either of two localities (Assateague Island and Savage Neck Dunes Natural Area Preserve) on the Eastern Shore of Virginia during extensive sampling by VDNH staff, despite the use of UV light traps in dune habitats during August.

Harpalus providens Casey
New State Record; New Southernmost Locality

Augusta Co.: ca. 5 mi/8 km W of Stokesville, pitfalls in mature red oak forest, 8 July 1989, B. Flamm (2♂♂); same locality, but in plot two years following clear-cutting, 8 August 1989, B. Flamm (1♀). *Highland Co.*: Sapling Ridge trail to Bear Camp Knob, 6 mi/9.6 km N of Hightown, 3 June 1990, C.A. Pague (1♂). *Rockingham Co.*: crest of Shenandoah Mountain at jct. Co. Rte. 924 and FS 85, 17 June 1988, K. A. Buhlmann (1♂,1♀). *Warren Co.*: 4 mi/6.4 km SE of Front Royal, Smithsonian Conservation and Research Center, in mature mesic woods, 7-22 July 1993, VMNH survey (2♀♀). *Wythe Co.*: crest of Lick Mountain, ca. 3000 ft., 2 mi/3 km SE of Wytheville on Co. Rte. 640, 27 April 1974, RLH (1♀).

According to Noonan's treatment (1991: 49, 281, under the name *H. viduus*), this species ranges from Quebec and Maine southwestward to Wisconsin and Missouri; the southernmost locality cited being the "Cheat Mountains" [probably SE of Huttonsville, Pocahontas Co.], West Virginia. Our material from the first four counties listed above does not extend the range southward, but the site on Lick Mountain in Wythe County is about 140 mi/210 km south of the Cheat Mountains and notably disjunct from the other Virginia sites.

Amblygnathus iripennis (Say) New State Record

The vast majority of specimens of this species seen by Ball & Maddison (1987) in their revision of *Amblygnathus* originated in Florida; only one extralimital sample from New Jersey was cited. In view of the apparent abundance of *A. iripennis* in Florida as far north as Jacksonville, it is the more remarkable that neither this species nor *A. mexicanus* (LeConte) was mentioned in Fattig's (1949) account on Georgia carabids - even in his super-inclusive list of "probable" species. Neither was entered in the comprehensive roster of South Carolina carabids compiled by Kirk (1969, 1970), although a locality, apparently Florence, is shown in Ball & Maddison's (1987) range map for *A. mexicanus*. Only this year was Ciegler (2000) able to cite South Carolina records for *A. iripennis*.

We can now provide three localities for *A. iripennis* in Virginia. While these are better than no records, it must be recalled that during the past decades UV trapping conducted for hundreds of hours all over eastern Virginia obtained only these few. Perhaps UV light is not the best technique for collecting species of *Amblygnathus*.

Accomack Co.: Assateague Island, White Hills, along jeep trail north of the Chincoteague National Wildlife Refuge toll booths, UV, 24 July 1998, A. C. Chazal (1). *Isle of Wight Co.*: 3.0 km ESE of Windsor, UV, 11 September 1978, R. Zimmerman (1). *Sussex Co.*: swamp on Co. Rte. 608, 4 mi/6.4 km SE of Sussex Court House, UV, 15 September 1998, RLH (1).

Acupalpus alternans (LeConte)

This species, unusual for the supernumerary setae on the elytra (and, in this specimen, also the pronotal disk), was included in the B&L (1993) list for Virginia on the basis of the following capture: *Rockingham Co.*: small stream beside Va. Rte. 259, ca. 3 mi/5 km NW of Fulks Run, 18 August 1978, RLH (1).

The specimen was collected during "splashing" for *Bembidion* species, a technique which has never yielded another Virginia specimen of *A. alternans* in nearly 40 years of assiduous application, yet the species is said to be abundant along stream edges in Kentucky (Lindroth, 1968: 929). Northwestern Virginia appears to be at or very near the southern limits of distribution for this inhabitant of northeastern United States.

Acupalpus longulus Dejean
New State Record; Probable New Northernmost Locality

Credited by B&L (1993) to the Coastal Plain from North Carolina to Texas, this species occurs in eastern Virginia although not abundantly: *Isle of Wight Co.*: 3.5 km ESE of Windsor on Co. Rte. 636, UV, 17 July 1978, R. Zimmerman (1, det. G. E. Ball).

This slight range extension northward from North

Carolina lends some credence to the record for Delaware if not that for Rhode Island (both disallowed by B&L, 1993). Until the former is verified, our Virginia locality appears to be the northernmost for this species.

Acupalpus rectangulus Chaudoir New State Record

With a range that encompasses most of eastern North America, it is only fortuitous that Virginia could not be cited by B&L (1993). We have material from several counties in the Piedmont and Coastal Plain regions (probably many more are to be found in the unsorted backlog of small harpalines at VMNH):

Accomack Co.: Assateague Island, beside pond west of Ragged Point trail, UV, 11 August 1998, SMR (1); Assateague Island, White Hills, along jeep trail 0.1 km N of the Chincoteague National Wildlife Refuge toll booths, UV, 1 September 1998, A. C. Chazal (1). *Chesterfield Co.*: Scotford Road, 1 mi/1.6 km W jct. Co. Rte. 653 and US Rte. 360, 8 June 1996, SMR (1). *Cumberland Co.*: 7 km S of Columbia, berleseate in mixed hardwoods by stream, 20 April 1996, RLH (1). *Dinwiddie Co.*: Namozine Swamp, ca. 3.5 mi/5.6 km N of Ford, UV, 7 June 1992, RLH (2). *Greensville Co.*: pine woods, 1 mi/1.6 km E of Claresville, UV, 9 May 1993, RLH (1). *Halifax Co.*: Dan River floodplain 3 mi/5 km NW of Turbeville on Co. Rte. 658, UV, 16 August 1992, RLH (1). *Isle of Wight Co.*: Antioch Pines Natural Area Preserve, 5 km S of Zuni, along Blackwater River, UV, 21 May 1996, SMR & RLH (1).

In addition to the key characters used by Lindroth (1968) and others, it may be noted that in our material of *A. rectangulus* the 3rd elytral interval is provided with 4-6 setae, against only 3 in the single specimen of *A. longulus* (a useful difference if shown to be constant in the latter species).

PENTAGONICINI

Pentagonica picticornis Bates New State Record

Existing state and provincial records in B&L (1993) outline a curious distribution for this nicely colored beetle: Quebec and New Hampshire south to Maryland, thence west and south as far as Texas and New Mexico; it also inhabits Mexico and Guatemala (Reichardt, 1968). *A priori*, one might have suspected *P. picticornis* to enter Virginia, if at all, in one of the northern counties rather than in the southeastern Coastal Plain. Our single specimen bears the following data: *Isle of Wight Co.*: Blackwater Ecologic Preserve, 7 km S of Zuni, UV, 28 June 1995, SMR (1). The bright orange pronotum and bicolored antennae render this carabid unmistakable.

Pentagonica flavipes flavipes (LeConte)
New State Record; Probable New Northernmost Locality

In contrast to the preceding species, *P. flavipes* is apparently confined to southeastern United States: Arkansas to South Carolina according to B&L (1993), who excluded Brimley's (1938) record (reported as *P. f. bicolor*) from Raleigh, North Carolina. In his review of this genus, Reichardt (1968) noted that although the name *bicolor* had been long considered to represent only a "variety" of *P. flavipes*, he regarded this taxon as a full species occurring from Texas to Guatemala. This restriction of the name should not have militated against acceptance of the Raleigh record as valid for the species *P. flavipes* in the broad sense, the more so since identification of that material as "*bicolor*" could only have been erroneous. It is our opinion that the Georgia, Illinois, Mississippi, and North Carolina records for "*bicolor*" rejected by B&L (1993) are probably valid localities for *P. flavipes*, again the result of early misdeterminations. Reichardt (1968) noted that "... the distribution of North American species given in catalogues (Leng, 1920 and Csiki, 1932) is mostly based on unreliable identifications."

We can now document a Virginia specimen which agrees precisely with Reichardt's (1968) definition of the nominate subspecies *P. f. flavipes*: *Accomack Co.*: Assateague Island, White Hills, along jeep trail 0.6 km N of the Chincoteague National Wildlife Refuge toll booths, UV, 29 September 1998, SMR (1). This record represents a substantial range extension (ca. 330 km) to the northeast from Raleigh, and lends credence to an earlier report for New Jersey that was discounted by B&L (1993).

PLATYNINI

Tetraleucus picticornis (Newman) New State Record

Widely distributed over much of eastern North America, including North Carolina and Maryland (B&L, 1993), this attractive species has been absent from the Virginia list until now only by default. It apparently is not common, and we have material from only one site: *Isle of Wight Co.*: Antioch Pines Natural Area Preserve, 5 km S of Zuni, along Blackwater River, UV, 21 May 1996, SMR & RLH (5).

PERIGONINI

Perigona nigriceps (Dejean) New State Record

An exotic species, widely introduced and naturalized in much of eastern North America as far west as Illinois and Arkansas (B&L, 1993). All of our material was taken at

blacklight traps, with two samples obtained in the Coastal Plain and three in the Piedmont.

Dinwiddie Co.: Fort Pickett Military Reservation, jct. Lake and Pelham roads, 2 August 1995, SMR (3). *Isle of Wight Co.*: 3.5 km ESE of Windsor on Co. Rte. 636, 4 September 1978 (5), 11 September 1978 (1), R. Zimmerman. *Nottoway Co.*: Fort Pickett Military Reservation, Reservation (= Wilcox) Road, 7 September 1993, SMR (2). *Pittsylvania Co.*: Cascade Creek at Co. Rte. 860 bridge, 28 August 1989, RLH (1). *Sussex Co.*: swamp on Co. Rte. 608, 4 mi/6.4 km SE of Sussex Court House, 15 September 1998, RLH (2).

It is curious that despite these several captures of *P. nigriceps*, we have still not collected local material of *P. pallipennis* (LeConte), a native species cited for Virginia by B&L (1993).

LEBIINI

Calleida decora (Fabricius)
New State Record; New Northeasternmost Locality

With a known range extending from North Dakota south to Texas, and thence eastward in all coastal states as far north as North Carolina (B&L, 1993: 280), the occurrence of *C. decora* in Virginia was deemed probable and is now verified by the following records:

City of Norfolk: (without precise pin label data, but very likely from the Virginia Truck Crops Experiment Station), 5 June 1942, L. D. Anderson & H. G. Walker (1). *City of Virginia Beach*: False Cape State Park, dunes north of cemetery, UV, 18 August 1998, SMR et al. (1).

DISCUSSION

The 446 species of carabids attributed to Virginia by B&L (1993) ranked the state fourteenth among the continental states and provinces in terms of diversity. The new total of 473 raises the position of Virginia to no higher than sixth, trailing at least California (671), Texas (621), New York (520), Ontario (510), and British Columbia (485), and possibly other states that were in the 450-470 range at the time of the B&L (1993) checklist. Additional species of carabids have been collected recently in Virginia and will be documented in a future publication, raising the state's total even closer to 500 species.

