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# *BARTONIA*

## Journal of the Philadelphia Botanical Club

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Membership/subscription correspondence:
Elizabeth Farley
The Philadelphia Botanical Club
Botany Department
Academy of Natural Sciences
1900 Benjamin Franklin Parkway
Philadelphia, PA 19103-1195

Manuscript submission:
Roger Latham, Editor
*Bartonia*
P.O. Box 57
Wallingford, PA 19086-0057
rogerlatham@dca.net

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# Structure and Composition of a Northern Hardwood Forest Exhibiting Regeneration Failure

DANIEL S. TOWNSEND, JENNIFER S. SEVA[1], CAROL HEE-SEAGLE[2] AND GLEN MAYERS[3]
*Biology Department, University of Scranton, Scranton, PA 18510*
*townsenddl@UofS.edu*

ABSTRACT. We surveyed trees (dbh >10.0 cm), saplings (>140 cm tall to dbh ≤10.0 cm), seedlings/sprouts (11 to 140 cm tall) and shrubs of a hemlock-mixed northern hardwoods forest at Lacawac Sanctuary in northeastern Pennsylvania. The canopy (24 species, 490.5 stems $ha^{-1}$) was dominated by eastern hemlock (*Tsuga canadensis*) with red maple (*Acer rubrum*) and red oak (*Quercus rubra*) as subdominants. Other canopy trees, in descending order of importance, were chestnut oak (*Quercus prinus*), American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), white pine (*Pinus strobus*) and sweet birch (*Betula lenta*). The sapling stratum (22 species, 239.5 stems $ha^{-1}$) was dominated by *T. canadensis* with *F. grandifolia*, *A. rubrum* and *A. saccharum* as subdominants. Oak saplings were rare (*Q. rubra*) or absent (*Q. prinus*). Sapling density was only 49% that of canopy density. Small saplings (0.1 to 2.5 cm dbh) were very sparse (14.0 stems $ha^{-1}$) and 82% were *T. canadensis* or *F. grandifolia*. The seedling/sprout layer (23 species, 444 stems $ha^{-1}$) was dominated by *F. grandifolia* (236 stems $ha^{-1}$), which occurred solely as root suckers. Only 6% of seedlings/sprouts (24.7 stems $ha^{-1}$) were >30 cm tall, the majority of which were *F. grandifolia* (18.6 stems $ha^{-1}$) and *T. canadensis* (4.8 stems $ha^{-1}$). Hence, the Lacawac Sanctuary forest was almost devoid of woody stems from 31 cm tall to 2.5 cm dbh, exhibiting much lower densities than most other eastern U.S. forests, either second-growth or old-growth, that we surveyed. Only forests with very high densities of white-tailed deer (*Odocoileus virginianus*) had comparably low seedling and sapling densities.

## INTRODUCTION

Lacawac Sanctuary is a 202-ha forested nature preserve located on the Pocono Plateau (Allegheny Plateaus Province) in northeastern Pennsylvania. Although it lies within Braun's (1950) hemlock-white pine-northern hardwood forest region, Lacawac's location is quite close (ca. 15 km east) to the border between the northern hardwood and Appalachian oak forest regions (Kuchler 1964; Rhoads and Klein 1993). Russell et al. (1993) viewed Lacawac as occupying the transition zone between the two forest biomes, but assigned it to the Appalachian oak forest based on the fairly high percentage of oak (*Quercus*) pollen in a sediment core from Lake Lacawac. We conducted this study, in part, to address the question of Lacawac Sanctuary's forest type affiliation by quantitatively documenting its current structure and composition.

Dramatic changes occurred in eastern North American forests subsequent to European settlement, principally as a consequence of human activities (Whitney 1994). Timbering and clearing of land for agriculture resulted in widespread destruction of eastern forests during

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*Current addresses*: [1]5-1 Denver Road, Denver, PA 17517; [2]Department of Marine Science, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599; [3]74 Indian Rocks, Lake Ariel, PA 18436

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the eighteenth and nineteenth centuries (Whitney 1994). Land use changes during the twentieth century have allowed forests to recover in many areas, including Pennsylvania, although forest composition and structure have changed considerably from pre-settlement forests (Whitney 1994). Two changes in eastern North American forests that have occurred during the twentieth century include an apparent decline in oak dominance (Abrams 1992) and the increased importance of red maple (*Acer rubrum*; Abrams 1998). Oak decline is attributed to widespread regeneration failure arising from a combination of factors, including understory competition from late successional, shade-tolerant species, selective logging, and long-term fire suppression (Abrams 1992). The increasing importance of red maple seems to arise from its adaptability to a range of light and edaphic conditions, combined with widespread fire suppression (Lorimer 1984; Abrams 1998).

Browsing by overabundant white-tailed deer (*Odocoileus virginianus* Zimmerman) is another factor that has dramatically altered eastern forest structure and composition in the twentieth century (Whitney 1994). Deer at densities greater than 8 to 10 deer km$^{-2}$ can significantly affect forest community structure (Whitney 1984, 1990; Frelich and Lorimer 1985; Tilghman 1989; Anderson and Katz 1993; Rooney and Dress 1997), plant population ecology (Anderson 1994; Balgooyen and Waller 1995; Rooney 1997) and other wildlife (DeCalesta 1994). Excessive browsing can significantly reduce or eliminate regeneration of woody species (Anderson and Loucks 1979; Alverson and Waller 1997; Healy 1997; Rooney and Waller 1998), reduce density and reproductive success of shrubs and herbs (Allison 1990a, 1990b, 1992; Anderson 1994; Rooney 1997) and lower the diversity of forest herbs (Rooney and Dress 1997).

At Lacawac Sanctuary, anecdotal observations of high deer abundance and browsing damage to woody and herbaceous vegetation date from the early 1970s (Arthur Watres, pers. comm.). Low levels of deer hunting occurred on the sanctuary until 1984, when hunting was banned. When we began this study in 1991, an obvious browse line at 1.5 to 1.6 m and a dearth of understory plants were evident throughout the sanctuary. Annual deer hunts, reinitiated at Lacawac in 1994, have harvested an average of 22 deer yr$^{-1}$. In a 2000 census at the sanctuary, we estimated deer density at 19 to 29 deer km$^{-2}$ (Townsend, unpubl.). It is therefore likely that deer densities prior to the study on which we report here were at least as high. Our second objective in this study was to quantitatively document the condition of the woody understory in the sanctuary forest.

## Field Site Description

Lacawac Sanctuary (41°23′ N, 75°17′ W) is a 202-ha nature preserve located at the northern edge of the Pocono Plateau, in Paupack Township, Wayne County, Pennsylvania. The Pocono Plateau is a moderately rolling elevated tableland that lies in the eastern glaciated region of the Allegheny Plateaus Province. The Pocono Plateau forest represents the southeastern-most extent of the hemlock-white pine-northern hardwoods region, and is bounded to the west, south and east by Appalachian oak forest (Braun 1950; Kuchler 1964; Rhoads and Klein 1993).

The climate of Wayne County is typified by cold winters and moderately warm summers, with temperatures ranging from a mean daily minimum of -11.4° C in January-February to mean daily maxima of 26.7° C and 25.9° C in July and August, respectively. Average daily temperatures range from -5.1° C in January to 19.9° C in July (Martin 1985). Mean annual precipitation is 98.2 cm, about 55% of which falls during the growing season of April through September. Mean annual snowfall is 145.3 cm; on average, 52 days a year have at least 2.5 cm of snow on the ground (Martin 1985).

The sanctuary, situated on the north shore of Lake Wallenpaupack (a man-made hydropower reservoir), includes a 20.2-ha glacial lake, Lake Lacawac, and virtually its entire watershed. Sanctuary elevations range from 366 m to 460 m. Most of the sanctuary has moderately rolling topography, with steeper slopes and bedrock outcrops occurring as ledges that drop more than 60 m to the shore of Lake Wallenpaupack in the southern part of the sanctuary. The bedrock of the sanctuary area is red Catskill sandstone (Mowbray 1971). Upland soils are derived mainly from glacial till, and are comprised of extremely stony loams of the Lordstown, Mardin, and Oquaga Series, and moderately well drained and somewhat poorly drained extremely stony loams of the Wellsboro Series (Martin 1985). Soil depths range from very shallow (in the ledges area) to greater than 1.5 m in some portions of the sanctuary (Martin 1985). Lacawac Sanctuary is more than 95% forested.

## METHODS

We surveyed four areas of upland forest on the sanctuary, covering approximately 100 ha, during June-August 1991-92. Based on sanctuary historical records, the time since last major timbering in the four stands ranged from 65 to 110 years.

We used a point-centered quarter method to sample canopy trees (Cottam and Curtis 1956; Brower et al. 1990), which we defined as those with dbh (diameter at breast height = diameter at 1.37 m) $>10$ cm. Sampling points were spaced at random distances between 25 and 50 m along parallel transects spaced at random intervals of 25 to 50 m. Any canopy tree with multiple trunks at breast height was counted as a single individual and represented by the sum of the basal areas of all living trunks.

Saplings, seedlings, sprouts, shrubs and lianas were sampled in one 10-m × 10-m plot at each point. Plots were placed at random in one of the four quarters at each point, with a plot corner at the point and two sides extending out along the cardinal compass points that defined the quarter. Saplings were defined as stems $>1.4$ m tall and $0.1 \text{ cm} < \text{dbh} \leq 10.0$ cm. Seedlings and sprouts were defined as stems 11 to 140 cm tall; we did not systematically record seedlings or sprouts $\leq 10$ cm tall. We examined each seedling-sized plant at ground level to determine whether it was a true seedling or a sprout. The vast majority of sprouts that we recorded (98.3%) were root suckers of *Fagus grandifolia*; a few others were basal sprouts of other species. In each plot, we identified and counted the number of saplings, seedlings, sprouts, shrubs and lianas; and we measured the dbh of each sapling, and the height of each seedling, sprout or shrub.

We indexed browsing damage to the root suckers of *F. grandifolia* under four categories (unbrowsed, light, moderate, heavy) based on evidence of deer bites that removed live terminals or branches (we did not include shoots that had been browsed in previous years or that had not produced new growth). "Unbrowsed" suckers were those that lacked any evidence of browsing on the terminal or any branch. "Light" browsing was recorded for any sucker with at least one, but no more than 50%, of its terminal and branches removed. "Moderate" browsing was recorded for suckers with more than 50% but not all of their shoots removed. "Heavy" browsing was recorded when all live shoots on a root sucker had been bitten off.

For each canopy tree and sapling species, we calculated density, relative density (RD), frequency, relative frequency (RF), basal area, relative basal area (RA), and importance value

(IV = (RD + RF + RA)/3) (Brower et al. 1990). For seedlings and sprouts, shrubs, and lianas, we computed density, RD and RF, and IV = ((RD + RF)/2) (Brower et al. 1990). We computed summary statistics for all variables using the values from each of the four stands as independent data points.

For each forest stratum in each of the four stands, we computed species richness, Simpson's diversity index, $D_s$, and Simpson's coefficient of evenness, $E_s$ (Simpson 1949, Brower et al. 1990). We then compared means for each variable among strata using one-way ANOVA (Zar 1999). We computed Morisita's index of community similarity ($I_M$) to make pairwise comparisons of the composition of canopy, sapling, and seedling/sprout strata (Horn 1966, Brower et al. 1990). Morisita's index ranges from zero when communities have no overlap to one when they are identical. All nomenclature follows Gleason and Cronquist (1991).

We compared Lacawac's forest structure and composition to several published studies in eastern U.S. forests. We developed an initial list of studies in which measures of composition and structure were given for all species in the canopy, sapling and seedling strata. We selected studies from the list so as to include both old-growth and second-growth forests that were representative of several eastern deciduous forest regions (Braun 1950), including mixed mesophytic, oak-hickory, oak-chestnut, beech-maple, and northern hardwood forests. We also included studies that covered more than one site, especially when sites differed in deer density and consequent browsing pressure.