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Three True Bugs New to the Virginia Fauna, Including the First Record of the Family Schizopteridae (Heteroptera)

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Twenty-two families of true bugs (Heteroptera) have been treated in the Insects of Virginia series (Bobb, 1974; Hoffman, 1971, 1975, 1996a). Notable additional records for these families have been provided by Hoffman (1992, 1994, 1996b, 1999), Hoffman et al. (1998), Hobson et al. (1998), and Stevenson & Roble (1997).

Bobb (1974) monographed the aquatic and semiaquatic heteropteran fauna of Virginia, treating 14 families, 32 genera, and 112 species. Of these taxa, one family (Pleidae), two genera, and 16 species were considered likely to occur in the state on the basis of records from nearby states. To our knowledge, none of these "hypothetical" species has been documented in Virginia during the past quarter-century. However, Bobb (1974) overlooked Drake & Chapman's (1953) paper that mentioned unspecified Virginia specimen records for *Neoplea striola* (Fieber), the lone regional representative of the family Pleidae. Like Bobb, neither of us has encountered this species in Virginia, nor have we seen any specimens, suggesting that it is rare in the state. The only recent addition to the aquatic and semiaquatic heteropteran fauna of Virginia is Hoffman's (1996b) report of the gerrid *Limnoporus dissortis* (Drake & Harris), a species (and genus) not discussed by Bobb (1974).

In this paper, we add another genus of aquatic Heteroptera to the Virginia fauna, provide the first Virginia record of the rarely collected terrestrial family Schizopteridae, and add a species of Miridae to the state tally for this largest family of Heteroptera.

CORIXIDAE

This is the most diverse family of aquatic Heteroptera, occurring worldwide and found in a wide range of aquatic habitats, including brackish water. Bobb (1974) treated five genera and 36 species (including 5 hypotheticals) within the family Corixidae from Virginia, including *Trichocorixa* (6 species), *Palmacorixa* (3 species), *Corisella* (1 species), *Hesperocorixa* (10 species), and *Sigara* (16 species). The recent capture of *Ramphocorixa acuminata* (Uhler) in southeastern Virginia adds another genus and species of water boatman to the state's fauna. Males of this species are easily recognized by the presence of an elongated, pointed vertex (front portion of head; see figures in Abbott [1912], Froeschner [1962], and Sanderson [1982], among others); females have round vertexes. Other diagnostic characters for this species include the presence of a broad, conspicuous apex of the scutellum and a deeply incised upper margin of the male pala (section of foreleg; Fig. 1).

Collection data are: *City of Suffolk*: Great Dismal Swamp National Wildlife Refuge, Williamson Ditch, 16 May 1998, UV light, S. M. Roble and E. L. Quinter, (1 ♂, 1 ♀; both in VMNH).

Hungerford (1948) reported *R. acuminata* from 13 mostly midwestern and western states (those nearest to Virginia were Ohio and Georgia), the District of Columbia, and Mexico. Hilsenhoff (1970) added a lone record from Wisconsin and Morse et al. (1980) reported *R. acuminata* from South Carolina. Polhemus et al. (1988) gave the same range as Hungerford (1948), except for the addition of Wisconsin and omission of New Mexico. Uhler's (1897) original report (and hence type locality) of *R. acuminata* from Baltimore, Maryland, was discounted by Hungerford (1948) and Polhemus et al. (1988). Hungerford (1948) noted that he found only specimens labeled "Tex." in Uhler's collection and therefore designated one of these as the neotype. Based on this action, Polhemus et al. (1988) recognized Texas as the type locality for *R. acuminata*.

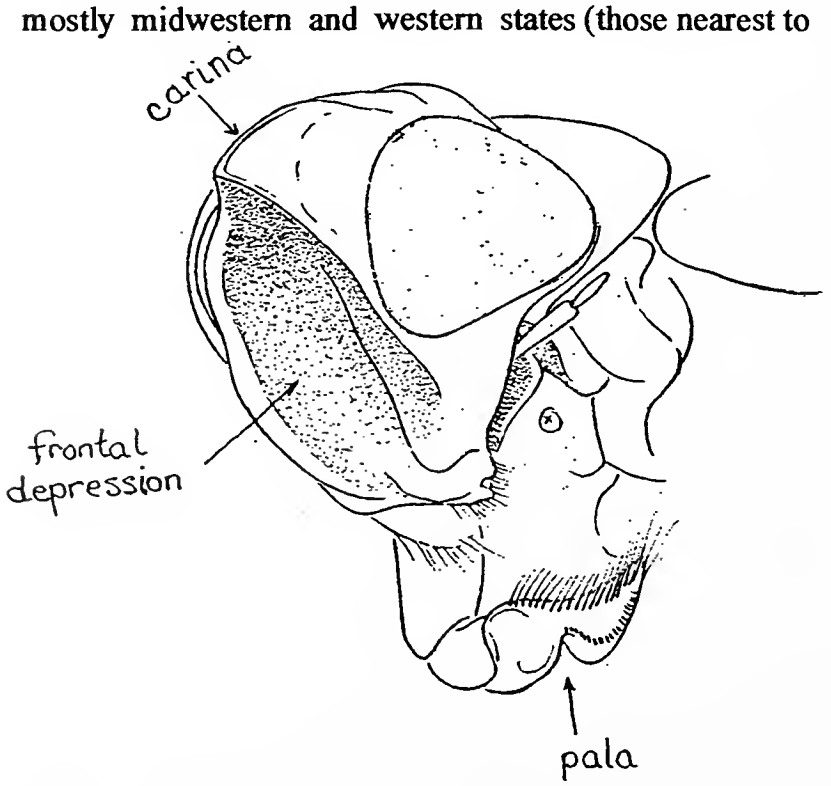

Fig. 1. Anteriolateral view of head region of adult male *Ramphocorixa acuminata*. (Left foreleg removed; attachment point indicated by circled "X".)

Brimley (1938) did not include *R. acuminata* among the corixids known from North Carolina, and none of the supplements (Brimley, 1942; Wray, 1950, 1967) to his list of that state's insect fauna mentioned new records for this family. Sanderson (1982) attributed this species to the corixid fauna of North and South Carolina without providing any details. Matta (1979) did not record *R. acuminata* during his surveys of the aquatic insect fauna of the Great Dismal Swamp of North Carolina and Virginia.

The natural history of *R. acuminata* was studied in detail by Abbott (1912) and Griffith (1945), both of whom confirmed the unusual oviposition behavior first reported by Forbes (1878). Females of this species preferentially attach their eggs to the bodies (carapace) of crayfish, which may be almost entirely covered by the eggs; however, this relationship is not obligatory. Abbott's (1912) specimens were obtained from a pond, whereas Griffith (1945) reported that the crayfish and corixid are typically found together in water holes (burrows). The eggs of *R. acuminata* may be protected from drought and predators by this relationship. Most corixids overwinter as adults, but Griffith (1945) found viable eggs of *R. acuminata* overwintering on crayfish. He also determined that this species is bivoltine and reported that dissected females had many fully developed eggs in their bodies.

Bobb's (1974:132-133) key to the genera of Virginia corixids can be modified to include *Ramphocorixa* by adding the following couplet:

1a. Vertex of males conically produced anteriad (acuminate), frons deeply concave; pala of male forelegs nearly divided by deep transverse groove on dorsal surface; costal margin of elytra in females with an elongate-ellipsoid, polished thickening at basal third of length.....*Ramphocorixa*

Vertex of males not acuminate; pala of male forelegs without deep transverse groove on dorsal side; costal margin of females not thickened at basal third.....2

SCHIZOPTERIDAE

The rarely collected family Schizopteridae contains extremely minute (0.8-2.0 mm) true bugs with strongly sclerotized forewings that are most frequently found in damp soil and leaf litter (Slater & Baranowski, 1978). The family is primarily tropical and subtropical in distribution, and very rare in the United States, where it is represented by four species in four genera. One of these species, *Nannocoris arenaria* Blatchley, is known only from Florida and another, *Corixidea major* McAtee & Malloch, only from Tennessee (Slater & Baranowski, 1978; Henry, 1988). A third species, *Schizoptera bispina* McAtee & Malloch, is known in the United States only from Florida, but also occurs in Guatemala and Mexico (Henry, 1988).

The fourth North American member of this family is *Glyptocombus saltator*, which was described by Heidemann (1906) from Plummer's Island, Maryland (Potomac River just outside the District of Columbia). Slater & Baranowski (1978) added reports for Michigan and Tennessee, whereas Henry (1988) indicated that this species was known from Maryland, Michigan, Tennessee, Washington (in error for Washington, DC; corrected by Henry & Froeschner, 1992), and the District of Columbia. Although the total number of collection localities for *G. saltator* is unknown to us, we suspect that it is less than ten, and possibly as few as three or four.

One of us (RLH) has examined several hundred berlese and pitfall samples from all regions of Virginia, and never found *G. saltator* prior to this report, attesting to the rarity of this species in the state. Therefore, we were pleasantly surprised to discover *G. saltator* in pitfall samples obtained by Virginia Division of Natural Heritage personnel. Four specimens were captured in pitfall traps operated in conjunction with two short (5-7 m) sections of drift fence placed near the margins of two semipermanent, interdunal ponds at the Savage Neck Dunes Natural Area Preserve, ca. 6 km SW of Eastville, Northampton County near the southern end of the Delmarva Peninsula. The drift fences and pitfall traps were operated continuously for six months (22 April-28 October 1999) and checked at monthly intervals. Capture dates for the specimens (all males; deposited in VMNH) of *G. saltator* were as follows: 24 June-28 July (1); 27 August-23 September (1); 23 September-28 October (2). Habitat in the vicinity of the drift fences consisted primarily of loblolly pine (*Pinus taeda*), American holly (*Ilex opaca*), and red maple (*Acer rubrum*), with lesser amounts of sweetgum (*Liquidambar styraciflua*) and flowering dogwood (*Cornus florida*). Herbaceous vegetation was sparse and consisted primarily of short, scattered ferns.

A fifth Virginia specimen of *G. saltator* was trapped more than a decade ago, but was only recently discovered in a collection of millipeds at VMNH. These specimens were captured in a drift fence-pitfall array operated by former Division of Natural Heritage zoologist Kurt A. Buhlmann at the Oceana Naval Air Station, City of Virginia Beach. The specimen of *G. saltator* (♂) was obtained between 14 June and 28 June 1989 from a pitfall trap placed near the jet fuel storage facility on the base; this site is ca. 1 mi/1.6 km SSE jct. U.S. Route 58 and Great Neck Road. The drift fence-pitfall array was operated continuously from 29 March 1989 to 6 February 1990, and checked every 2-3 weeks, but no additional specimens of *G. saltator* were recovered from the trap samples.

Heidemann (1906) noted that *G. saltator* was very difficult to collect, stating that it was "...only to be found by sifting fallen leaves, rubbish, and earth." Collection dates for the type series of four specimens ranged from 9 September to 8 October. We are not aware of the collection dates for the Michigan or Tennessee records of this species. *Glyptocombus saltator* is about 1.5 mm long; its large head and eyes comprise nearly 50% of the total body (Fig. 2). As implied by the species name, this minuscule insect is capable of jumping (Heidemann, 1906), even though the hind femora are not enlarged as in most saltatory species. The life history of *G. saltator* is unknown.

A feature that was not adequately noted in Heidemann's (1906) original description of *G. saltator*, but exhibited by our specimens (particularly that from Oceana Naval Air Station), is enlargement of the distal half of the conspicuously yellowish protibiae, which are densely beset with short, pale setae, producing a diffuse "bottle-brush" appearance.

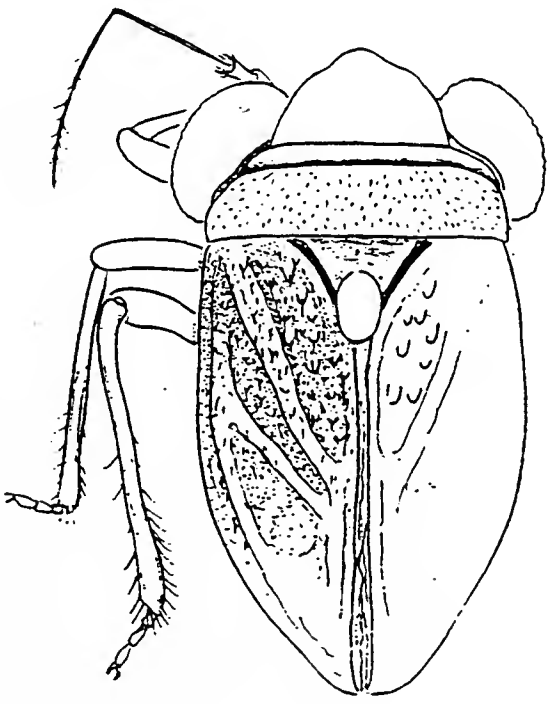

Fig. 2. Dorsal view of adult male *Glyptocombus saltator*.

MIRIDAE

The plant bug *Parthenicus vaccini* (Van Duzee) appears to have an Atlantic and Gulf coastal distribution, as it has been recorded from Massachusetts, New York, New Jersey, Maryland, Florida, and Mississippi (Henry, 1982; Henry & Wheeler, 1988). The species name was evidently derived from transient specimens captured by sweeping *Vaccinium*; however, concerted efforts by Henry (1978) to collect *P. vaccini* on cranberry and blueberry proved futile. The true host plants were identified by Henry (1978, 1982) as *Hudsonia tomentosa* and *H. ericoides* (Cistaceae); he also noted the capture of a few adults on *Lechea maritima,* another member of this family.

On 6 September 1981, Henry collected *P. vaccini* on *H. tomentosa*, a mat-forming, dune plant commonly known as sand-heather, at the north end of Assateague Island in Worcester Co., Maryland (Henry, 1982). Since the southern portion of this island is in Virginia, and contains habitats virtually identical to those on the Maryland end, it comes as no surprise that *P. vaccini* can now be added to the fauna of the former state. Our collection data are: *Accomack Co.*: Assateague Island, Chincoteague National Wildlife Refuge, "North Gate" dunes, 2 November 2000, SMR & RLH (1 ♀, VMNH).

Most females of *P. vaccini* are brachypterous (Henry, 1982), as is true of the specimen we swept from clumps of *H. tomentosa* in low, back dune habitats ca. 300 m inland from the Atlantic Ocean. The collection site is 6.5 km south of the Maryland state line (via the coastline) and approximately 30-40 km south of Henry's (1982) collection site at the northern end of Assateague Island.

ACKNOWLEDGMENTS

Faunal surveys of Savage Neck Dunes Natural Area Preserve were funded by the U.S. Fish and Wildlife Service and the Virginia Department of Conservation and Recreation. Anne Chazal, Amber Foster, and Jennifer Allen assisted with installing and checking the drift fences and pitfall traps at the preserve. Lloyd Culp, refuge manager for Great Dismal Swamp National Wildlife Refuge, and Irvin Ailes, refuge biologist for Chincoteague National Wildlife Refuge, issued scientific collecting permits to SMR.

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Banisteria, Number 16, 2000

The Northernmost Population of the Scorpionfly *Brachypanorpa jeffersoni* Byers (Mecoptera: Panorpodidae)

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Brachypanorpa is one of the insect genera represented by closely related species in the southern Appalachians and the Pacific Northwest, obviously surviving fragments of a former transcontinental distribution. The genus was erected by F. M. Carpenter (1931) for the Appalachian endemic first named *Panorpodes carolinensis* by Banks in 1905 and *P. oregonensis* McLachlan. At the time - 26 years after Banks' (1905) description - *B. carolinensis* was still known only from the Black Mountains, North Carolina, and a single collection from Linville Falls, on the Blue Ridge escarpment some 22 mi/35 km northeast of the Black Mountains.

Carpenter (1953) treated the species again, giving new records which extended the known range south into northern Georgia and northwest to Roan Mountain on the North Carolina-Tennessee border. In the same year, a specimen of *Brachypanorpa* was collected on Mount Rogers by E. C. Turner of the VPISU Entomology Department, and one year later, I obtained another at the same locality, but at a somewhat higher elevation in the spruce-fir forest. This latter specimen was identified by Sophy Parfin (USNM) and reported by her (1955) as *B. carolinensis,* with some differences from more southern material being noted. This record extended the known range nearly 45 mi/72 km north of Linville Falls, and added Virginia to the list of states of record.

There the situation rested for another decade, until George W. Byers commenced his long tenure as summer instructor at the Mountain Lake Biological Station, and initiated an ongoing study of the Mecoptera of southwestern Virginia. During the summers of 1967-69, Professor Byers investigated the northern populations of *B. carolinensis* and became convinced they were specifically distinct from nominate *B. carolinensis,* sensu Banks, reporting his findings in 1976 with the description of *B. jeffersoni.* This new form, named for the third president of the United States, was found to be allopatric with *B. carolinensis,* with localities in Ashe Co., North Carolina, Johnson Co., Tennessee, and Grayson Co., Virginia. Byers (1976) commented that *Brachypanorpa* "...has not been found in the Great Smoky Mountains or on other major Appalachian ridges west of the Blue Ridge."

The range of the genus, and *B. jeffersoni* in particular, can now be extended no less than 65 mi/104 km further to the northeast, at least tripling the area known to date (Fig. 1). On 6 June 1993, Carl Hoffman and I collected a number of scorpionflies in a moist, shady site on Sugar Run Mountain, 8.6 mi/14 km SW of Narrows, Giles County, Virginia; four of them (2 VMNH, 2 USNM) proved to be males of *B. jeffersoni.* On large-scale maps, the site is identified as Big Horse Gap, at the intersection of Forest Service road P612 and the access road to Sugar Run lookout tower. The elevation is approximately 3890 ft (1185 m) ASL. Insects were collected primarily by sweeping low herbs and ferns, notably large stands of *Osmunda cinnamonea* in a seepage area.

This northernmost locality for *B. jeffersoni* is also the first for the Ridge and Valley physiographic province and presages discovery of the species elsewhere along the Clinch-Walker mountain complexes. Specific searches that I have made to date at Burkes Garden, Tazewell Co., have been unsuccessful, but perhaps the time or biotope was not optimal. Byers (1976) found *B. jeffersoni* to be very abundant at several stations along the forest service road up Whitetop Mountain in June of three successive years, but determined efforts by VMNH staff to duplicate his success have been fruitless, despite attention to the habitats (and probably some of the same sites) detailed in his paper. Perhaps population densities fluctuate in this

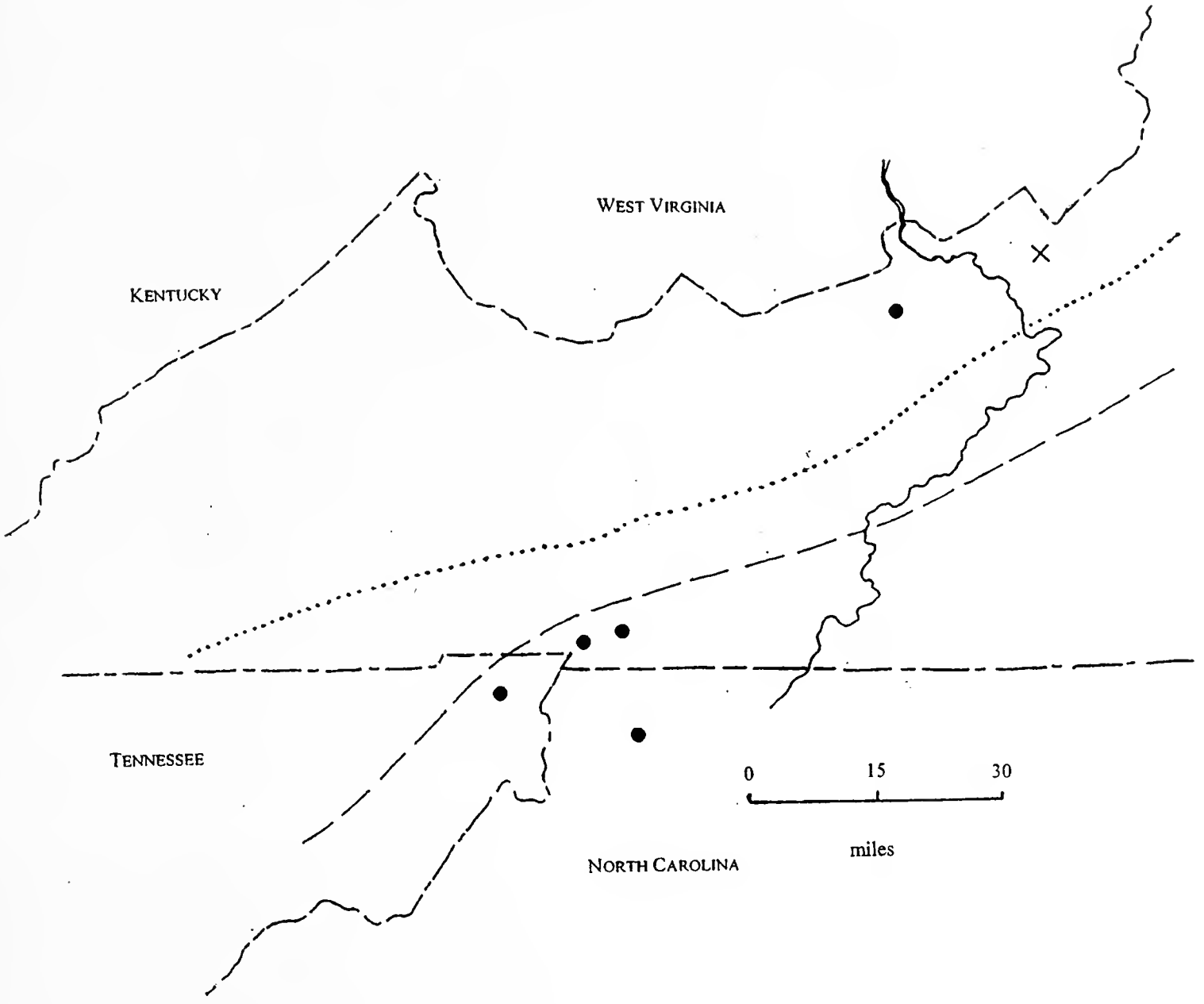

Fig. 1. Known collection sites for *Brachypanorpa jeffersoni.* The northwestern edge of the Blue Ridge physiographic province is shown by dashed lines, the eastern edge of the folded Appalachians by the dotted line. The location of Mountain Lake is indicated by the "X". The course of the New River across Virginia is also shown.

species.