## RESULTS

We sampled 392 points and associated plots (total plot area sampled = 3.92 ha), and recorded 43 taxa of canopy trees, saplings, seedlings/sprouts, shrubs, and lianas. We recorded 1,568 canopy trees (dbh >10 cm) comprising 24 species, yielding a density of 490.5 stems $ha^{-1}$ and a total basal area of 34.7 $m^2$ $ha^{-1}$ (Table 1). Canopy trees had a mean dbh of 30.0 cm and a mean basal area of 708 $cm^2$ $tree^{-1}$.

*Tsuga canadensis* was the dominant canopy tree, with an IV almost twice that of either *Acer rubrum* or *Quercus rubra*, the two subdominant trees (Table 1). These three species accounted for 65.6% of total IV. *Acer rubrum* had higher density and frequency but lower basal area than *Q. rubra* (Table 1), a result of *Q. rubra* stems being less common but much larger (mean basal area = 1,147 $cm^2$ $tree^{-1}$) than *A. rubrum* (mean basal area = 509 $cm^2$ $tree^{-1}$). *Quercus prinus*, *Fagus grandifolia* and *Acer saccharum* constituted a third group of important canopy trees (Table 1). The three oak species we observed, *Q. rubra*, *Q. prinus*, and *Q. alba* (white oak), together comprised 22.2% of canopy density and 26.4% of canopy IV.

One hundred ninety single-trunked canopy trees had dbh ≥40 cm, including *T. canadensis* (36% of total), *Q. rubra* (30%), *Q. prinus* (11%), *A. saccharum* (8%), *A. rubrum* (4%) and *P. strobus* (3%). The largest individual trees that we recorded included *P. strobus* (dbh = 81 cm), *Q. rubra* (77.5 cm) and *Liriodendron tulipifera* (tuliptree; 72.1 cm).

We recorded 947 saplings comprising 22 species, yielding a mean density among the four stands of 239.5 stems $ha^{-1}$ and a mean basal area of 3.5 $m^2$ $ha^{-1}$ (Table 2). No saplings occurred in 94 (24%) of the plots we sampled. The sapling layer was dominated by *T. canadensis*, with a mean IV (37.6%) greater than that of the three subdominant species (*F. grandifolia, A. rubrum* and *A. saccharum*) combined (Table 2). In contrast to *T. canadensis* and *Acer* spp., the vast majority (>99%) of *F. grandifolia* saplings were root sprouts. *Quercus* was effectively absent from the sapling stratum; we recorded only 10 *Q. rubra* saplings (2.8 stems

TABLE 1. Canopy tree density (stems ha$^{-1}$), basal area (m$^2$ ha$^{-1}$), relative density (RD), relative frequency (RF), relative basal area (RA), and importance value (IV) at Lacawac Sanctuary in 1991-1992; IV is the mean of RD, RF, and RA. Data are given as means (SEM).

| Species | Density | Basal Area | RD | RF | RA | IV |
|---|---|---|---|---|---|---|
| *Tsuga canadensis* (L.) Carriere | 157.2 (30.2) | 10.79 (2.05) | 32.8 (6.4) | 26.5 (4.1) | 31.1 (5.9) | 30.1 (5.4) |
| *Acer rubrum* L. | 94.0 (22.7) | 4.69 (1.23) | 19.7 (5.4) | 19.9 (4.5) | 13.8 (3.9) | 17.8 (4.6) |
| *Quercus rubra* L. | 74.4 (31.4) | 8.26 (2.27) | 14.3 (5.1) | 14.8 (3.5) | 24.0 (6.7) | 17.7 (5.1) |
| *Quercus prinus* L. | 39.5 (12.6) | 3.19 (1.02) | 7.7 (2.4) | 8.5 (2.6) | 9.0 (2.8) | 8.4 (2.6) |
| *Fagus grandifolia* Ehrhart | 31.8 (5.1) | 1.65 (0.34) | 6.4 (0.6) | 7.7 (0.8) | 4.7 (1.0) | 6.3 (0.8) |
| *Acer saccharum* Marshall | 29.2 (10.6) | 1.75 (0.82) | 5.8 (2.2) | 5.9 (2.0) | 4.9 (2.3) | 5.6 (2.1) |
| *Pinus strobus* L. | 16.6 (6.6) | 1.11 (0.45) | 3.4 (1.3) | 3.8 (1.5) | 3.3 (1.4) | 3.5 (1.3) |
| *Betula lenta* L. | 16.1 (6.0) | 0.85 (0.37) | 3.6 (1.6) | 4.3 (1.8) | 2.5 (1.1) | 3.5 (1.5) |
| *Fraxinus americana* L. | 9.8 (4.4) | 0.59 (0.31) | 2.0 (0.9) | 2.7 (1.2) | 1.6 (0.9) | 2.1 (1.0) |
| *Carya* spp.* | 4.8 (1.7) | 0.42 (0.19) | 0.9 (0.3) | 1.3 (0.4) | 1.2 (0.5) | 1.1 (0.4) |
| *Tilia americana* L. | 3.7 (3.3) | 0.36 (0.30) | 0.8 (0.7) | 1.0 (0.9) | 1.0 (0.8) | 0.9 (0.8) |
| *Betula alleghaniensis* Britton | 2.8 (1.2) | 0.19 (0.12) | 0.6 (0.3) | 0.8 (0.4) | 0.6 (0.4) | 0.7 (0.3) |
| *Ostrya virginiana* (Miller) K. Koch | 2.3 (1.4) | 0.05 (0.04) | 0.5 (0.3) | 0.7 (0.4) | 0.1 (0.1) | 0.4 (0.2) |
| *Prunus serotina* Ehrhart | 1.8 (0.8) | 0.08 (0.04) | 0.4 (0.2) | 0.5 (0.2) | 0.2 (0.1) | 0.4 (0.2) |
| *Liriodendron tulipfera* L. | 1.7 (1.1) | 0.28 (0.16) | 0.3 (0.2) | 0.4 (0.3) | 0.8 (0.5) | 0.5 (0.3) |
| Other species⁺ | 4.8 | 0.42 | 1.0 | 1.2 | 1.2 | 1.0 |
| Totals | 490.5 | 34.7 | | | | |

*Includes *Carya glabra* (Miller) Sweet, *C. ovata* (Miller) K. Koch and *C. tomentosa* (Poiret) Nutt.
⁺Other species (IV) include *Quercus alba* L. (0.3), *Nyssa sylvatica* Marshall (0.2), *Populus grandidentata* Michx. (0.2), *Pinus rigida* Mill. (0.1), *Carpinus caroliniana* Walter (0.1), *Picea glauca* (Moench) Voss (<0.1), *Pinus resinosa* Aiton (<0.1).

TABLE 2. Sapling* density (stems ha$^{-1}$), relative density (RD), relative frequency (RF), relative basal area (RA), and importance value (IV) at Lacawac Sanctuary in 1991-1992; IV is the mean of RD, RF, and RA. Data are given as means (SEM).

| Species | Density | RD | RF | RA | IV |
|---|---|---|---|---|---|
| *Tsuga canadensis* (L.) Carriere | 86.5 (14.8) | 41.8 (10.6) | 33.1 (7.9) | 45.6 (11.4) | 40.2 (10.0) |
| *Fagus grandifolia* Ehrhart | 40.4 (8.3) | 16.8 (1.8) | 15.7 (1.2) | 13.2 (0.5) | 15.2 (1.0) |
| *Acer rubrum* L. | 36.4 (25.1) | 11.7 (6.3) | 13.9 (4.9) | 14.9 (6.7) | 13.5 (5.9) |
| *Acer saccharum* Marshall | 22.6 (8.7) | 8.6 (2.9) | 10.1 (3.1) | 8.1 (2.1) | 8.9 (2.7) |
| *Ostrya virginiana* (Miller) K. Koch | 11.7 (4.0) | 4.7 (1.5) | 5.9 (2.3) | 4.9 (1.5) | 5.2 (1.7) |
| *Pinus strobus* L. | 10.6 (9.2) | 3.2 (2.4) | 3.5 (2.1) | 2.9 (2.5) | 3.2 (2.3) |
| *Betula* spp.** | 6.1 (1.3) | 3.1 (0.9) | 4.8 (1.3) | 3.2 (1.2) | 3.6 (1.1) |
| *Hamamelis virginiana* L. | 6.1 (5.1) | 1.8 (1.4) | 2.2 (1.6) | 0.7 (0.4) | 1.5 (1.1) |
| *Amelanchier* spp.*** | 5.2 (2.5) | 2.1 (1.0) | 2.4 (0.9) | 1.4 (0.6) | 2.0 (0.8) |
| *Ilex verticillata* (L.) A. Gray | 3.1 (3.1) | 1.9 (1.9) | 1.4 (1.4) | 0.6 (0.6) | 1.3 (1.3) |
| *Nyssa sylvatica* Marshall | 2.9 (1.7) | 1.2 (0.7) | 1.6 (1.3) | 1.4 (0.9) | 1.4 (1.0) |
| *Quercus rubra* L. | 2.8 (1.8) | 1.0 (0.5) | 1.8 (0.9) | 1.3 (0.8) | 1.3 (0.7) |
| *Fraxinus americana* L. | 1.9 (0.7) | 0.8 (0.3) | 1.3 (0.5) | 0.7 (0.3) | 0.9 (0.4) |
| Other species⁺ | 3.2 | 1.3 | 2.3 | 1.1 | 1.8 |
| Total Density | 239.5 | | | | |

*Saplings were defined as stems >1.4 m tall (with a minimum dbh = 0.1 cm) and a dbh ≤10.0 cm.
**Includes *Betula lenta* L. and *B. alleghaniensis* Britton.
***Includes *Amelanchier arborea* (Michx. f.) Fern. and *A. laevis* Weig.
⁺Other species (IV) include *Carya ovata* (Miller) K. Koch (0.6), *Carpinus caroliniana* Walter (0.3), *Abies balsamea* (L.) Miller (0.2), *Tilia americana* L. (0.2), *Acer saccharinum* L. (0.1), *Crataegus* sp. (0.1), and *Pinus resinosa* Aiton (0.1).

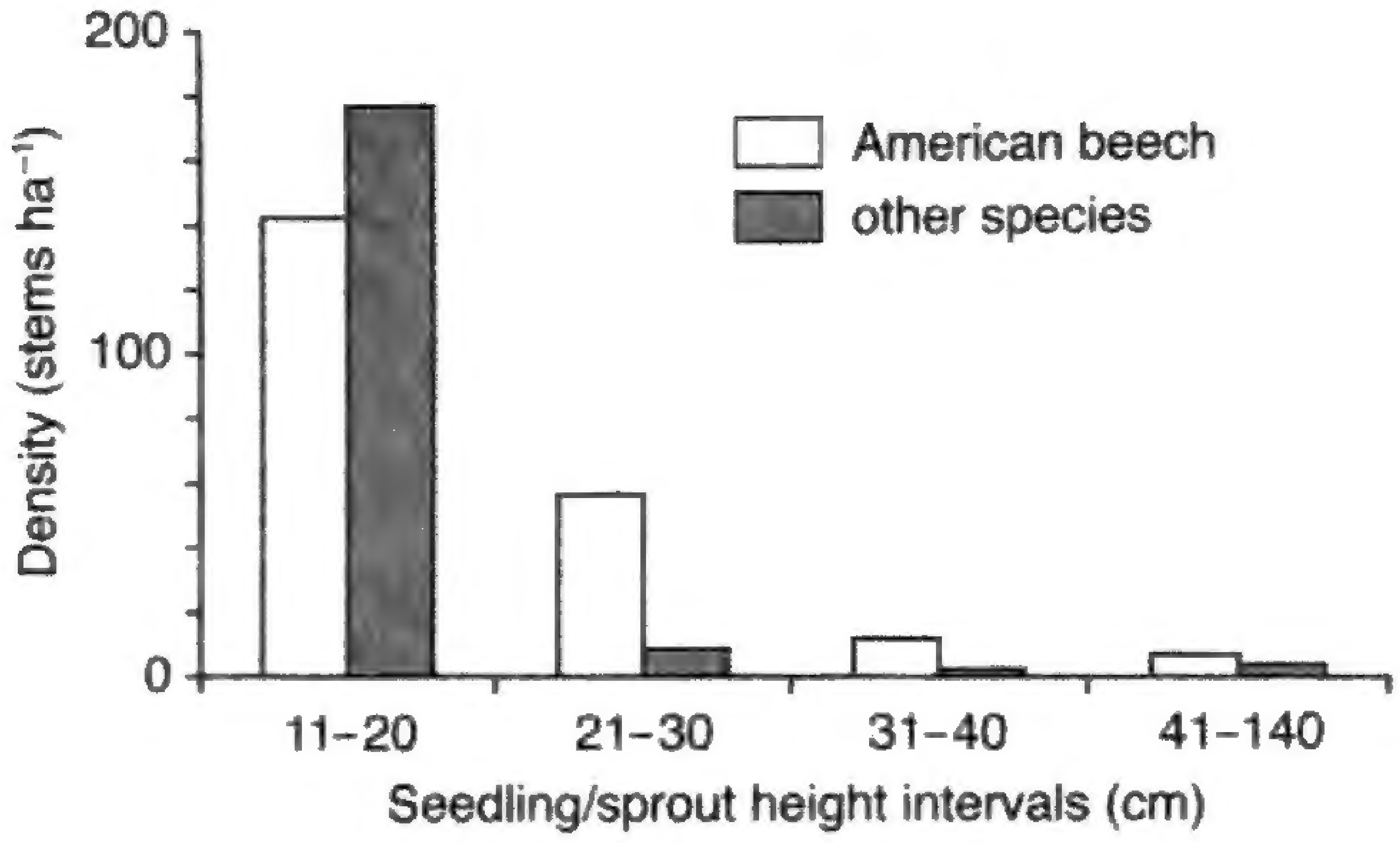


Figure 1. Density of seedlings and sprouts at Lacawac Sanctuary in 1991-92. Open bars represent the root sprouts of American beech (*Fagus grandifolia* Ehrhart); hatched bars represent the seedlings and sprouts of all other species.

$ha^{-1}$, 1.3% of sapling IV) and no saplings of *Q. prinus* or *Q. alba* (Table 2).

The density of saplings was only 49% of that of canopy trees (Tables 1, 2). In fact, the ratio of sapling density to canopy tree density was <1.0 for every species except *F. grandifolia* (1.27), including *T. canadensis* (0.55), *A. rubrum* (0.39), *Q. rubra* (0.04), *Q. prinus* (0), *A. saccharum* (0.77), *Betula* spp. (0.32), *P. strobus* (0.64), and *Fraxinus americana* (white ash; 0.19). The dearth of saplings was especially acute for the smallest size interval (dbh = 0.1 to 2.5 cm), in which we recorded only 57 stems (14.0 stems $ha^{-1}$), 82% of which were *T. canadensis* or *F. grandifolia* (Table 3).

We recorded 1,600 seedlings and sprouts (11 to 140 cm tall), comprising 23 species with a mean seedling/sprout density of 444 stems $ha^{-1}$ (Table 4). *Fagus grandifolia* dominated this stratum, with 42% of seedling/sprout IV; however, it occurred only as root sprouts, never as true seedlings or basal stem sprouts. Among the seedlings/sprouts of other species ($n$ = 743; 190 stems $ha^{-1}$), *Q. rubra* and *T. canadensis* were most important, while *A. rubrum*, *Amelanchier* spp. (serviceberry) and *P. strobus* comprised a third tier (Table 4). In contrast to *F. grandifolia*, most seedling-sized plants of other species were true seedlings; basal stem sprouts were rare ($n$ = 21) and there were no root sprouts.

Most *F. grandifolia* root sprouts (91.5%) were ≤30 cm tall (Figure 1) and showed evidence of extensive and repeated browsing. Of 857 beech root sprouts that we recorded, none were unbrowsed, and only a few (2%) showed light browsing. The vast majority were moderately (34%) or heavily (64%) browsed. Moderately to heavily browsed sprouts typically occurred as low, shrubby plants with thickened stems bearing numerous short branches (usually less than 10 cm) and a few small leaves.

For canopy species other than beech, the great majority of seedlings and sprouts (96.8%) were ≤30 cm tall (Figure 1); we recorded only 24 true seedlings that were >30 cm tall and 79% of those were *T. canadensis*. Although *Q. rubra* seedlings were fairly abundant (18.3% of seedling/sprout density), only 5 seedlings were 21 to 30 cm and none were >30 cm. We recorded only 10 *Q. prinus* seedlings/sprouts (four were basal stem sprouts); all were 11 to 20 cm. Seedlings and sprouts of understory tree and tall shrub species, including *Hamamelis virginiana* (witch-hazel), *Ilex verticillata* (winterberry), *Rhododendron maximum* (white-laurel), *Vitis labrusca* (fox grape), *Kalmia latifolia* (mountain-laurel), and *Vaccinium corymbosum* (highbush blueberry) were rare or absent (Table 4), and always ≤20 cm tall when present.

Because the heavy shade of *T. canadensis* may often result in low regeneration, we tested the hypothesis that seedling density varied with hemlock density among the four stands using the Pearson product-moment correlation coefficient (Zar 1999). The density of true seedlings (excluding sprouts) ranged from 79 to 301 seedlings $ha^{-1}$ among the four forest stands, while density of *T. canadensis* (canopy trees and saplings combined) ranged from 154 to 348 trees $ha^{-1}$. The correlation ($r_s$ = -0.686, $n$ = 4, $P$ >0.10) was not significant, although

TABLE 3. Sapling size distribution at Lacawac Sanctuary in 1991-1992. *n* = number of stems recorded in 392 100m² plots. Dashes indicate that a species did not occur in a size class.

| | | Dbh Intervals (cm) | | | |
|---|---|---|---|---|---|
| Species | *n* | 0.1-2.5 | 2.6-5.0 | 5.1-7.5 | 7.6-10.0 |
| *Tsuga canadensis* (L.) Carriere | 347 | 21 | 73 | 93 | 160 |
| *Acer rubrum* L. | 137 | — | 28 | 50 | 59 |
| *Fagus grandifolia* Ehrhart | 165 | 26 | 39 | 61 | 39 |
| *Acer saccharum* Marshall | 97 | 4 | 36 | 25 | 32 |
| *Ostrya virginiana* (Miller) K. Koch | 49 | 2 | 14 | 15 | 18 |
| *Pinus strobus* L. | 38 | — | 13 | 11 | 14 |
| *Betula* spp.* | 22 | 1 | 7 | 5 | 9 |
| *Hamamelis virginiana* L. | 23 | 1 | 20 | — | 2 |
| *Amelanchier* spp.** | 19 | — | 11 | 4 | 4 |
| *Quercus rubra* L. | 10 | — | 1 | 2 | 7 |
| *Nyssa sylvatica* Marshall | 10 | — | 2 | 5 | 3 |
| *Fraxinus americana* L. | 8 | 1 | 3 | 2 | 2 |
| Other species⁺ | 23 | 1 | 13 | 6 | 3 |
| Density (stems $ha^{-1}$) | 239.5 | 14.0 | 65.8 | 70.6 | 89.1 |

*Includes *Betula alleghaniensis* Britton and *B. lenta* L.
**Includes *Amelanchier arborea* (Michx. f.) Fern. and *A. laevis* Wieg.
⁺Includes *Abies balsamea* (L.) Miller, *Acer saccharinum* L., *Carpinus caroliniana* Walter, *Carya ovata* (Miller) K. Koch, *Crataegus* sp., *Ilex verticillata* (L.) A. Gray, *Pinus resinosa* Aiton, and *Tilia americana* L.

TABLE 4. Seedling and sprout* density (stems $ha^{-1}$), relative density (RD), relative frequency (RF), and importance value (IV) at Lacawac Sanctuary in 1991-1992; IV is the mean of RD and RF. Data are given as means (SEM).

| Species | Density | RD | RF | IV |
|---|---|---|---|---|
| *Fagus grandifolia* Ehrhart | 235.9 (86.8) | 49.9 (6.7) | 34.0 (2.6) | 41.9 (4.0) |
| *Quercus rubra* L. | 85.6 (25.0) | 18.3 (4.2) | 30.1 (7.6) | 24.2 (5.8) |
| *Tsuga canadensis* (L.) Carriere | 54.6 (12.1) | 15.9 (5.3) | 15.6 (2.9) | 15.7 (3.9) |
| *Acer rubrum* L. | 22.7 (9.7) | 4.4 (1.4) | 5.4 (1.2) | 4.9 (1.2) |
| *Amelanchier* spp.** | 15.5 (5.9) | 3.8 (1.3) | 4.2 (1.6) | 4.1 (1.5) |
| *Pinus strobus* L. | 11.3 (6.8) | 2.0 (1.4) | 2.9 (1.7) | 2.5 (1.5) |
| *Fraxinus americana* L. | 3.5 (1.4) | 1.6 (1.0) | 2.3 (1.2) | 2.0 (1.1) |
| *Quercus prinus* L. | 2.3 (0.8) | 1.0 (0.6) | 1.7 (0.8) | 1.3 (0.7) |
| *Acer pensylvanicum* L. | 2.2 (2.2) | 0.5 (0.5) | 0.5 (0.5) | 0.5 (0.5) |
| *Rhododendron maximum* L. | 1.9 (1.9) | 0.4 (0.4) | 0.2 (0.2) | 0.3 (0.3) |
| *Prunus serotina* Ehrh. | 1.5 (0.9) | 0.2 (0.1) | 0.4 (0.2) | 0.3 (0.2) |
| *Ilex verticillata* (L.) A. Gray | 1.5 (1.5) | 0.3 (0.3) | 0.2 (0.2) | 0.3 (0.3) |
| *Carya* spp.*** | 1.2 (0.9) | 0.7 (0.7) | 1.1 (0.9) | 0.9 (0.8) |
| Other species⁺ | 3.8 | 1.0 | 1.1 | 1.1 |
| Total Density | 443.6 | | | |

*Seedlings and sprouts were defined as stems 11 to 140 cm tall.
**Includes *Amelanchier arborea* (Michx. f.) Fern. and *A. laevis* Wieg.
***Includes *Carya glabra* (Miller) Sweet, *C. ovata* (Miller) K. Koch, and *C. tomentosa* (Poiret) Nutt.
⁺Other species (IV) include *Betula* spp. (0.3), *Tilia americana* L. (0.3), *Vitis labrusca* L. (0.2), *Acer saccharum* Marshall (0.1), *Hamamelis virginiana* L. (0.1), and *Nyssa sylvatica* Marshall (0.1).