Superficially, males of *B. jeffersoni* appear to be a small *Panorpa* without wing markings (females have only rudimentary wing pads), but a closer inspection shows that the head is not prolonged into the long "beak" of typical panorpids (Figs. 2, 3).

The somewhat dogmatic assertion embodied in the title of this paper is made with considerable assurance. Professor Byers' prolonged inventory of Mecoptera and Tipulidae at the Mountain Lake Biological Station has made that site one of the most intensively collected in North America for scorpionflies, and it seems utterly improbable that *B. jeffersoni* would have been overlooked if it did occur on Salt Pond Mountain.

In some of the most spectacular terrain in the central Appalachians, the two great *massifs* of Salt Pond and Flat Top mountains, once a continuous megaridge, now confront each other at six miles across the valley of the New River in central Giles County, over which they tower by 2300 ft (700 m). The currently known distribution of *B. jeffersoni* in Virginia finds close parallels in the salamander *Plethodon jordani metcalfi* Dunn, and the millipeds *Rudiloria kleinpeteri* (Hoffman) and *Brachycybe lecontii* Wood, cumulatively attesting to the efficacy of this valley as a significant biogeographic constraint for southern Appalachian endemics.

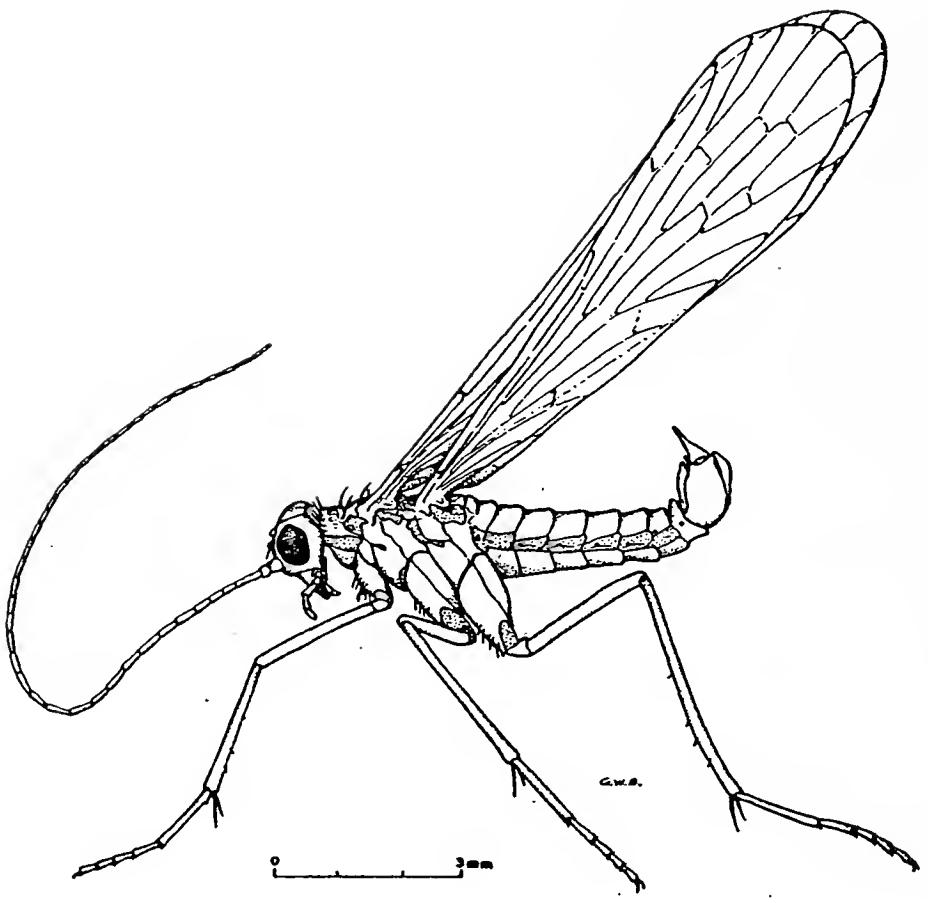

Fig. 2. *Brachypanorpa jeffersoni* Byers. Left lateral view of male paratype (from Byers, 1976).

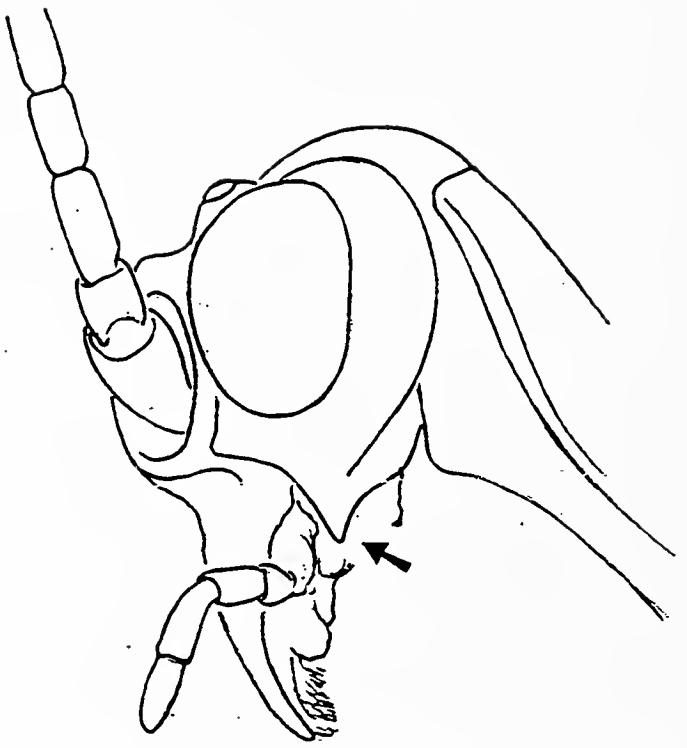

Fig. 3. *Brachypanorpa jeffersoni* Byers. Head of male from Flat Top Mountain, Virginia; lateral view to show general shape (not prolonged ventrad) and location of the genal projection typical of the genus (arrow).

ACKNOWLEDGMENTS

Professor George W. Byers has been so kind as to verify my tentative identification of the Giles County specimens as *B. jeffersoni*, to review a draft of this document, and to allow me to include his original drawing of this species.

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Shorter Contributions

Banisteria, Number 16, 2000

PREVIOUSLY OVERLOOKED RECORDS OF THE LEAST WEASEL (*MUSTELA NIVALIS*) FROM VIRGINIA.–The least weasel (*Mustela nivalis*) has a Holarctic distribution that extends south in the Appalachians to Tennessee (Tuttle, 1968) and North Carolina (Barkalow, 1967; Lee et al., 1982). Handley (1979, 1991b) identified the subspecies found in Virginia as *Mustela nivalis allegheniensis* Rhoads (see also Sheffield & King, 1994), whereas Linzey (1998) erroneously reported it as *Mustela nivalis rixosa* Bangs, a more northern form. The least weasel is the smallest carnivore in Virginia, attaining a total length of 165-220 mm and a weight of 25-65 g (Linzey, 1998). Handley (1979, 1991a, b) placed this species in the "status undetermined" category for Virginia, noting the need to gather more information on its distribution and natural history in the state.

Knowledge of the distribution of the least weasel in Virginia has accumulated slowly. Patton (1939) first documented *M. nivalis* from the state on the basis of one specimen and a subsequent sighting that he obtained at Blacksburg in Montgomery County. Llewellyn (1942) added two more specimen records from Blacksburg (including one that he captured on the fifth floor of the wildlife building at Virginia Polytechnic Institute!), plus two new records (only one specimen retained) from near Dayton in Rockingham County. Neither Bailey (1946) nor Handley & Patton (1947) provided additional Virginia records for this species, but Handley (1949) found the skull and skeletal remains of a least weasel in a barn owl (*Tyto alba*) pellet obtained near Blacksburg. Handley (1979) reported that the least weasel was known from eight specimens collected in five Virginia counties (Fauquier, Giles, Montgomery, Roanoke, and Rockingham). A dozen years later, he remarked that there was still only a total of 13 voucher specimens of *M. nivalis* available for the state (Handley, 1991b), with records from seven counties in the Ridge and Valley province (Augusta, Bath, Giles, Montgomery, Roanoke, Rockingham, and Shenandoah) and two Piedmont localities (Appomattox and Fauquier counties). Since 1980, more than 30 least weasels have been captured and released in the Blacksburg area, and a few others have been recorded in Giles County during the past five years (J. A. Cranford, pers. comm.). Linzey (1998) mentioned additional records from Rockbridge (Bridgewater College campus) and Scott (vicinity of Yuma) counties, but did not indicate if the latter record was vouchered. More recently, Bellows et al. (1999) documented this species in Caroline County, the first Coastal Plain record for Virginia.

In the fall of 1997, we learned of two previously unpublished records for *M. nivalis* from the vicinity of Venrick Run at the western base of Sand Mountain in Wythe County (ca. 5 km S of Wytheville). A local landowner reported that his domestic cat(s) had killed two least weasels near his barnyard (elevation ca. 2400 ft/730 m) over a period of several weeks. One specimen was mounted by a taxidermist (Fig. 1) and is currently in the possession of the landowner. The second

Fig. 1. Mounted specimen of *Mustela nivalis* from near Venrick Run, Wythe County, Virginia.

specimen was given to a state game biologist for disposition in the USNM (E. Blankenship. pers. comm.); however, no such specimen exists in that collection (R. D. Fisher, *in litt.*, February 1998) and the current fate of this specimen is unknown to us. The exact dates of the two captures were not recorded, but are thought to have occurred in the 1980s (E. Blankenship. pers. comm.). The Wythe County site is about midway between the previously reported localities of Blacksburg and Yuma in southwestern Virginia.

The USNM contains a partial specimen (#542284) of *M. nivalis* collected by C. E. Tufts in Vienna, Fairfax County, Virginia on 3 May 1981 (R. D. Fisher, pers. comm.); the USNM database indicates that this specimen (not seen by us) lacks a fibula, radius, and all four feet, suggesting that it had been predated before discovery. This represents a previously unpublished county record from the inner Piedmont region of (suburban) northern Virginia. The nearest documented locality for this species is 19 km NW of Glenn Echo, Montgomery County, Maryland (Handley, 1991a).