TABLE 5. Shrub and liana density (stems ha$^{-1}$), relative density (RD), relative frequency (RF), and importance value (IV) at Lacawac Sanctuary in 1991-1992; IV is the mean of RD and RF. Data are given as means (SEM).

| Species | Density | RD | RF | IV |
|---|---|---|---|---|
| *Vaccinium angustifolium* Aiton* | 251.3 (108.5) | 50.5 (21.0) | 41.9 (12.1) | 46.2 (16.3) |
| *Rhododendron maximum* L. | 182.4 (133.7) | 36.2 (18.2) | 26.5 (12.0) | 31.4 (15.0) |
| *Vitis labrusca* L. | 20.4 (8.9) | 9.1 (6.3) | 17.0 (6.5) | 13.1 (6.2) |
| *Kalmia latifolia* L. | 6.3 (3.2) | 1.0 (0.4) | 3.6 (1.5) | 2.3 (0.9) |
| *Vaccinium corymbosum* L. | 4.2 (2.7) | 0.6 (0.4) | 2.6 (1.5) | 1.6 (0.9) |
| *Rubus hispidus* L. | 2.5 (0.8) | 0.7 (0.3) | 3.3 (1.3) | 2.0 (0.8) |
| *Berberis thunbergii* DC. | 1.7 (1.7) | 0.5 (0.5) | 1.4 (1.4) | 1.0 (1.0) |
| *Parthenocissus quinquefolia* (L.) Planchon | 2.3 (1.3) | 1.0 (0.7) | 1.6 (0.9) | 1.3 (0.8) |
| *Viburnum acerifolium* L. | 0.4 (0.4) | 0.1 (0.1) | 0.4 (0.4) | 0.2 (0.2) |
| *Ribes* sp. | 0.6 (0.6) | 0.1 (0.1) | 0.4 (0.4) | 0.2 (0.2) |
| *Sambucus racemosa* L. | 0.3 (0.3) | 0.2 (0.2) | 0.9 (0.9) | 0.5 (0.5) |

*may include some plants of *V. pallidum* Aiton.

the negative sign and size suggest a potential inverse relationship between the two variables (statistical power was low due to small sample size). However, even in one forest stand where *T. canadensis* was third in importance (IV = 13.7) behind *A. rubrum* (IV = 25.2) and *Q. rubra* (IV = 18.8), seedling density was only 288 seedlings ha$^{-1}$, 98.8% of which were 11 to 30 cm tall.

The shrub layer was sparse, with 196 (50%) of the plots we surveyed lacking any shrubs or lianas. *Vaccinium angustifolium* (lowbush blueberry) was the most common shrub, occurring in 27.8% of all plots at a mean density of 251 stems ha$^{-1}$ (Table 5). The majority (92.5%) of *V. angustifolium* shrubs were ≤30 cm tall. *Rhododendron maximum*, the only other common shrub, occurred in 15.3% of all plots at a mean density of 182 stems ha$^{-1}$ (Table 5). *Kalmia latifolia* and *Vaccinium corymbosum* were minor constituents of the shrub layer. *Vitis labrusca* was the most common liana (Table 5).

There were significant differences among the four strata (trees, saplings, seedlings/sprouts and shrubs) in species richness ($F_{3,12}$ = 9.80, $P$ = 0.002), species diversity ($F_{3,12}$ = 11.00, $P$ <0.001), and species evenness ($F_{3,12}$ = 8.60, $P$ = 0.003). Multiple comparisons tests for all three variables indicated that significant ANOVAs were solely a consequence of significantly lower richness, diversity and evenness of shrubs (all $P$ <0.05) compared to the other three strata. Although means of all three variables declined from trees to saplings to seedlings, the declines were not statistically different.

Morisita's index of community similarity indicated fairly strong overlap between canopy trees and saplings (Mean $I_M$ = 0.82, SEM = 0.05), a much lower overlap between saplings and seedlings/sprouts (Mean $I_M$ = 0.45, SEM = 0.04), and the lowest overlap between canopy trees and seedlings/sprouts (Mean $I_M$ = 0.38, SEM = 0.05). The differences in similarity values were significant ($F_{2,11}$ = 21.62, $P$ <0.001).

## DISCUSSION

### Forest Type Affiliation

The Lacawac forest is a hemlock-red maple-red oak mixed hardwoods forest, at least in its canopy composition. We agree with Russell et al. (1993) that it could be viewed as a transition between the Appalachian oak and northern hardwoods biomes, and our canopy data confirm their findings of a stronger oak presence than would be expected of a typical northern hardwoods forest (Table 1). However, for several reasons, we suggest that Lacawac should be regarded as more closely affiliated with the northern hardwoods than the Appalachian oak forest (Braun 1950, Kuchler 1964). First, only two *Quercus* species were common, and *Q. rubra* is not an unusual constituent of northern hardwoods forests, especially in eastern areas of the Allegheny Section (Braun 1950). Second, besides *T. canadensis* and *A. rubrum* being the two most common species, *F. grandifolia*, *A. saccharum*, *P. strobus* and *B. lenta* were all fairly well represented in the canopy. Third, sapling composition was strongly representative of a typical northern hardwoods forest (Table 2), with a virtual absence of *Quercus*.

Our results add Lacawac to a list of eastern U.S. forests in which *Quercus* is declining in importance (Crow 1988, Abrams and Downs 1990, Abrams 1992). Although still important in the canopy, the striking dearth of *Q. rubra* or *Q. prinus* in the sapling and seedling strata portends a steady oak decline at Lacawac over the next several decades as canopy trees die. Oak regeneration failure at Lacawac is likely the result of a combination of factors, including heavy shade (especially in hemlock-dominated stands), the absence of fire for at least the last 50 years, and deer browsing (Crow 1992; Abrams 1992). There have been no fires in the sanctuary forest since 1948, and probably for several decades before that (Arthur Watres, pers. commun.).

**Regeneration Failure**

The forest understory at Lacawac Sanctuary was largely devoid of sizeable seedlings or sprouts and small saplings. Densities of seedlings/sprouts and saplings were among the lowest values reported in the literature for any of several eastern U.S. forests that we surveyed, either second-growth or old-growth (Table 6). In second growth forest stands in Wisconsin, Anderson and Katz (1993) found seedling densities (stems 15 cm tall to 1.3 cm dbh by their definition) ranging from 7,079 stems $ha^{-1}$ in stands "subjected to intense deer browsing pressure" to 16,055 stems $ha^{-1}$ in stands where deer had been excluded for 27 years. Using more liberal size limits (11 cm tall to 2.5 cm dbh), we recorded densities of only 458 stems $ha^{-1}$ (Figure 1, Table 3). In a Pocono Plateau hardwood forest located about 50 km south of Lacawac, Held and Giuliani (1989) reported sapling densities (stems 1.0 m tall to 10.0 cm dbh by their definition) of 1,658 stems $ha^{-1}$. By contrast, stems in the same size range at Lacawac occurred at a density of 241 stems $ha^{-1}$. Even discounting Held and Giuliani's (1989) inclusion of *Kalmia latifolia* among saplings (we report them as shrubs), sapling density at their site was still about six times greater than at Lacawac.

In a western Pennsylvania old-growth forest, where deer browsing had severely impacted the understory, Whitney (1984) found densities of small saplings (30 cm tall to 2.5 cm dbh by his definition) that ranged from 28 to 110 stems $ha^{-1}$. Applying the same size criteria, we found densities of 38.7 stems $ha^{-1}$ at Lacawac. Whitney's (1984) was the only eastern forest site that we found in the literature with seedling and sapling densities as low as those at Lacawac.

We propose the use of the ratio of sapling density to canopy density as a useful measure of understory condition. In most forests, sapling to canopy density ratios are >1.0 (Table 6). The ratio at Lacawac (0.49) was much lower than in any study we examined, except for a second-growth forest in northern Wisconsin (sapling/canopy density = 0.11) noted to have been subjected to "intense deer browsing pressure" (Anderson and Katz 1993).

TABLE 6. Densities (stems ha$^{-1}$) of seedlings, saplings, and canopy trees in some eastern U.S. forests. For size class definitions of seedlings, saplings, and canopy trees, which vary among studies, see table footnotes.

| Study Location | Forest Status | Dominant Canopy Species | Seedling Density | Sapling Density | Canopy Density | Sapling:Canopy Density Ratio |
|---|---|---|---|---|---|---|
| Pennsylvania[1] | 2nd growth | TSCA-ACRU-QURU | 444 | 240 | 491 | 0.49 |
| Pennsylvania[2] | 2nd growth | ACRU-FAGR | 26,367 | 1,658 | 559 | 2.97 |
| Pennsylvania[3] | 2nd growth | BELE-QUPR-QURU | 47,020 | 1,620 | 464–560** | 2.89–6.65** |
| | | QUPR-QURU | 56,690 | 1,676 | | |
| | | Mixed *Quercus* | 66,350 | 3,085 | | |
| | | QUAL | 95,600 | 2,619 | | |
| Pennsylvania[4] | Old growth | TSCA-FAGR | 20,259 | 273 | 358 | 0.76 |
| | | TSCA | 19,631 | 611 | 413 | 1.48 |
| Pennsylvania[5] | Old growth | FAGR-ACRU-LITU | 53,300 | 450 | 405 | 1.11 |
| Ohio[6] | Old growth | ACSA-FAGR | — | 647 | 414 | 1.56 |
| Kentucky[7] | Old growth | CAOV-ACRU | 8,665 | 429 | 373 | 1.15 |
| Wisconsin[8] | 2nd growth | | | | | |
| Site A | | ABBA | 16,055 | 2,643 | 675 | 3.92 |
| Site B | | TSCA-BEAL | 12,372 | 7,326 | 386 | 18.98 |
| Site C | | TSCA | 11,749 | 955 | 545 | 1.75 |
| Site D | | TSCA-ACSA | 7,079 | 41 | 390 | 0.11 |

*Dominant species acronyms: ABBA–*Abies balsamea* (L.) Miller, ACRU–*Acer rubrum* L., ACSA–*Acer saccharum* Marshall, BEAL–*Betula alleghaniensis* Britton, BELE–*Betula lenta* L., CAOV–*Carya ovata* (Miller) K. Koch, FAGR–*Fagus grandifolia* Ehrhart, LITU–*Liriodendron tulipifera* L., QUAL–*Quercus alba* L., QUPR–*Quercus prinus* L., QURU–*Quercus rubra* L., TSCA–*Tsuga canadensis* (L.) Carriere.

**The authors gave a range of sapling densities in the four stands; density ratios were computed using the lowest sapling density/highest canopy density (1,620/560) and the highest sapling density/lowest canopy density (3,085/464).

[1]Northeastern Pennsylvania (this study): seedlings 11 to 140 cm tall, saplings >140 cm tall to 10 cm dbh, canopy trees >10 cm dbh.

[2]Northeastern Pennsylvania (Held and Giuliani 1989): seedlings <1.0 m tall, saplings 1.0 m tall to 10 cm dbh, canopy trees ≥10 cm dbh.

[3]Central Pennsylvania (Nowacki and Abrams 1992): seedlings <1.5 m tall, saplings 1.5 m tall to 10 cm dbh, canopy trees ≥10 cm dbh.

[4]Northwestern Pennsylvania (Whitney 1984): seedlings/small sprouts <30 cm tall, saplings 30 cm tall to 9.0 cm dbh, canopy trees >9 cm dbh.

[5]Southwestern Pennsylvania (Abrams and Downs 1990): seedlings <137 cm tall, saplings 137 cm tall to 10 cm dbh, canopy trees >10 cm dbh.

[6]North-central Ohio (Cho and Boerner 1991): subcanopy trees 2.5 ≤ dbh < 10 cm, canopy trees dbh ≥10 cm.

[7]South-central Kentucky (Chester et al. 1995): shrubs/seedlings <2.54 cm dbh, saplings 2.54 cm to 10.16 cm dbh, canopy trees ≥10.16 cm dbh.

[8]Northern Wisconsin (Anderson and Katz 1993): seedlings >15 cm tall to 1.3 cm dbh, saplings >1.3 cm to 9.0 cm dbh, canopy trees >9.0 cm dbh. Site A (Pike Lake exclosure), deer excluded for 27 yr; Site B (Flambeau Forest exclosures), deer excluded for 12 yr; Site C (Menominee County forest), moderate deer density; Site D (Flambeau Forest), high deer density.

We hypothesize that the striking failure of regeneration in the forest at Lacawac is, at least in part, a consequence of overbrowsing by white-tailed deer. The very low density of saplings, especially those in the 0.1 to 2.5 cm dbh size class (Table 3), suggests that regeneration failure extends many years into the past. Observations made subsequent to this study (Townsend, unpubl. data) of seed production and the density of seedlings ≤ 10 cm tall suggest that neither seed rain nor germination rates have limited recruitment into the size class that was so badly depleted of woody stems. Furthermore, there are no other vertebrate browsers in the Lacawac forest that would constitute alternative causes of regeneration failure (David Byman, pers. comm.).

Shading by *T. canadensis* likely accounts, in part, for the very low densities of seedlings and small saplings that we observed in the Lacawac forest. However, we did not find a significant correlation between hemlock density and seedling density among the four stands we studied, and regeneration failure occurred in all four stands that we studied, including one that was dominated by *A. rubrum* and *Q. rubra*, with lower *T. canadensis* importance. Furthermore, even in stands dominated by *T. canadensis*, sprouting (by root suckers or basal sprouts) should represent an important alternative regeneration mechanism for many woody species. But we found a virtual absence of sprouts of canopy trees, understory trees or tall shrubs (except for *F. grandifolia*) everywhere in the sanctuary. And even *F. grandifolia*, reportedly a less preferred food for deer (Bramble and Goddard 1953; Richards and Farnsworth 1971), exhibited significant evidence of browsing.

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## Literature Cited

Abrams, M.D. 1992. Fire and the development of oak forests. BioScience 42: 346-353.

Abrams, M.D. 1998. The red maple paradox. BioScience 48: 355-364.

Abrams, M.D. and J.A. Downs. 1990. Successional replacement of old-growth white oak by mixed mesophytic hardwoods in southwestern Pennsylvania. Canadian Journal of Forest Research 20: 1864-1870.

Allison, T. D. 1990a. The influence of deer browsing on the reproductive biology of Canada yew (*Taxus canadensis* Marsh.) I. Direct effect on pollen, ovule, and seed production. Oecologia 83: 523-529.

Allison, T. D. 1990b. The influence of deer browsing on the reproductive biology of Canada yew (*Taxus canadensis* Marsh.) II. Pollen limitation: an indirect effect. Oecologia 83: 530-534.

Allison, T. D. 1992. The influence of deer browsing on the reproductive biology of Canada yew (*Taxus canadensis* Marsh.) III. Sex expression. Oecologia 89: 223-228.

Alverson, W.S. and D.M. Waller. 1997. Deer populations and the widespread failure of hemlock regeneration in northern forests. Pp. 280-297 *in* W.J. McShea, H.B. Underwood and J.H. Rappole (eds.), The Science of Overabundance: Deer Ecology and Population Management, Smithsonian Institution Press, Washington, DC.

Anderson, R.C. 1994. Height of white-flowered trillium (*Trillium grandiflorum*) as an index of deer browsing intensity. Ecological Applications 4: 104-109.

ANDERSON, R.C. AND A.J. KATZ. 1993. Recovery of browse-sensitive tree species following release from white-tailed deer *Odocoileus virginianus* Zimmerman browsing pressure. Biological Conservation 63: 203-208.

ANDERSON, R.C. AND O.L. LOUCKS. 1979. White-tailed deer (*Odocoileus virginianus*) influence on structure and composition of *Tsuga canadensis* forests. Journal of Applied Ecology 16: 855-861.

BALGOOYEN, C.P. AND D. M. WALLER. 1995. The use of *Clintonia borealis* and other indicators to gauge impacts of white-tailed deer on plant communities in northern Wisconsin, USA. Natural Areas Journal 15: 308-318.

BRAMBLE, W.C. AND M.K. GODDARD. 1953. Seasonal browsing of woody plants by white-tailed deer in the Ridge and Valley Section of Central Pennsylvania. Journal of Forestry 51: 815-819.

BRAUN, E. L. 1950. Deciduous Forests of Eastern North America. Hafner Publishing Company, New York.

BROWER, J., J. ZAR AND C. VON ENDE. 1990. Field and Laboratory Methods for General Ecology, 3rd ed. Wm. C. Brown Publishers, Dubuque, Iowa.

CHESTER, E.W., S.M. NOEL, J.M. BASKIN, C.C. BASKIN AND M.L. MCREYNOLDS. 1995. A phytosociological analysis of an old-growth upland wet woods on the Pennyroyal Plain, Southcentral Kentucky, USA. Natural Areas Journal 15: 297-307.

CHO, D.-S. AND R.E.J. BOERNER. 1991. Structure, dynamics, and composition of Sears Woods and Carmean Woods state preserves, north-central Ohio. Castanea 56: 77-89.

COTTAM, G. AND J.T. CURTIS. 1956. The use of distance measures in phytosociological sampling. Ecology 37: 451-460.

CROW, T.R. 1988. Reproductive mode and mechanisms for self-replacement of northern red oak (*Quercus rubra*): a review. Forest Science 34: 19-40.

CROW, T.R. 1992. Population dynamics and growth patterns for a cohort of northern red oak (*Quercus rubra*) seedlings. Oecologia 91: 192-200.

DECALESTA, D.S. 1994. Effect of white-tailed deer on songbirds within managed forests in Pennsylvania. Journal of Wildlife Management 58: 711-718.

FRELICH, L.E. AND C.G. LORIMER. 1985. Current and predicted long-term effects of deer browsing in hemlock forests in Michigan, USA. Biological Conservation 34: 99-120.

GLEASON, H.A. AND A. CRONQUIST. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada, 2nd ed. The New York Botanical Garden, Bronx, New York.

HEALY, W.M. 1997. Influence of deer on the structure and composition of oak forests in central Massachusetts. Pp. 249-266 *in* W.J. McShea, H.B. Underwood and J.H. Rappole (eds.), The Science of Overabundance: Deer Ecology and Population Management, Smithsonian Institution Press, Washington, DC.

HELD, M.E. AND E.R. GIULIANI. 1989. Structure and composition of the forest community at Hickory Run State Park, Carbon County, Northeastern Pennsylvania. Journal of the Pennsylvania Academy of Science 63: 93-96.

HORN, H.S. 1966. Measurement of "overlap" in comparative ecological studies. American Naturalist 100: 419-424.

KUCHLER, A.W. 1964. Potential Natural Vegetation of the Coterminous United States. Special Publication No. 36, American Geographical Society, New York, NY.

LORIMER, C.G. 1984. Development of the red maple understory in northeastern oak forests. Forest Science 30: 3-22.

MARTIN, G.D. 1985. Soil survey of Wayne County, Pennsylvania. U.S.D.A. Soil Conservation Service.

MOWBRAY, B. 1971. Lake Lacawac. Frontiers (April 1971): 20-23.

NOWACKI, G.J. AND M.D. ABRAMS. 1992. Community, edaphic, and historical analysis of mixed oak forests of the Ridge and Valley Province in central Pennsylvania. Canadian Journal of Forest Research 22: 790-800.

RHOADS, A. F. AND W. M. KLEIN, Jr. 1993. The Vascular Flora of Pennsylvania, Annotated Checklist and Atlas. American Philosophical Society, Philadelphia, PA.

RICHARDS, N.A. AND C.E. FARNSWORTH. 1971. Effects of cutting level on regeneration of northern hardwoods protected from deer. Journal of Forestry 69: 230-233.

ROONEY, T.P. 1997. Escaping herbivory: refuge effects on the morphology and shoot demography of the clonal forest herb *Maianthemum canadense*. Journal of the Torrey Botanical Society 124: 280-285.

ROONEY, T.P. AND W.J. DRESS. 1997. Patterns of plant diversity in overbrowsed primary and mature secondary hemlock-northern hardwood forest stands. Journal of the Torrey Botanical Society 124: 43-51.

ROONEY, T.P. AND D.M. WALLER. 1998. Local and regional variation in hemlock seedling establishment in forests of the upper Great Lakes region, USA. Forest Ecology and Management 111: 211-224.

RUSSELL, E.W.B., R.B. DAVIS, R.S. ANDERSON, T.E. RHODES AND D.S ANDERSON. 1993. Recent centuries of vegetational change in the glaciated north-eastern United States. Journal of Ecology 81: 647-664.

SIMPSON, E.H. 1949. Measurement of diversity. Nature 163: 688.

TILGHMAN, N.G. 1989. Impacts of white-tailed deer on forest regeneration in northwestern Pennsylvania. Journal of Wildlife Management 53: 524-532.

WHITNEY, G.G. 1984. Fifty years of change in the arboreal vegetation of Hearts Content, an old-growth hemlock-white pine-northern hardwood stand. Ecology 65: 403-408.

WHITNEY, G.G. 1990. The history and status of the hemlock-hardwood forests of the Allegheny Plateau. Journal of Ecology 78: 443-458.

WHITNEY, G.G. 1994. From Coastal Wilderness to Fruited Plain. Cambridge University Press, Cambridge, United Kingdom.

ZAR, J.H. 1999. Biostatistical Analysis, 4th ed. Prentice Hall, Upper Saddle River, NJ.

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# Interrelationships Among Achene Weight, Orientation, and Germination in the Asters *Doellingeria umbellata* var. *umbellata*, *Symphyotrichum novae-angliae* and *S. puniceum* (Asteraceae)

JERRY G. CHMIELEWSKI AND SONAM RUIT
*Department of Biology, Slippery Rock University of Pennsylvania, Slippery Rock, PA 16057*
*jerry.chmielewski@sru.edu*

ABSTRACT. The effects of achene weight and orientation (up, horizontal, or down) on total germination or the time taken to germinate were examined among *Doellingeria umbellata* var. *umbellata*, *Symphyotrichum novae-angliae*, and *S. puniceum*. Achenes of *S. novae-angliae* and *D. umbellata* that germinated were on average heavier than were those that did not germinate. All achenes of *S. puniceum* germinated irrespective of treatment or size. Achenes of all species germinated three to four times more quickly in agar medium trials, irrespective of orientation, than in filter-paper trials. Species varied in response to germination media: a greater proportion of *D. umbellata* var. *umbellata* achenes germinated on agar than on filter paper; more *S. novae-angliae* germinated on filter paper; and germination of *S. puniceum* was similar in both. Total germination was not affected by orientation for any species. Achene weight was not correlated with the time taken to germinate for either *S. puniceum* or *D. umbellata*, irrespective of orientation. In contrast, for *S. novae-angliae* the time to germinate was negatively correlated with achene weight regardless of orientation. However, achenes of *S. novae-angliae* oriented in the up position took significantly longer to germinate than did those in the horizontal or down positions. The results of this study indicate that differential allocation of resources occurs in the three commonly co-occurring, weedy aster species and that germination success in them may or may not be related to these allocations, genetic factors, or environmental conditions, but not orientation.

## INTRODUCTION

Certain physical and chemical requirements, such as those related to light quality, moisture availability, oxygen concentration, pH, and temperature regime, must be satisfied for seed germination to occur (Evanari 1956; Toole et al. 1956; Bradbeer 1988). The relationship between and among these requirements, microsite characteristics and seed morphology will define both total germination and time taken for germination to occur (e.g., Harper 1977; Jones 1978; Bewley and Black 1982; Baskin and Baskin 1979, 1985; Prinzie and Chmielewski 1994). Although interspecific differences occur in a variety of seed characteristics (e.g., seed size or seed coat characteristics), intraspecific differences, that is, the production of morphologically different seeds within a species (e.g., Weiss 1980; Forsyth and Brown 1982; Maun and Payne 1989; McGinley 1989; Zhang 1993; Venable et al. 1995), appear to be restricted, with exceptions, to relatively short-lived, fugitive species,

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particularly weeds, in the families Asteraceae, Brassicaceae, Chenopodiaceae, and Poaceae (Harper 1977).

Species whose seed types have different constraints on their evolution, such as ray and disk achenes in the Asteraceae (specifically in subfamily Tubuliflorae), provide a unique view of the adaptive consequences of seed heteromorphism. In these species, seed functions tend to diverge (Venable 1985). Reduced dispersability and delayed germination are characteristic of the outer achenes, whereas distance dispersal and quick germination are more typical of the central achenes (Forsyth and Brown 1982; McEvoy 1984; Venable and Levin 1985; Tanowitz et al. 1987).