Acknowledgments

We thank Robert D. Fisher for providing data regarding the USNM holdings of *M. nivalis allegheniensis*. Edward Blankenship shared information about the Wythe County records and allowed us to visit his property and photograph the mounted specimen. Funding to conduct field surveys on Sand Mountain was provided by a grant from the Western Virginia Land Trust to the Division of Natural Heritage, Virginia Department of Conservation and Recreation. Color slides of the mounted specimen are on file at the Division of Natural Heritage.

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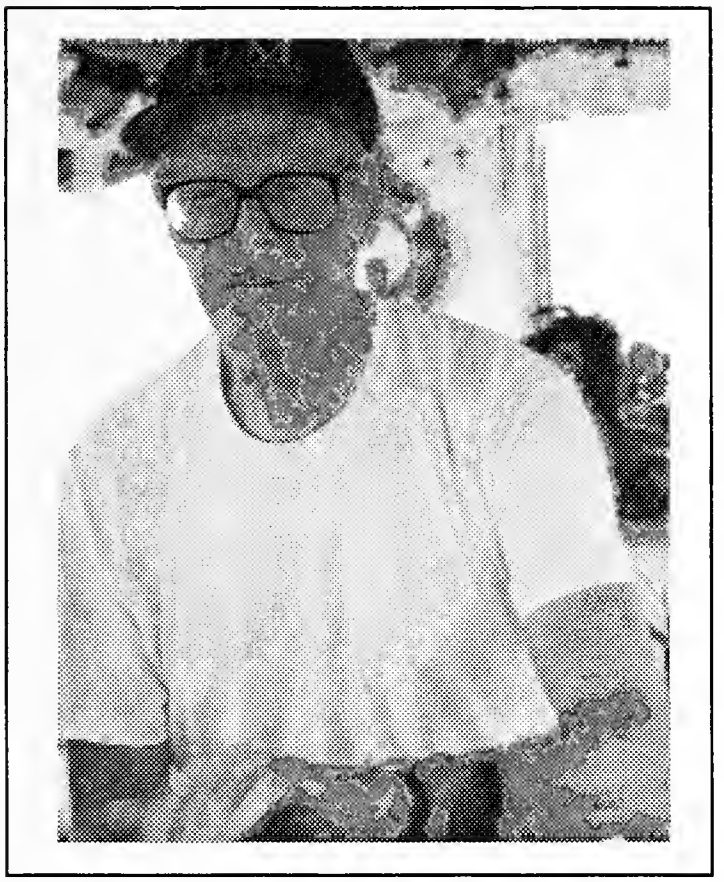
Miscellanea

Charles Overton Handley, Jr.

A Remembrance



Charles O. Handley, Jr., age 75, died of a malignant brain tumor on June 9, 2000, following a brief illness. Charles was born in Longview, Texas, on July 14, 1924 and grew up in Virginia where his father (1897-1977) was a wildlife biologist (see The Raven 49: 69-70). A Curator of Mammals at the Smithsonian Institution, National Museum of Natural History at the time of his death, he began his employment at the NMNH with the Fish and Wildlife Service in the Division of Birds in 1946 and transferred to the Smithsonian staff in the Division of Mammals in 1950. He was an active member of the museum staff for more than fifty-three years. Charles earned his B.S. at Virginia Polytechnic Institute in 1944 (pre-med), and his M.A. and Ph.D. in Zoology from the University of Michigan in 1947 and 1955, respectively.

Although known to many of us as an explorer, natural scientist, and author, Charles was also a patient and caring teacher who, whether in the field or in more structured situations, loved to share his knowledge of nature with anyone who would listen. As part of the Smithsonian Resident Associate Program he taught several courses, both youth and adult, each year from 1966-1992; several of the kids now have their Ph.D.s. In the period 1962-1978 he taught a graduate level mammalogy course at the University of Virginia's Mountain Lake Biological Station ten times, and for two summers he taught mammalogy and directed graduate students at the Rocky Mountain Biological Laboratory. He was on the committees of graduate students from eight universities and served as field or dissertation advisor of pre- and post-doctoral students from several continents.

Charles was known to be a very precise, thoughtful, and careful scientist and author. Among his colleagues he was known as a guardian of the conventions and rules of nomenclature, publication, citation, and measurement. A necessary hurdle before publishing was the Handley test. No doubt, a high percentage of the manuscripts published on Virginia mammals in the past 50 years first passed over his desk for review. An omen of his future achievements in the field of mammalogy, Charles was in his early 20s when his book *Wild Mammals of Virginia* was published. I had the good fortune of collecting the first specimens of two Virginia mammals and also published on several range expansions—state records or locations that he had predicted in the book in 1947! Indeed, Charles was the patriarch of Virginia mammalogy. No one knew more about the diversity and ecology of mid-Atlantic mammals than Charles. Nobody knew more about factors that limit or encourage distributions of mammals of the mid-Atlantic region than did Charles. On a local scale, he personally obtained more than 50 years of bird notes and data from small mammal transects at the University of Virginia's Mountain Lake Biological Station. On a somewhat grander scale, the thoughts brought forth in his "Appalachian mammalian geography—Recent Epoch" (1972) and in his "Terrestrial mammals of Virginia: trends in distribution and diversity" (1992), are necessary—even fun—reading for anybody with an interest in mammals of the region.

Charles' knowledge of Virginia mammals served as a keystone to biologists, land managers, and others concerned with Virginia mammals. From 1977 to 1998 he served as chairman of the Virginia Mammal Advisory Committee. He was the primary author of the mammal chapter and author or co-author of many of the mammal species accounts in the proceedings of both the 1978 and 1989 symposia on Virginia's threatened and endangered species. Charles' efforts and contributions did not go unrecognized. Among awards that he received were the Thomas Jefferson Medal from the Virginia Museum of Natural History Foundation for outstanding contributions to natural history, as well as a Certificate of Appreciation from the Board of Directors of the Virginia Department of Game and Inland

Fisheries for his efforts in the conservation of endangered species. At least 12 taxa were named for him, including a winged bat fly, *Trichobius handleyi* Wenzel; a mite, *Hoffmania handleyi* Brennan and Jones; a hummingbird, *Amazilia handleyi* Wetmore; the mouse possum *Marmosa handleyi* Pine; and a bat, *Lonchophylla handleyi* Hill.

Charles was best known internationally for his work on mammals of the New World tropics. He was an expert on Latin American bats and rodents. It is difficult to find publications on the distribution, systematics, ecology, community structure, roosting, and foraging behaviors of various species of bats of that area that do not cite one of Charles' works. As a recent example, in the first number of the 1999 volume of the *Journal of Mammalogy*, at least three different papers cited work that Charles completed in Latin America.

Charles' publications, which number over 200 and include more than 50 dated 1990 or later, tell an interesting story about the mark that he made in biology. It is an unusually diffuse mark with subjects ranging from birds and bats to figs and whales. It includes a paper from "the European Theater of War," where he served with the U.S. Army 120th Infantry in 1944-1945. He published at least 60 papers on birds. He published articles of general interest, select encyclopedic accounts, articles on measuring specimens and bio-illustration, and popular articles in wildlife magazines. He published no less than 18 reviews of scientific publications, works that covered diverse groups, topics, and geographical areas. The list below includes most of Charles' publications that concern organisms of the mid-Atlantic area. It includes both peer and non-peer reviewed publications. Numerous papers summarizing results of Audubon Christmas Bird Counts and review articles are among those articles not included. In a broader geographical sense, the bibliography presented here is very incomplete—it does not include more than 80 peer-reviewed research articles and books on mammals of tropical America. Whether their research involves Virginia birds, mid-Atlantic mammals or mammals of Panama, Venezuela, or Brazil, future researchers will necessarily have to note his work in order to pursue their own studies—both in an immediate sense, and that of the broadly defined discipline.

Here we remember our colleague and friend and are reminded that Charles O. Handley, Jr. was a major contributor in our attempts to learn Virginia's natural history. In addition to two daughters, Rebecca and Rachael, from an earlier marriage, Charles is survived by Darelyn, his wife of 32 years, and their two sons, Benjamin and Thomas. One cannot help but think that it must have been very special to Charles to have co-authored papers with his father, Charles O. Handley, Sr. (1946 and 1950), Darelyn (1996), and Ben (1998).

The Smithsonian Institution has established the Handley Memorial Fund to finish manuscripts underway and to assist Latin American students wishing to study at the National Museum of Natural History. Contributions may be sent to the Division of Mammals, NMNH, Smithsonian Institution, Washington, DC 20560-0108.

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Book Reviews

Ground Beetles and Wrinkled Bark Beetles of South Carolina (*Coleoptera: Geadephaga: Carabidae and Rhysodidae*) by Janet C. Ciegler. 2000. Biota of South Carolina. Volume 1. Clemson University, Clemson, South Carolina. 149 pp. Available for $20.00, including shipping, from Public Service Bulletin Room, 82 Poole Agricultural Center, Clemson University, Clemson, SC 29634 or purchase at http://cufan.clemson.edu/olos/

Inasmuch as the federal government of the world's richest country has declined to invest either funds or leadership in the initiation of a comprehensive national biological survey, the burden of conducting this basic resource inventory has fallen, regrettably and wrongfully, upon individual enlightened states. Although an admirable precedent and tradition has existed in several states - notably Illinois and California - for a long time, and extremely useful local summaries of various taxa have appeared over the years, no particular standard or format has ever been established and followed. As a result, only a relatively few arthropod groups have been treated, and these in widely divergent levels of thoroughness. The number of nationwide synopses of the scope and calibre of E. G. Linsley's magnificent work "The Cerambycidae of North America" is pitifully small.

Because many qualified taxonomists prefer to channel their time and energy into systematic treatments rather than faunistic accounts, state surveys seem destined to limp along in the status of underappreciated and underfunded charities. Still, a number of states have in recent decades undertaken surveys of at least their insect fauna, the results appearing in serial fashion - basically whenever a specialist could be enlisted to perform the work. Florida, Virginia, Nebraska, and Mississippi are some states which come to mind; the newest member of the fraternity is South Carolina, with its "Biota of South Carolina" series published by the recently organized Biodiversity Initiative of the College of Agriculture, Forestry, and Life Sciences at Clemson University.

This series has been inaugurated in an authoritative and beautifully produced synopsis of the carabid and rhysodid beetles of South Carolina by Janet Ciegler, a resident of Columbia with years of field and museum experience with the beetle fauna of that state. The soft cover design is so attractive that the contents must be of the highest calibre to measure up, and in the opinion of this reviewer, the match is complimentary to both.

From the position of one who has been for several decades conducting parallel work on the carabids of Virginia, only 100 miles to the north, having a detailed treatment of a very similar fauna is obviously of the greatest interest. Although the two states have about the same number of species, Virginia's list contains far more boreal forms, whereas that of South Carolina is more clearly biased toward austral species, reflecting particularly the proportion of land surface encompassed by the Appalachians by the two states. From the biogeographic perspective, it is gratifying to be able to determine what distribution a local species may have elsewhere in its total range, and that is now possible for this part of the southeast.