Studies that previously reported total germination in aster species (Nichols 1934; Delisle 1938; Wetmore and Delisle 1939; Avers 1953; Havercamp and Whitney 1983; Jones 1978; Kothman and Kallah 1978; Peterson and Bazzaz 1978; Baskin and Baskin 1979, 1985; Allen et al. 1983; Pitelka et al. 1983; Clampitt 1987; Chmielewski 1991; Prinzie and Chmielewski 1994; Bosy and Aarssen 1995) collectively did not differentiate between the essentially monomorphic achenes produced by ray and disk florets. Both Chmielewski (1991) and Prinzie and Chmielewski (1994) indicated their uneasiness in excluding such a potential source of variation in germination trials and recommended a procedural guide for future studies dealing with the evolutionary significance of achene germination strategies in heterogamous composites (Chmielewski and Huff 1995). Although achenes derived from either ray or disk florets were indistinguishable in the aster *Eurybia divaricata* (L.) Nesom (*Aster divaricatus* L.), ray achenes were on average lighter than disk achenes, and this difference was due to increased allocation to the embryo rather than the pericarp. Further, pericarp thickness decreased with increasing achene weight in the disk achenes. Neither total germination nor the time taken to germinate by ray or disk achenes was correlated with achene weight or embryo weight, but instead varied inversely with pericarp weight for ray achenes only. The authors recommended that, unless the consequences of differential allocation to the embryo and pericarp of achenes are documented, future germination studies should differentiate between ray and disk achenes. A second study, using *Doellingeria. umbellata* (Miller) Nees var. *umbellata* (*Aster umbellatus* Mill. var. *umbellatus*), indicated that the number of days to germination was not correlated with any measured aspect of achene weight for either ray or disk achenes whether the pappus was removed or intact (Chmielewski 1999). The production of morphologically and ecologically indistinguishable ray and disk achenes would suggest that the significance of the heterogamous capitula (specifically the ray florets) rests in their attractiveness to pollinators (Chmielewski 1999). Based on these studies we conclude that the information gained by separating disk and ray achenes for use in germination studies does not warrant the additional effort necessary to distinguish the two.

Although the effects of physical and chemical requirements on germination have been studied for a variety of species (e.g., Bewley and Black 1982), as have general seed morphology (e.g., Williams and Harper 1965; McEvoy 1984; Venable and Burquez 1989) and dimorphism (see Chmielewski 1999), the relationship between patterns of within-achene allocation and seed orientation have not (Rowlee 1893; Sheldon 1974; Peart 1984; Bosy and Aarssen 1995).

Prior to 1994 the literature treats the aster species included in this study as members of *Aster*, but chloroplast DNA evidence (Xiang and Semple 1996) and gene sequence data (Noyes and Rieseberg 1999) demonstrate that *Doellingeria*, *Symphyotrichum*, and other genera are distant from *Aster*. Reference to the aster literature in general follows recently defined infraspecific classifications (Semple and Chmielewski 1987; Semple et al. 1991) and revised generic combinations (Nesom 1994). For the sake of clarity the *Aster* epithet referenced will appear in parentheses with each first use of the new aster epithet.

In this study we examine the relationship between within-achene allocation (total weight, embryo weight, and pericarp weight) and orientation on germination in three clonal species, *Doellingeria umbellata* var. *umbellata*, *Symphyotrichum novae-angliae* (L.) Nesom (*Aster novae-angliae* L.) and *S. puniceum* (L.) Löve and Löve (*Aster puniceus* L.). These species were selected for this study because each is considered weedy through at least part of their respective ranges (Alex et al. 1980; Anonymous 1990; Mulligan 1992), they often co-occur in open, abandoned fields, they are easily distinguishable, mean achene weight occurs in the upper, middle, and lower weight classes found in the asters, and clonal structure differs among the species. *Doellingeria umbellata* forms clones that are neither freely spreading nor compact, but rather continuous in the sense that the inflorescences of adjacent stems touch or overlap, but are not crowded. *Symphyotrichum puniceum* forms clones that are freely spreading and open; adjacent stems may be quite distant. *Symphyotrichum novae-angliae* forms clones that are extremely compact, the stems being tightly clustered (Semple et al. 1996).

## METHODS

Mature capitula of *Doellingeria umbellata*, *Symphyotrichum novae-angliae*, and *S. puniceum* were harvested from groupings of stems (likely clones) growing in an abandoned field on the Slippery Rock University campus (Slippery Rock, Pennsylvania) during the fall of 1998. The capitula were placed in manila envelopes and returned to the laboratory where they were allowed to air dry for 1 week. Following air drying, the capitula were stored ($-4 \pm 2°$ C) in the dark for 20 weeks. The following spring >400 achenes of each species that appeared full and resisted a gentle pinch with forceps were randomly selected for germination trials. Achenes were not separated on the basis of whether they were of the disk or ray type.

For some germination trials, the pappus was teased from the achene. Teasing entailed lightly brushing the pappus bristles with fine forceps until the majority had detached; those few that remained were actively grasped and plucked. Individual achenes were then weighed on a Cahn C-33 microbalance ($\pm 2$ $\mu$g). Just prior to sowing, achenes were surface sterilized with a 30% bleach solution to minimize or eliminate fungal growth.

The first germination trial entailed the horizontal placement of achenes on moistened filter paper in $150 \times 15$ mm petri dishes. These were placed in a Biotronette Mark III environmental chamber with a temperature of $24 \pm 2°$ C, 12 h photoperiod, and light intensity of 218 $\mu$mol $s^{-1}$ $m^{-2}$. The petri dishes were randomly re-positioned on a daily basis. Achenes were examined daily for 135 days (coincident with the last day of the agar study trial); germination was indicated by either the emergence of the radicle or cotyledons, whichever appeared first. Petri dishes were moistened regularly as needed. This germination trial allowed for the post-germination recovery of pericarps. Pericarps were harvested for each germinated achene as soon as they could be removed from the seedling. Air-dried pericarps were subsequently individually weighed. Embryo weight was determined to be the difference between total achene weight and pericarp weight. The results of this germination trial were used to: (1) establish the relationships among total achene weight, pericarp weight, and embryo weight for each species; (2) determine the relationship between within-achene allocation to both total germination and time taken to germinate; and (3) provide baseline data for the achene orientation germination trial.

The second germination trial was designed to determine the relationship between achene weight and orientation on germination. Following surface sterilization with a 30% bleach solution, individually weighed achenes were sown into a 0.8% agar medium prepared with de-ionized water (following the methodology of Bosy and Aarssen 1995) and poured to a depth of approximately 1 cm into 150 × 15 mm petri dishes. Individual achenes (100 per position for each species) were placed below the agar surface and positioned vertically upward (pappus end up), horizontally, or vertically downward (pappus end down). Each petri dish contained a maximum of 30 achenes oriented in only one position. The viscosity of the agar was such that sown achenes were not only suspended in the agar in a specific orientation, but also completely in contact with it throughout the germination trial. Conditions for germination were similar to the previous trial. The petri dishes were randomly repositioned within the environmental chamber on a daily basis. Achenes were examined daily for 38 days during which the agar remained moist and the majority of germination had occurred. Germination was indicated by either the emergence of the radicle or cotyledons, whichever came first.

SAS/STAT (SAS Institute Inc. 1989) procedures and options were used for data analysis. The UNIVARIATE procedure was used to summarize descriptive statistics (achene weight, pericarp weight, embryo weight, and time taken to germinate) for the respective species. The Shapiro-Wilk W statistic was used to test for normality. Because much of the data were not normally distributed, the non-parametric Mann-Whitney or Kruskal-Wallis tests (using the $\chi^2$ approximation of the NPAR1WAY procedure) were used for between- and among-group comparisons respectively. The FREQ procedure and TESTP TABLE option were used to compare total germination in respective trials. Relationships between combinations of characters were determined for each species by calculating correlation coefficients. The CORR procedure, SPEARMAN option was used for this purpose.

## RESULTS

***Doellingeria umbellata* var. *umbellata*** (Table 1)

The mean achene weights of randomly selected samples assigned to each germination trial were not significantly different. Thus, differences between or among trials with respect to total germination or time taken to germinate cannot be attributed to differences in achene weight. Significantly fewer achenes germinated in each of the agar trials compared to the filter-paper trial. However, much of the germination in the filter-paper trial occurred beyond the 38-day limit of the agar trial, with only 9.7% of the filter-paper trial achenes germinating within the agar trial time frame. Total germination was not affected by orientation in the three agar trials. Germination was weakly correlated with achene weight for each of the germination trials. Achenes that germinated in each trial were heavier than achenes that did not, but the weight of germinated achenes did not differ across trials. For the filter-paper trial, embryo weight was positively correlated with both achene weight and the number of days taken by an achene to germinate. Also for this trial, pericarp weight was negatively correlated with the number of days taken to germinate. No other correlations among achene weight, pericarp weight, embryo weight, and days taken to germinate were significant for any of the trials. The time taken by an achene to germinate was significantly greater for the filter-paper trial compared to any other. The time taken by an achene to germinate was not affected by orientation in the three agar trials.

TABLE 1. Summary of descriptive statistics (± standard deviation) for achenes of *Doellingeria umbellata* var. *umbellata* germinated in petri dishes on filter paper or agar medium in one of three orientations. Weight in mg.

| | | Agar Orientation | | |
|---|---|---|---|---|
| | Filter Paper | Pappus End Up | Pappus Horizontal | Pappus End Down |
| Number of achenes sown | 103 | 100 | 100 | 100 |
| Mean achene weight | 0.758 ± 0.115 | 0.761 ± 0.167 | 0.744 ± 0.158 | 0.727 ± 0.154 |
| Number of ungerminated achenes | 37 | 71 | 65 | 72 |
| Mean ungerminated achene weight | 0.712 ± 0.126 | 0.734 ± 0.178 | 0.702 ± 0.160 | 0.694 ± 0.152 |
| Number of germinated achenes | 66 | 29 | 35 | 28 |
| Mean germinated achene weight | 0.784 ± 0.100 | 0.825 ± 0.116 | 0.821 ± 0.122 | 0.814 ± 0.127 |
| Comparison of mean achene weight (germinated versus ungerminated; df = 1) | $\chi^2 = 7.6742$<br>$P = 0.0056$ | $\chi^2 = 4.2695$<br>$P = 0.0388$ | $\chi^2 = 12.412$<br>$P = 0.0004$ | $\chi^2 = 11.961$<br>$P = 0.0005$ |
| Mean pericarp weight | 0.221 ± 0.043 | | | |
| Mean embryo weight | 0.563 ± 0.102 | | | |
| Mean number of days to germinate | 75.9 ± 33.9 | 22.5 ± 7.5 | 25.3 ± 6.5 | 22.0 ± 7.2 |
| Median number of days to germinate | 83 | 23 | 25 | 22 |

***Symphyotrichum novae-angliae*** (Table 2)

Mean achene weights of randomly selected samples assigned to each germination trial were not significantly different. Thus, differences between or among trials in total germination or time taken to germinate cannot be attributed to differences in achene weight. Significantly more achenes germinated in each of the agar trials compared to the filter-paper trial. Further, only 35% of the filter-paper trial achenes germinated within 38 days, the duration of the agar trials. Total germination was not affected by orientation in the three agar trials. Germination was not correlated with achene weight for each of the germination trials. Achenes that germinated were heavier than achenes that did not germinate, but the weight

TABLE 2. Summary of descriptive statistics (± standard deviation) for achenes of *Symphyotrichum novae-angliae* germinated on filter paper or agar medium in one of three orientations. Weight in mg.

| | | Agar Orientation | | |
|---|---|---|---|---|
| | Filter Paper | Pappus End Up | Pappus Horizontal | Pappus End Down |
| Number of achenes sown | 102 | 100 | 100 | 100 |
| Mean achene weight | 0.374 ± 0.074 | 0.362 ± 0.095 | 0.369 ± 0.096 | 0.379 ± 0.090 |
| Number of ungerminated achenes | 55 | 23 | 15 | 21 |
| Mean ungerminated achene weight | 0.378 ± 0.070 | 0.313 ± 0.109 | 0.264 ± 0.113 | 0.341 ± 0.093 |
| Number of germinated achenes | 47 | 77 | 85 | 79 |
| Mean germinated achene weight | 0.371 ± 0.079 | 0.377 ± 0.086 | 0.388 ± 0.079 | 0.389 ± 0.089 |
| Comparison of mean achene weight (germinated versus ungerminated; df = 1) | $\chi^2 = 0.3857$<br>$P = 0.6250$ | $\chi^2 = 6.3853$<br>$P = 0.0115$ | $\chi^2 = 14.139$<br>$P = 0.0115$ | $\chi^2 = 4.8604$<br>$P = 0.0115$ |
| Mean pericarp weight | 0.076 ± 0.025 | | | |
| Mean embryo weight | 0.294 ± 0.081 | | | |
| Mean number of days to germinate | 22.6 ± 24.3 | 8.5 ± 7.5 | 5.1 ± 4.1 | 6.9 ± 5.1 |
| Median number of days to germinate | 9 | 6 | 4 | 6 |

of germinated achenes did not differ across trials. For the filter-paper trial embryo weight was positively correlated with achene weight. For the agar trials achene weight was negatively correlated with the number of days taken by an achene to germinate. No other correlations (among achene weight, pericarp weight, embryo weight, and days taken by an achene to germinate) were significant. The time taken by an achene to germinate was not only significantly different among the four trials, but also among the agar orientation trials.

***Symphyotrichum puniceum*** (Table 3)

Mean achene weights of the randomly selected samples assigned to each germination trial differed; those used for the agar trial and sown horizontally were, by chance, significantly lighter than others. Although 100% of the achenes germinated irrespective of treatment, only 82% of the filter-paper trial achenes germinated within 38 days, the duration of the agar trials. Germination was not correlated with achene weight. For the filter-paper trial embryo weight was positively correlated with achene weight. Pericarp weight was positively correlated with achene weight, but negatively correlated with the number of days taken by an achene to germinate. No other correlations among achene weight, pericarp weight, embryo weight, and days taken to germinate were significant for any of the trials. The time taken by an achene to germinate was significantly greater for the filter-paper trial compared to any other. The time taken by an achene to germinate was not affected by orientation in the three agar trials.

TABLE 3. Summary of descriptive statistics (± standard deviation) for achenes of *Symphyotrichum puniceum* germinated on filter paper or agar medium in one of three orientations. Weight in mg.

| | | Agar Orientation | | |
|---|---|---|---|---|
| | Filter Paper | Pappus End Up | Pappus Horizontal | Pappus End Down |
| Number of achenes sown | 101 | 100 | 100 | 100 |
| Mean achene weight | 0.293 ± 0.053 | 0.294 ± 0.048 | 0.267 ± 0.054 | 0.284 ± 0.051 |
| Number of germinated achenes | 101 | 100 | 100 | 100 |
| Mean germinated achene weight | 0.293 ± 0.053 | 0.294 ± 0.048 | 0.267 ± 0.054 | 0.284 ± 0.051 |
| Mean pericarp weight | 0.100 ± 0.028 | | | |
| Mean embryo weight | 0.193 ± 0.046 | | | |
| Mean number of days to germinate | 18.2 ± 19.3 | 4.0 ± 2.1 | 4.5 ± 2.6 | 4.8 ± 3.0 |
| Median number of days to germinate | 8 | 3 | 3 | 3 |

## DISCUSSION

Achene weight is quite variable among the asters, with at least a 10-fold difference evident (Delisle 1938; Wetmore and Delisle 1939; Peterson and Bazzaz 1978; Havercamp and Whitney 1983; Pitelka et al. 1983; Chmielewski 1991, 1999; Prinzie and Chmielewski 1994) among the weedy species (Alex et al. 1980; Anonymous 1990; Mulligan 1992). *Eurybia divaricata*, the single non-weedy aster for which achene weight is available, produces comparatively light achenes (Chmielewski and Huff 1995).

Achenes of *Doellingeria umbellata*, *Symphyotrichum novae-angliae*, and *S. puniceum*, all wetland or facultative wetland species (U.S. Department of the Army 1987), occur in the upper, middle, and lower weight classes, respectively, found in the asters. Achenes of *D. umbellata* are, on average, nearly twice the weight of those produced by many aster species.

In this study, achenes of *D. umbellata* were significantly heavier, averaging 0.8 mg, with some >1.1 mg, than reported values (0.6 mg in Chmielewski 1999). Although achene weight in *S. novae-angliae* was first reported as 0.41 to 0.45 mg (Delisle 1938; Wetmore and Delisle 1939), a significantly lower mean value of 0.20 mg (pappus removed) was subsequently reported (Havercamp and Whitney 1983). In considering that the pappus of aster achenes typically weighs between 0.06 and 0.08 mg (Chmielewski 1999) the values reported in the present study (0.36-0.38 mg) are comparable to those in the former two reports (weight includes adjoining pappus), but not the latter. These values are also comparable to that reported for a white-flowered hybrid (0.41 mg) of the species (Delisle 1938). Achene weight in *S. puniceum* (0.26-0.30 mg), the only weedy, obligate wetland aster species for which values are available, tends toward the lowest achene-weight class in the asters. Variation in achene weight both within and among aster species may be attributable to cytotypic differences, clonal variation, yearly variation, or a combination of these or other factors. Past studies on asters suggested that because achene weight in some species may be correlated with total germination, the evolutionary significance of achene weight is associated with pre-germination phenomena such as dispersal and post-germination phenomena such as seedling survival or vigor (Chmielewski 1991, 1999; Prinzie and Chmielewski 1994). None of these phenomena were part of this investigation.

Following late autumn dispersal, aster achenes imbibe on the soil surface and are exposed to stratification temperatures during the winter months, germinating in early spring (Baskin and Baskin 1979). Germination is controlled by the phytochrome system, with red and white light promoting germination and darkness and far-red light inhibiting germination (Peterson and Bazzaz 1978; Baskin and Baskin 1979). Despite this controlling system, germination immediately following harvest is quite variable. Some of the weedier species, for example *Symphyotrichum ericoides* (L.) Nesom (*Aster ericoides* L.), *S. falcatum* (Lindl.) Nesom (*A. falcatus* Lindl. in Hook.), *S. lanceolatum* (Willd.) Nesom (*A. lanceolatus* Willd.), *S. pilosum* (Willd.) Nesom (*A. pilosus* Willd.), *S. sericeum* (Vent.) Nesom (*A sericeus* Vent.), and *S. tradescantii* (L.) Nesom (*A. tradescantii* L.) germinated readily (60-80%) immediately following harvest (Keever 1950; Jones 1978; Baskin and Baskin 1979, 1985). These values are contrasted by comparatively low immediate post-harvest germination in *S. lateriflorum* (L.) Löve and Löve (*A. lateriflorus* [L.] Britton), *S. praealtum* (Poir.) Nesom (*A. praealtus* Poir.), *S. novae-angliae* (L.) Nesom, *S. oolentangiense* (Riddell) Nesom (*A. azureus* Lindl. in Hook.), *S. drummondii* (Lindl.) Nesom (*A. drummondii* Lindl. in Hook.) and *S. sagittifolium* (Wedem. ex Willd.) Nesom (*A. sagittifolius* Wedem. ex Willd.) (Keever 1950; Jones 1978; Baskin and Baskin 1979, 1985).

The relationship between cold-temperature exposure and germination in *Symphyotrichum novae-angliae* and other asters is poorly defined. Germination in the red form of *S. novae-angliae* (32%) exceeded that of the typical form (8%), but the conditions under which germination occurred were not specified (Rowlee 1893). No difference in total germination was reported between refrigerated (exposed to an outdoor cold frame; 64.5%) or unrefrigerated (61.5%) achenes sown directly in the greenhouse (Nichols 1934). Germination immediately following harvest was reportedly low (6%), but increased considerably following two months of refrigeration in a moist atmosphere (Jones 1978). In our study, germination of refrigerated achenes ranged between 15 and 54%, depending on trial. No comparable cold treatment data are available for *Doellingeria umbellata* or *S. puniceum*.

Based on germination, viability is maintained for at least 135 days by *D. umbellata*, 110 days by *S. novae-angliae*, and 67 days (all achenes of the species had germinated by this day) by *S. puniceum*. Germination of surface sown achenes of *D. umbellata* on fine-grained vermiculite occurred until the 90th day of a 150-day germination trial (Chmielewski 1999). Uninjured, soaked achenes of *S. novae-angliae*, which did not germinate spontaneously, remained viable and germinable for over eight months provided they were maintained in a moist atmosphere (Jones 1978). Nichols (1934) had previously reported that refrigerated achenes of *S.* novae-angliae remained viable for 28 days and germinated in a minimum of 14 days, whereas those that were not refrigerated remained viable for at least 78 days and germinated in a minimum of 43 days. These results suggest that viability, as applied in each of the respective studies, varies not only among species, but also within a species. Clonal differences, yearly variation, or a combination of these or other factors may account for the latter. Although the longevity of buried aster achenes is not well documented (Livingston and Allessio 1968; Rabinowitz 1981; Johnson and Anderson 1986; Leck and Leck 1998), viability of at least three months is necessary to allow for spring germination in these and other aster species.

Achene weight had a relatively insignificant role in affecting total germination in *Doellingeria umbellata* and no effect in either *Symphyotrichum novae-angliae* or *S. puniceum*. Previous studies on other species also reported that achene weight may or may not affect germination. For example, heavy achenes of *Oclemena acuminata* (Michx.) E.L. Greene (*Aster acuminatus* Michx.) exhibited significantly higher germination than did the lighter achenes (Pitelka et al. 1983). Both tetraploid and hexaploid achenes of *S. lanceolatum* did not begin to germinate with any regularity unless above minimum weights (Chmielewski 1991). Germination was positively correlated with achene weight for *S. pilosum* (Prinzie and Chmielewski 1994), but was not related to achene weight for either ray or disk achenes of *Eurybia divaricata* (Chmielewski and Huff 1995). Achene weight did not affect total germination in ray or disk achenes of *D. umbellata* for which the pappus was removed or remained intact (Chmielewski 1999). Our results in conjunction with previous reports suggest that the relationship between achene weight and total germination in asters is species-specific.

Variability in achene weight presumably reflects a balance between architectural constraints associated with the capitulum and the evolutionary pressures associated with dispersal, persistence, predator avoidance, germinability, or seedling competition (Harper 1977; Jolls and Werner 1989). The three species included in this study exhibited different strategies in the allocation of resources within achenes and between allocation patterns and the time taken to germinate. As achene weight increased in *Doellingeria umbellata*, embryo weight also increased, but pericarp weight was static. Differential allocation between heavy and light achenes was not previously reported for the species (Chmielewski 1999). The time taken by these achenes to germinate was positively correlated with achene weight, but negatively correlated with pericarp weight. As achene weight increased in *Symphyotrichum novae-angliae* so did embryo weight, but the time to germination was not affected. Both pericarp weight and embryo weight increased with increasing achene weight in *S. puniceus* but the time to germination was not affected. A significant inverse relationship between pericarp weight fraction and achene weight, with heavier achenes having proportionately thinner pericarp, was predicted by the crude model presented in Prinzie and Chmielewski (1994). Because it is the embryo, which by imbibition and cell expansion provides the physical force required to rupture the pericarp (Cook 1980), heavier achenes should germinate with greater regularity and should do so more quickly than lighter achenes. Ray achenes of *Eurybia divaricata* were significantly lighter than disk achenes, the difference being due to increased allocation to the embryo as opposed to pericarp, but total germination did not differ between the two (Chmielewski and Huff 1995).