The presentation of material is fairly traditional: introductory sections treat the natural background of South Carolina, collecting and preparation procedures, and materials and methods. A comprehensive key to all genera opens the systematic section, and being based largely on easily visible characters, does not lead necessarily to tribal groupings although some couplet choices do define various tribes. An interesting innovation is the use of center headings throughout the key: "Setose Elytra" at couplet 5, "Scaritini and Clivinini" at couplet 37, and "Two pairs of supraorbital punctures" at couplet 56, in the tradition of many keys in Arnett's "Beetles of the United States" (1960), in which however each center heading encompasses a taxonomic unit. There is a "quick key" which lists all of the center headings with the appropriate key couplet number, so that one can quickly skip down through the complete key if the particular character is known.

The text sequence follows the arrangement of the catalog by Bousquet & Larochelle (1993). Tribal center headings are employed, and for many, but not all, of the tribes, there is some general information about the group. Keys to the South Carolina species are provided for all but monospecific genera; these are credited as being adapted from various sources, but in my opinion are generally superior to the originals in terms of clarity and inclusion of additional species. It is clear that the author has prepared the keys to be as user-friendly as possible. Each species account includes a brief description, a list of localities, and usually, a statement about seasonal

occurrence and habitat (or method of collection). The author treats 479 species as being either known from the state or likely to occur there; 41 of these are noted to be first records for South Carolina. There is a four-page bibliography of mostly recent literature, a concordance of localities with counties and physiographic regions, a glossary of scientific terms, and an index.

The book is printed in an 8.5 x 11 inch page size, double-columns, with unjustified right margins. The paper is not coated, but with a smooth surface and heavy enough that no show-through occurs. The text is set in 11 point, in what seems to be the very readable Times New Roman font.

Now, as someone who has already given the book pretty heavy use, I think the strongest features are the following:

Firstly, the production values are excellent. The cover design is striking and effective, both in the use of colors (white wording on two shades of green) and type faces. The cover picture of a live *Galerita bicolor* is eye-catching. Page layout is balanced and attractive, the use of headings judicious. Page margins are adequate, and spacing between lines, headers, and paragraphs generous. Boldface is used with discretion. Whoever designed the format deserves compliments.

Secondly, this is the best-illustrated book of its kind I have ever seen. Virtually every structure or color pattern mentioned anywhere in the text is depicted in precisely detailed line drawings, said to be computer-generated and diagrammatic, but as clear and sharp as could possibly be wished. Ms Ciegler has a talent for showing details from just the right perspective for maximum effectiveness, somewhat in the way that a good taxonomist is able to present an adequate description of a species in just a few well-chosen lines, and I envy her ability to do this. No pains have been spared to make South Carolinian carabids accessible to the beginner (as well as, I might add, to those with some experience already), with the greatest emphasis admittedly placed upon identification.

In that respect, and insofar as I have tested the keys in some of my problem genera (e.g., *Clivina, Paratachys, Amara*), I am pleased with the results. Many southern carabids occurring in eastern Virginia are not included in the manuals by either Lindroth (1963-69) or Downie & Arnett (1996), and I am grateful to Ms Ciegler for working them into her keys adapted from those or other sources. In this sense, then, the book may be considered a success, and one I would strongly recommend to anyone with an interest in carabids of eastern North America.

Having said that, it may seem ungenerous and inconsistent to itemize less positive impressions. I want to emphasize that these reservations and doubts do not detract from the value and importance of the book, but would cause me to score it as a 9 instead of a 10. I have in the past attempted similar works (of lesser magnitude), and nobody knows better the difficulty involved in achieving a product free of error and containing material that gratifies the spectrum of potential users. In particular, I do not know to what extent the author in this case was constrained by a format outline fixed for the entire series by the editorial board. Perhaps my major regret is that the presentation was so condensed, the species accounts in particular having the form of bare bones: "just the facts". What's there is fine, but I am sure that Ms Ciegler could have added so much more relating to the natural history of the beetles, interesting details about their distribution, in-state variation, inherent local taxonomic problems, all collectively facets of the species' "personality". I realize that the expense of publishing is high, but with a base of 150 pages, enough discussion to put some life into the accounts - not necessarily for all species to be sure - would not have consumed more than six or eight additional pages.

I am perplexed by the criteria for inclusion of species likely to occur in South Carolina although not yet actually captured there. Apparently (p. 3) all carabids known from *both* north and south ("North Carolina and Georgia", or "New Jersey and Florida") were considered as candidates, and this is entirely reasonable since such records almost guarantee that the species will be found in South Carolina. But what about species which are known from adjoining states on one side or the other? Without making a count, I am sure that there are equally as many which extend as far northeast as central Georgia, or as far south as central North Carolina, which merit attention. For instance, why exclude from the probable list *Cyclotrachelus morio,* recorded from Lanier, Bryan County, Georgia (Freitag, 1969), only 25 miles from the South Carolina state line? *Cyclotrachelus blatchleyi*, known from the same Georgia locality, *is* included, but only as a doubtful species because Bousquet & Larochelle (1993) discounted (probably correctly)

Kirk's (1970) records for western South Carolina. But that should not militate against the high probability that *blatchleyi* does occur north of the Savannah River. One short sentence concluding the species account for *blatchleyi* could have noted its proximity and served as a challenge for searches around Hardeville, for instance, to establish its residency. And in this general context, could not Kirk's material from Oconee and Pickens counties (presumably in the Clemson collection) have been rechecked, in the light of Freitag's (1969) monograph, to see what species it really is?

On the other side of this coin, there are some species (e.g., *Sericoda bogemanni*, p. 107) which are entered in the keys and species accounts (and presumably included in the state total count), although the basis for inclusion was previously published misidentifications of species not even native to southeastern United States, *as clearly specified in the text*! Why legitimize obviously incorrect information, complicate keys, and waste text space on species that will never be found in South Carolina? I think an introductory section disposing of these wills-of-the-wisp collectively would have been a preferable solution. Many others (e.g., *Calathus gregarius*, p. 106) are included on no better basis than being mentioned for the state in the Bousquet & Larochelle (1993) catalog, which in turn does not specify the source for each state record (mostly compiled from the literature).

In the interest of brevity, I suppose, no statements of species' ranges are provided, since such information may be gained from the Bousquet & Larochelle catalog. While this point is true, it is a departure from the otherwise beginner-friendly tone of the entire work. Why should an amateur coleopterist (or entomologist in general) be expected to obtain a secondary - perhaps not readily available - reference book when it would have been so easy to state that species A occurred from North Carolina to Texas in the Coast Plain, or that species B was chiefly Canadian in range and only extended down to South Carolina along the Appalachians? In my view, the single weakest strand in the fabric of this generally excellent treatment is its strict focus on species' occurrences in South Carolina only, and even there, in the briefest context possible. Although a list of known localities is given for each species, the reader must consult the physiographic concordance in Appendix A, then the state county map on p. 2, to reconstruct an image of in-state distribution. Several sentences (at most) in each species account could have obviated this extra work by the interested user.

Lastly, a few strictly personal, idiosyncratic, reactions. At several places through the text, vernacular names ("common names", although rarely used by the general public or even biologists), have been provided at the tribal, and occasionally, the specific level. I completely fail to follow the rationale for this condescension by taxonomists to the lay public (including administrators, economic entomologists, ecologists, and environmental program managers). If people can live comfortably with words like *Tyrannosaurus* and *Chrysanthemum*, why resort to such inventions as "Minute Ground Beetles" for the species of Bembidiini (but not trechines, which are also minute), or even worse, the negative and demeaning "Dingy Ground Beetles" for Harpalini (some of which are iridescent little beauties that nobody can possibly slander as being "dingy")? Anyone interested enough in beetles to want to identify them to species can surely comprehend collective terms like "bembidiines" or "harpalines" or whatever. I certainly cannot say much in defense of "Say's Ground Beetle" for *Chlaenius pennsylvanicus*. Say did name it, but he also named a hundred other ground beetles, any of which should be equally entitled to the name. Why the *Chlaenius*?

For some not immediately apparent reason, perhaps editorial, individual drawings in a group are not numbered as figures. This results in a collective caption identifying the drawings as, for example, "Figures 69-70, left to right" or as "top" and "right". I cannot see that this is an improvement over the traditional practice of sticking a number beside each drawing. And, occasional arguments citing "greater readability" to the contrary, I do *not* like ragged right margins, and they seem out of place in an otherwise impeccable typographic design.

I was initially confused by the method of citing alternative (or previous) taxonomic usages under both generic and specific headings. An example: the heading "Genus ***Lophoglossus*** LeConte, 1852" is followed by the information "*Pterostichus* Bonelli, 1809, subgenus *Lophoglossus,* LeConte, 1852; Arnett, 1960: 126." Could this not have been presented as "*Lophoglossus*: Arnett, 1960: 126 (as subgenus of *Pterostichus*)" or even omitted altogether? This sort of information is not especially useful to a beginner, and a more advanced student can, if inclined, turn to Bousquet & Larochelle

(1993) for authors and dates.

To summarize: the author, the editor, and the publisher are to be complimented on a successful collaboration to produce this extremely useful treatment of South Carolina carabids. It is elegantly designed, durably produced, and the profuse, excellent illustrations are beyond praise. I use it on a daily basis, as my basic source for southern carabids that get into Virginia. If the various reservations expressed in the foregoing paragraphs seem unduly pusillanimous, they reflect basically the wish to have had more precision in geographic and taxonomic areas (more reliance on original sources, less on compiled lists), and for inclusion of more of the author's knowledge about these beetles as parts of the South Carolina biosphere. Perhaps subsequent parts of the "Biota of South Carolina" can be a little more generous in such respects. And one hopes that Janet Ciegler will be the author of many such contributions.

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The Butterflies and Moths (*Lepidoptera*) *of Kentucky: An Annotated Checklist* by Charles van Orden Covell, Jr. 1999. Kentucky State Nature Preserves Commission, Scientific and Technical Series No. 6, Frankfort, KY. 220 pp. Available for $15.00, plus $2.00 shipping, (Kentucky residents add $0.90 sales tax) from Kentucky State Nature Preserves Commission, 801 Schenkel Lane, Frankfort, KY 40601-1403.

The insect order Lepidoptera, comprising about 112,000 described species of butterflies and moths, ranks second only to beetles (Coleoptera; ca. 290,000 described species) as the most diverse group of organisms on Earth (Wilson, 1992). In North America, there are more than 11,000 described species of Lepidoptera (including ca. 760 butterflies), ranking this order fourth behind Coleoptera (>23,600 species), Diptera (true flies; >19,500 species), and Hymenoptera (ants, bees, wasps, and relatives; >17,400 species) (Kosztarab & Schaefer, 1990). Despite the relatively few species, butterflies are clearly the most popular group of insects among the general public, as evidenced by the ever-growing membership roles of the Virginia Butterfly Society, an organization formed at approximately the same time (1992) as the Virginia Natural History Society.

This new publication, the sixth in a series initiated by the Kentucky State Nature Preserves Commission in 1980 (and the first since 1986), is the first attempt to summarize all known butterfly and moth records (>100,000) for the state. It was prepared by Charles Covell, the leading authority on the Lepidoptera of Kentucky and author of the Peterson field guide to eastern moths (Covell, 1984). This publication is the culmination of a 35-year project initiated by Dr. Covell upon his arrival at the University of Louisville in the fall of 1964 following the completion of his Ph.D. studies at Virginia Polytechnic Institute and State University.

During this time, he has conducted field work in every county (120) in Kentucky, systematically visiting each in an attempt to record at least five butterfly species per county. He has also sampled for moths at many locations in Kentucky, particularly state parks and nature preserves. Dr. Covell helped found the Society of Kentucky Lepidopterists in 1974, and obtained many records from its members during the past quarter century.

Introductory chapters include a detailed history of Lepidoptera surveys and studies in Kentucky, a very brief summary of the physiography of the state, and a short discussion on the conservation of Lepidoptera, including the value and ethics of voucher specimen collection, and the author's concerns regarding butterfly releases at weddings and other festive occasions.

The bulk of this publication (160 pages) consists of an annotated checklist of all butterfly and moth species that have been recorded in Kentucky. It treats 2,387 species in 65 families; the author predicts that as many as 300-400 additional species (mostly moths) will eventually be documented in the state. The first supplement to this list is already in press (C. V. Covell, pers. comm.). Although published butterfly lists exist for virtually every state, few state lists are available for moths (exceptions include Florida, Maine, Michigan, New York, Vermont, and Wisconsin). The present work is thus an important contribution to our knowledge of the distribution of Lepidoptera, especially moths, in eastern North America. By comparison, the last detailed report concerning Virginia's butterfly fauna was published a half century ago (Clark & Clark, 1951); the state's moth fauna has never been treated in detail.

The checklist is arranged in systematic order, generally following the sequence in Hodges et al. (1983). Each species account consists of the scientific name and author, common name (if one exists), Hodges et al. (1983) checklist number, parks, reserves, and counties of occurrence, flight dates, and remarks. Nearly 70 Kentucky parks, reserves, and other important "habitat sites" are identified by 3-letter acronyms. The 120 Kentucky counties are also identified by 3-letter acronyms; their locations are plotted on a grid map of the state. Detailed collection data are provided for species known from five or fewer Kentucky counties. Also, taxa described from Kentucky are identified as such in the various species accounts. Flight date information varies from two extreme dates (earliest and latest records) to a series of dates, the latter typically reserved for infrequently encountered species. Comments in the remarks section include information on the number of generations per year, rarity or abundance status, and taxonomic comments. Following the checklist, there is a section entitled "Species Erroneously Attributed to Kentucky" (limited to two species), an extensive bibliography, and a detailed index of scientific and common names.

The publication is printed on 8.5 x 11 inch glossy paper and bound with a soft cover featuring a color photograph of the striking, sexually dimorphic Diana fritillary (*Speyeria diana*). It was well-edited and proofread; I detected few typographical errors. I found the county acronym list to be of limited immediate value in interpreting the Kentucky distribution of each species, probably due in large part to my lack of familiarity with the locations of the various counties in the state. The addition or substitution of small county dot maps, especially for species known from more than a handful of counties, would have been very useful to out-of-state readers. Perhaps cost constraints precluded the inclusion of such maps.

I do not claim to have expertise comparable to the author regarding current moth and butterfly taxonomy (the latter seems to vary from year to year or author to author as evidenced by the recent use of three different generic names for one group of small hairstreaks), so must assume that most of the names used in this publication are correct. However, I noted a few apparent discrepancies in the moth list. For example, Ferguson et al. (1991) transferred *Orthonama centrostrigaria* to the genus *Costaconvexa*. Also, *Probole alienaria* is mentioned as the former (= old) name of *P. nyssaria*, whereas Hodges et al. (1983) listed the latter as a junior synonym of the former, thus indicating that the opposite is correct. These taxa were treated as separate species by Covell (1984).

Features lacking from this publication that I would have liked to have seen are summary tables as well as a discussion of the fauna, such as its diversity and composition relative to other well-documented eastern and midwestern states, biogeography, critical habitats, and habitats and areas of the state most in need of future inventory. Also, with the exception of several major range extensions, there is no indication in the various species accounts as to which records represent the first Kentucky reports for certain species; I believe this would have been of interest to some readers.

In an attempt to rectify one of the items mentioned in the previous paragraph, I have prepared several summary tables concerning the moth and butterfly faunas of Kentucky. In two of these tables I have provided comparative data for Virginia, based on a complete list of the state's butterfly and skipper fauna and an incomplete, preliminary list of Virginia's macro-moth fauna that has been compiled by staff of the Virginia Department of Conservation and Recreation, Division of Natural Heritage from literature sources,

Table 1. Summary of microlepidopteran (micro-moths) fauna of Kentucky; families with at least 10 species recorded from the state are listed separately.

Micro-moths Family	# of genera	# of species
Nepticulidae	5	28
Tischeriidae	1	19
Tineidae	22	45
Acrolophidae	2	12
Bucculatricidae	1	16
Gracillariidae	15	102
Oecophoridae	23	48
Coleophoridae	1	24
Cosmopterigidae	11	21
Gelechiidae	47	132
Sesiidae	8	23
Tortricidae	70	350
Limacodidae	14	19
Crambidae	84	149
Pyralidae	47	91
Pterophoridae	9	21
All others (30 families)	65	102
Total micro-moths	425	1202

selected museum records, and more than a decade of field sampling throughout the state.

The summary tables reveal that the known micro-moth fauna of Kentucky consists of 1,202 species in 46 families (Table 1); no comparable data are readily available for Virginia. The macro-moth faunas of Kentucky and Virginia are very similar (Table 2), with a large proportion of shared species. However, there are some species that are common in one state, but rare or apparently absent in the other. The preliminary macro-moth list for Virginia already contains more species than are included in Dr. Covell's checklist; more than 200 species on the Virginia list have not been recorded in Kentucky. Owing to a greater diversity of habitats and elevational ranges in Virginia, I predict that additional literature and museum searches, plus further field sampling, will reveal that our moth fauna contains 20-30% more species than the Kentucky fauna.

The butterfly and skipper faunas of the two states are also similar (Table 3), again with many shared species, although 30% more skippers have been recorded in Virginia. Overall, only 13 species of butterflies and skippers documented in Kentucky (mostly accidentals and vagrants) have not been found in Virginia, whereas 31 species (including numerous residents) documented in Virginia are not included in Covell's list for Kentucky.

Table 2. Comparison of the known macro-moth faunas of Kentucky and Virginia, including all 13 families and selected large genera; Virginia data are incomplete.

Macro-moths	Number of species		
Family/Genus	KY	VA	Shared
Thyatiridae	4	4	4
Drepanidae	3	3	3
Geometridae	230	235	185
Semiothisa	18	18	14
Epiplemidae	2	2	2
Mimallonidae	2	2	2
Apatelodidae	2	2	2
Lasiocampidae	9	8	7
Saturniidae	18	18	17
Sphingidae	43	36	34
Notodontidae	43	43	39
Arctiidae	58	55	50
Lymantriidae	11	14	11
Noctuidae	615	678	531
Acronicta	37	36	33
Catocala	56	60	50
Lithophane	16	12	10
Papaipema	27	26	21
Schinia	15	13	10
Zale	18	23	17
Total macro-moths	1040	1100	887

Table 3. Comparison of the known butterfly and skipper faunas of Kentucky and Virginia.

Skippers and Butterflies	Number of species		
Family	KY	VA	Shared
Hesperiidae (skippers)	50	65	48
Papilionidae	9	7	7
Pieridae	16	16	13
Lycaenidae	27	30	26
Riodinidae	2	2	1
Nymphalidae	41	43	37
Total butterflies	95	98	84
Total skippers and butterflies	145	163	132

In summary, this publication is an important contribution and should be in the libraries of all students of Lepidoptera in eastern North America. Hopefully, a comparable publication on the fauna of Virginia will be realized within the coming decade.

References

Clark, A. H., & L. F. Clark. 1951. The butterflies of Virginia. Smithsonian Miscellaneous Collections 116: 1-239.

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Kosztarab, M., & C. W. Schaefer (eds.). 1990. Systematics of the North American Insects and Arachnids: Status and Needs. Virginia Agricultural Experiment Station, Information Series 90-1. Virginia Polytechnic Institute and State University, Blacksburg, VA. 247 pp.

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Reports

1. President

Although the last two years have been rewarding for VNHS, there has been both elation and frustration with our accomplishments during this period. On the positive side, establishment of a home page, publication of the Big Levels Symposium, greater diversity of papers in *Banisteria* and at VAS, improved financial status, printing of a recruitment brochure, and numerous other small successes have kept VNHS moving forward. A society such as ours, run strictly by volunteers, must rely on the dedication and good will of a few magnanimous souls who comprise the Executive Committee. Without a team effort to keep VNHS financially solvent by adequate membership and scientifically productive through *Banisteria*, we would not have survived to the new millennium. When I assumed the presidency in fall 1997, I set out to continue what my predecessors had initiated and to set a few goals of my own. Let me review those activities as well as the general state of the Society.

Membership size and the need for recruitment of new members have been emphasized for the last 2 years. We prepared a membership brochure for distribution at the various meetings of professional and amateur biologists in Virginia. We also sent letters to all college libraries in the state, requesting that they consider membership in VNHS. Delinquent members were sent reminders to renew their membership for the new year. In addition, a home page was completed by Dr. Ken Stein and put on the internet to promote the society and solicit new members. In spite of these efforts, I regret that our membership continues to hover at roughly 150 members. VNHS needs an infusion of new members with a passion for natural history, but it will require new recruitment ideas to make this happen.

Only marginal success was achieved in our efforts to increase the number of manuscripts submitted to *Banisteria*. The review process, editing, and publication are being done expeditiously, but the number of submitted manuscripts has not kept pace with the journal's capabilities in papers per issue. There are much archived data in files and recently collected information in reports and theses that are suitable for publication on every campus and natural resource agency office. What is lacking is the self-motivation of biologists, or incentives by supervisors, to promote publication of research and inventory work. In most cases, unless there is recognition (financial, professional, or promotional) for such efforts, these data will not see the light of day. This is a problem that can only be addressed by resource managers and supervisors at an institutional and agency level; so until then, we will continue with our pleas to the membership and through personal contacts with other society and agency personnel.

There has been discussion for the last 3 years to consider an annual meeting of VNHS, apart from our section at the Virginia Academy of Science (VAS). However, we continue to have limited attendance at VAS, and the prospect of attracting a large gathering of members at a separate meeting seems unlikely without many more active members. The limited size of our society continues to inhibit our growth and advancement at all levels of performance in the

Commonwealth. The Executive Committee recognizes that societies such as ours require many years to grow, mature, and gain recognition for their accomplishments and contributions to natural resource conservation. Therefore, recruitment of active members interested in assuming leadership roles in VNHS must remain a top priority for the coming decade.

I would like to thank the Executive Committee, many who are founding members, for their zeal and dedication to VNHS. We have come a long way, but we cannot progress at an adequate pace without the active involvement of current members, and without new members to support our efforts to promote the importance of natural history in the quality of life in Virginia. VNHS needs to be a strong voice in the economic development of Virginia, so I ask that you please become active disciples to our cause. Without an input of your ideas and support to move us forward in membership and in stature, we cannot represent natural history concerns in the continuing economic growth of the Commonwealth. It has been a privilege to serve VNHS at this juncture of its early life history. I will continue my participation as a member and remain active to promote its conservation goals, as a professional biologist and a Virginian.

As a final note, the Executive Committee recognized two senior scientists and founding members of VNHS at our December meeting. Dr. Richard Hoffman and Dr. Michael Kosztarab, septuagenarians extraordinaire, were promoted to the title of Honorary Councilors of VNHS. This dynamic duo, with more than a century of expertise combined in the study of numerous invertebrate taxa, has been the backbone (vertebrata) and driving force in making VNHS possible. We are indebted to these gentlemen for their dedication, enthusiasm, and concern for the biota of Virginia, and for recognizing that natural history enthusiasts needed an organization to share our interests and to work toward conserving those species we all enjoy. They are role models for the rest of us to emulate.

Richard J. Neves, VNHS President

2. Secretary/Treasurer

We have 155 members, 22 of which are institutions or libraries. We were successful in reminding some members to renew their membership with the society by sending them *Banisteria* #15 with a second reminder. (In the spring, we had only 115 members.) **Each current member should attempt to recruit one new member by passing along the VNHS brochure included with this issue of *Banisteria.*** Also, please review the following lists of institutions, agencies, and organizations that currently receive *Banisteria.* If your institution, library or agency is not on this list, encourage the librarian or other appropriate person to subscribe to our peer-reviewed journal devoted to the natural history of Virginia.

Our treasury presently holds $6,175 (as of December 4, 2000). The expenses for the publication and mailing of this issue of *Banisteria* (#16) will be subtracted from this amount.

We continue to be grateful to Hampden-Sydney College for support with the paperwork concerning our treasury. Most recently we have a new secretary, Beckie Smith, who replaced Jean Hudson in the position of secretary/office manager in Gilmer Hall, the building that houses the sciences at Hampden-Sydney. Mrs. Smith has taken up where Mrs. Hudson left off in keeping our membership lists accurate and in preparing mailing labels. We welcome Mrs. Smith, and thank Mrs. Hudson for years of service to the Society.

Respectfully submitted,
Anne Lund, Secretary/Treasurer

Regional Library Subscriptions for 2000

Colleges and Universities (in-state listed first):

Christopher Newport University
Hampden-Sydney College
James Madison University
Longwood College
Lord Fairfax Community College
Marymont University
Roanoke College
Sweet Briar College
University of Richmond
Washington and Lee University
Duke University
Salisbury State University

Agencies, Institutions, and Organizations:

The Library of Virginia
Virginia Department of Conservation & Recreation,
Division of State Parks
The Nature Conservancy, Virginia Chapter
North Carolina Division of Parks & Recreation,
Natural Heritage Program
Tennessee Valley Authority, Natural Heritage Program
New York Botanical Gardens
Smithsonian Institution

3. Editor's Report

Banisteria is a well-edited, peer-reviewed journal designed for articles and scientific papers on the natural history of Virginia in the broadest sense. This is the place for manuscripts derived from natural history observations, small-scale field projects, distribution surveys and reviews, species inventories, reports for contracted environmental projects, and unpublished theses. The journal also is suited for papers on the history of natural history and for papers that deal with biographical material on naturalists who have worked in Virginia. To qualify for publication in our journal, the manuscript must pertain in some way to species of plants and animals native to the Commonwealth. Papers focusing largely on projects conducted outside of the state will be considered as long as there is a strong connection to Virginia in some way. Papers may be full length or shorter contributions, and we are always looking for book reviews. There are no page charges and authors are not required to be members of the VNHS to submit manuscripts. The editors will be happy to assist authors in their preparation of manuscripts. We would rather help get natural history information published for others to use than have it remain on the shelf or in someone's desk. Submit your papers on vertebrates, history, and biography to Joseph C. Mitchell and those on plants, invertebrates, and book reviews to Steven M. Roble.

The fall issue of *Banisteria* (number 16) will be published a little later than usual this year largely due to the slow rates of manuscript submission and reviewer return. We have long been plagued with too few manuscripts and are wondering why people are not submitting their observations, reports, and theses to us. It is not a hard thing to do. Our job is to help you get manuscripts in shape for publication so that valuable natural history observations are not lost forever.

The spring 2001 issue of *Banisteria* (number 17) will contain papers on a diverse array of organisms, as well as several book reviews. We are dedicating our efforts to publish this one in May. We would like several more papers to complete the issue, so submit your manuscripts now.

On a personal note - The quality of our journal continues to improve thanks to the persistence of editor Steve Roble. I want to thank him publicly for his dedication to detail and his tenacity to make this an accurate and attractive journal.

Joseph C. Mitchell, Co-editor

Announcements

1. A VNHS membership renewal form, membership recruitment brochure, and election ballot are enclosed with this issue of *Banisteria*. Membership in the VNHS is on a calendar year basis (expires in December). Please return your renewal form and 2001 dues check promptly to Anne Lund, VNHS Secretary/Treasurer. The ballot contains background information on the current slate of candidates for Vice President, Councilor (two vacancies), and Secretary/Treasurer. Please return ballots by April 1 to Werner Wieland, VNHS President.

2. Eighth Annual Meeting of the Virginia Natural History Society

The 8th annual meeting of the VNHS will be held on May 24, 2001, at James Madison University, Harrisonburg, VA. Contact Dr. Werner Wieland, VNHS President, for information about submissions of titles and abstracts, or visit this web site:

http://www.vacadsci.org/meet2001/meet2001.htm

The meeting is held in conjunction with the Virginia Academy of Science in the Biodiversity and Natural History Section.

VNHS members should attend our annual meetings and give papers. We all want to know what you are doing. Communication is a key part of documenting valuable natural history information; and it is ALL valuable.

Instructions for Contributors

Banisteria accepts manuscripts that contribute to the public and scientific knowledge of the natural history of Virginia. This publication is intended to be an outlet for the kind of information that is useful but would not be accepted in the mainstream journals. Information found in field notebooks and files that never made it into scientific journals is especially important. The focus of *Banisteria* is classical and therefore slanted toward organismal biology. Reviews of books relevant to Virginia's natural history and biographies of naturalists influential in this field are also welcomed by the editors.

Manuscripts on vertebrates, history, biography, and material for the Miscellanea section (announcements, news of members, obituaries, etc.) should be sent to Joe Mitchell. Manuscripts on plants, invertebrates, and book reviews should be sent to Steve Roble. Papers on other topics can be submitted to either editor. Mitchell and Roble will serve as editors for each other's papers and an associate editor will be asked to serve as editor for those papers written jointly by the co-editors.

Manuscripts should be sent in duplicate to the appropriate co-editor (see previous paragraph), who will in turn seek one or two reviews. Authors should retain both the original typescript and figures until final acceptance for publication. Photocopies are adequate for review purposes.

Manuscripts must be written on one side of standard size paper (21.5 x 28 cm) using double spacing throughout. Words should not be hyphenated. Manuscripts should be arranged in the following order: **title, author's name, author's address, text, acknowledgments, literature cited, tables, figure legends, figures**. Long manuscripts may follow standard sections, e.g., Materials and Methods, Results, and Discussion, although some papers may not be amenable to such division, and short manuscripts (<4-6 pages) need not have these sections. All pages should be numbered, including tables. The title should be concise but informative. It and the author's name and address should be centered at the top of the first page. The text should begin on the first page beneath the author's address. Use good judgment on arrangement of sections when other than the standard approach is necessary. Use italics or underlines for species' scientific names.

References: Use the following as a guide. Do not abbreviate journal names.

Journal article with 1 author:
Scott, D. 1986. Notes on the eastern hognose snake, *Heterodon platyrhinos* Latreille (Squamata:Colubridae), in a Virginia barrier island. Brimleyana 12: 51-55.

Journal article with 2 authors:
Tilley, S. C., & D. W. Tinkle. 1968. A reinterpretation of the reproductive cycle and demography of the salamander *Desmognathus ochrophaeus.* Copeia 1968: 299-303.

Journal article with 3+ authors:
Funderburg, J. B., P. Hertz, & W. M. Kerfoot. 1974. A range extension for the carpenter frog, *Rana virgatipes* Cope, in the Chesapeake Bay region. Bulletin of the Maryland Herpetological Society 10: 77-79.

Book:
Harris, L. D. 1984. The Fragmented Forest. University of Chicago Press, Chicago, IL. 211 pp.

Chapter in a book:
Gentry, A. H. 1986. Endemism in tropical versus temperate plant communities. Pp. 153-181 *In* M. Soule (ed.), Conservation Biology. Sinauer Associates, Inc., Sunderland, MA.

Report:
The Nature Conservancy. 1975. The preservation of natural diversity: A survey and recommendations. Report to the U.S. Department of Interior, Washington, D.C. 189 pp. (include report series and number if present).

Tables: Each table should be typed on a separate sheet of paper. A legend for each table should follow the number and must be on the same page as the table. Ruled, horizontal lines should be avoided except at the top and bottom of the table. Remember that **each table must fit within a space of 8.5 x 6.5 inches**, and that reduction may cause loss of detail.

Figures: Black and white line drawings are acceptable for publication. They should be no more than twice the size of final publication size, and if several are assembled as a plate, keep the ratio of height to width consistent with the rectangular shape of the page. The back of each figure should be labeled with the author's name.

Photographs: *Banisteria* will accept high contrast black and white photographs. Submit at least 5 x 7 inch photos and mount them if possible. Remember that reduction to fit column or page width will cause loss of detail.

Abbreviations: The following common abbreviations are accepted in *Banisteria:* n (sample size), no. (number), SVL (snout-vent length; define on first usage); DBH (diameter at breast height); yr (years), mo (months), wk (weeks), h (hours), min (minutes), s (seconds), P (probability), df (degrees of freedom), SD and SE (standard deviation and standard error), ns (not significant), l (liter), g (gram), mm (millimeter), m (meter), km (kilometer), and C (degrees Celsius). Do not abbreviate "male" and "female", or dates, or undefined terms.

Electronic transfer of manuscripts: Once a manuscript has been accepted for publication, one paper copy and an electronic copy on a 3.5 inch diskette should be sent to S. M. Roble. If possible, use IBM-compatible systems with Word Perfect or Microsoft Word. Please do not justify right-hand margins, and do not attempt to produce "camera-ready copy."

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Muscipula Regia, s.
Lychnis viscosa flore
amplo coccineo.