The embryo within an aster achene is arranged so that if the achene lands pappus end up, the cotyledons are up and the hypocotyl is down. With this arrangement the embryonic parts occur in the most advantageous position for germination (Rowlee 1893), the relationship between germination and seed orientation reflecting differential effects of gravity on the embryo (Bosy and Aarssen 1995).

The pappus of aster achenes assists in dispersal (Rowlee 1893; Carlquist 1967; Sheldon and Burrows 1973) and it also facilitates at least initial optimization of orientation for germination to occur (Rowlee 1893; Sheldon 1974; Bosy and Aarssen 1995). Following several days of soaking, the pappus of these and other aster species irreversibly collapses and the achenes rest more or less horizontally on the substrate. The pappus in some aster species may be less important in its effects on germination than anticipated, as germination in disk and ray achenes of *Doellingeria umbellata* was 2.5 to 3 times greater among achenes from which the pappus was removed compared with intact achenes (Chmielewski 1999). Similar results were reported for disk and ray achenes of *Eurybia divaricata* (Chmielewski and Huff 1995). In contrast, the status of the pappus, whether removed or intact, had little or no effect on germination in *Oclemena acuminata* (Pitelka et al. 1983).

Germination in *Doellingeria umbellata* was not affected by orientation in this study. However, the species did exhibit a range of germination percentages for horizontally oriented achenes (pappus removed) germinated on vermiculite (19.6% in Chmielewski 1999), filter paper (64%), and agar (35%). Because mean achene weights among these trials were similar, the observed differences must be attributable to some factor other than achene weight. Although the duration of the vermiculite (150 days) and filter paper (135 days) germination trials was comparable, the mean number of days to germinate on vermiculite (16), was considerably less than on the filter paper (76). Because germination of aster achenes was previously shown to be protracted (Chmielewski and Huff 1995), the authors suggested that it would be prudent to examine median, rather than mean, time to germination. Median germination time and mean time to germination for achenes of *D. umbellatum* were comparable within each of the respective germination trials. Also, if germination on filter paper was monitored for the same number of days as was germination on agar, only 9.7% of the achenes germinated compared to 64%, and the mean number of days to germinate decreased from approximately 76 to 18.

Total germination in *Symphyotrichum novae-angliae* for achenes sown with the pappus end down versus up was variable, but typically low (4 and 12% respectively; Rowlee 1893). Total germination in the red-colored form was similarly not affected by orientation, but the values were considerably higher at 28 and 32% respectively (Rowlee 1893). Contrasting total germination values of 67, 10, and 77% were reported for achenes sown with the pappus down, pappus up, or pappus oriented horizontally, respectively (Bosy and Aarssen 1995). In our study, total germination was not affected by orientation and was similar to that reported by Bosy and Aarssen (1995) for achenes sown horizontally. Further, inasmuch as orientation did not affect the number of days to germination in the latter study, results from our study indicate that horizontally sown achenes germinate more quickly than those with the pappus oriented down, and that these germinate more quickly than do those with the pappus oriented up. Median germination time and mean time to germination for achenes of *S. novae-angliae* were comparable for the three achene positions in agar, but approximately 2.5 times longer in the filter-paper trial. The disparate values for germination in the four studies cited, in concert with the germination values from this study for achenes sown horizontally on filter paper, suggest that germination in the species is more related to the source of the achene (ramet, clone, population, etc.) as opposed to orientation or germination medium. Subsequent comparative germination studies should consider the source of the achene in defining intraspecific variation.

Complete germination in *Symphyotrichum puniceum*, irrespective of achene weight, orientation, or medium suggests that behaviorally the species is the most general in terms of germination requirements. Median germination time and mean time to germination were comparable within each of the agar trials, but like *S. novae-angliae*, approximately 2.5 times shorter than the filter-paper trial.

Assuming that an achene has "found" a suitable site, many internal or local factors could affect germination. The results of this and previous studies indicate that within a species achene weight is variable, that immediate post-harvest germination and the consequences of refrigeration are variable, and that the duration of germination is variable among species. The significance of differential allocation of resources within achenes of the three species is witnessed in different times to germination (though the same is not necessarily true for other aster species). Total germination is typically not affected by orientation per se for these three species. However, total germination for at least the horizontally oriented achenes is affected, at least in part, by the medium upon which the achenes are sown. Germination may also be correlated with moisture availability on the various media, but in all cases saturation of the achenes was attempted. We conclude that for these three aster species, orientation affects germination in a specific site to the extent that it affects water availability or imbibition.

## Literature Cited


Allen, G.A., M.L. Dean, and K.L. Chambers. 1983. Hybridization studies in the *Aster occidentalis* (Asteraceae) polyploid complex of western North America. Brittonia 35: 353-361.

Alex, J.F., R. Cayouette, and G.A. Mulligan. 1980. Common and Botanical Names of Weeds in Canada. Agriculture Canada, Ottawa, Ontario. Publication 1397, 132 pp.

Anonymous. 1990. Composite List of Weeds. Weed Science Society of America.

Avers, C.J. 1953. Biosystematic studies in *Aster*. II. Isolating mechanisms and some phylogenetic considerations. Evolution 7: 317-327.

Baskin, J.M. and C.C. Baskin. 1979. The germination strategy of oldfield aster (*Aster pilosus*). American Journal of Botany 66: 1-5.

Baskin, J.M. and C.C. Baskin. 1985. The light requirement for germination of *Aster pilosus* seeds: temporal aspects and ecological consequences. Journal of Ecology 73: 765-773.

Bewley, J.D. and M. Black. 1982. Physiology and Biochemistry of Seeds in Relation to Germination. Vol. 2. Viability, Dormancy, and Environmental Control. Springer-Verlag, Berlin.

Bosy, J. and W. Aarssen. 1995. The effect of seed orientation on germination in a uniform environment: differential success without genetic or environmental variation. Journal of Ecology 83: 769-773.

Bradbeer, J.W. 1988. Seed Dormancy and Germination. Chapman and Hall, New York, NY.

Carlquist, S. 1967. The biota of long distance dispersal. V. Plant dispersal to Pacific islands. Bulletin of the Torrey Botanical Club 94: 129-141.

Chmielewski, J.G. 1991. Inter-relationships among cytotype and achene characteristics in *Aster lanceolatus* Willd. (Asteraceae). Beitrage zur Biologie der Pflanzen 66: 69-84.

Chmielewski, J.G. 1999. Consequences of achene biomass, within-achene allocation patterns, and pappus on germination in ray and disc achenes of *Aster umbellatus* var. *umbellatus*. Canadian Journal of Botany 77: 1-8.

Chmielewski, J.G. and A. Huff. 1995. Within-achene resource allocation in ray and disc achenes of the white-wood aster, *Aster divaricatus* (Asteraceae). Beitrage zur Biologie der Pflanzen 69: 295-307.

CLAMPITT, C.A. 1987. Reproductive biology of *Aster curtus* (Asteraceae), a Pacific Northwest endemic. American Journal of Botany 74: 941-946.

COOK, R. 1980. The biology of seeds in soil. Pp. 107-130 *in* O.T. Solbrig (ed.), Demography and Evolution in Plant Populations. University of California Press, Berkeley, CA.

DELISLE, A.L. 1938. Morphogenetical studies in the development of successive leaves in *Aster*, with respect to relative growth, cellular differentiation, and auxin relationships. American Journal of Botany 25: 420-430.

EVANARI, M. 1956. Seed germination. Pp 519-549 *in* A. Hollaender (ed.), Radiation Biology: Visible and Near Visible Light, vol. 3. McGraw-Hill, New York, NY.

FORSYTH, C. AND N.A.C. BROWN. 1982. Germination of the dimorphic fruits of *Bidens pilosa* New Phytologist 90: 151-164.

HARPER, J.L. 1977. Population biology of plants. Academic Press, New York, NY.

HAVERCAMP, J. AND G.G. WHITNEY. 1983. The life history characteristics of three ecologically distinct groups of forbs associated with the tall grass prairie. American Midland Naturalist 109: 105-119.

JOHNSON, R.G. AND R.C. ANDERSON. 1986. The seed bank of a tall grass prairie in Illinois. American Midland Naturalist 115: 123-130.

JOLLS, C.A. AND P.A. WERNER. 1989. Achene biomass and within achene allocation patterns of five co-occurring goldenrod species (*Solidago*: Compositae). American Midland Naturalist 121: 256-264.

JONES, A.G. 1978. Observations on reproduction and phenology in some perennial asters. American Midland Naturalist 99: 184-197.

KEEVER, C. 1950. Causes of succession on old fields of the piedmont, North Carolina. Ecological Monographs 20: 229-250.

KOTHMAN, N.M. AND M.S. KALLAH. 1978. Phenology, carbohydrate reserves and nutrient content of heath aster. Southwestern Naturalist 23: 347-362.

LECK, M.A. AND C.F. LECK. 1998. A ten-year seed bank study of old field succession in central New Jersey. Journal of the Torrey Botanical Society 125: 11-32.

LIVINGSTON, R.B. AND M.L. ALLESSIO. 1968. Buried viable seed in successional field and forest stands, Harvard Forest, Massachusetts. Bulletin of the Torrey Botanical Club 95: 58-69.

MAUN, M.A. AND A.M. PAYNE. 1989. Fruit and seed polymorphism and its relation to seedling growth in the genus *Cakile*. Canadian Journal of Botany 67: 2743-2750.

MCEVOY, P.B. 1984. Dormancy and dispersal in dimorphic achenes of tansy ragwort, *Senecio jacobaea* L. (Compositae). Oecologia 61: 160-168.

MCGINLEY, M.A. 1989. Within and among plant variation in seed mass and pappus size in *Tragapogon dubius*. American Journal of Botany 67: 1298-1304.

MULLIGAN, G.A. 1992. Common and Botanical Names of Weeds in Canada. Canadian Department of Agriculture Publication 1397. Ottawa, Ont., 2nd Edition.

NESOM, G.L. 1994. Review of the taxonomy of *Aster* sensu lato (Asteraceae: Astereae) emphasizing the New World species. Phytologia 77: 141-297.

NICHOLS, G.E. 1934. The influence of exposure to winter temperatures upon seed germination in various native American plants. Ecology 15: 364-373.

NOYES, R.D. AND L.H. RIESEBERG. 1999. ITS sequence data support a single origin for North American Astereae (Asteraceae) and reflect deep geographic divisions in *Aster* s.l. American Journal of Botany 86: 398-412.

PEART, M.H. 1984. The effects of morphology, orientation and position of grass diaspores on seedling survival. Journal of Ecology 72: 437-453.

PETERSON, D.L. AND F.A. BAZZAZ. 1978. Life cycle characteristics of *Aster pilosus* in early successional habitats. Ecology 59: 1005-1013.

PITELKA, L.F., M.E. THAYER, AND S.B. HANSEN. 1983. Variation in achene weight in *Aster acuminatus*. Canadian Journal of Botany 61: 1415-1420.

PRINZIE, T.P. AND J.G. CHMIELEWSKI. 1994. Significance of achene characteristics and within-achene resource allocation in the germination strategy of tetraploid *Aster pilosus* var. *pilosus* (Asteraceae). American Journal of Botany 81: 259-264.

RABINOWITZ, D. 1981. Buried viable seeds in a North American tall-grass prairie: The resemblance of their abundance and composition to dispersing seeds. Oikos 36: 191-195..

ROWLEE, W.W. 1893. Studies upon akenes and seedlings of plants of the Order Compositae. Bulletin of the Torrey Botanical Club 20: 1-17.

SAS INSTITUTE INC. 1989. SAS/STAT™ User's Guide, Version 6. 4th ed. SAS Institute Inc., Cary, NC.

SEMPLE, J.C. AND J.G. CHMIELEWSKI. 1987. Revision of the *Aster lanceolatus* complex, including *A. simplex* and *A. hesperius* (Compositae: Astereae): a multivariate morphometric study. Canadian Journal of Botany 65: 1047-1062.

SEMPLE, J.C., J.G. CHMIELEWSKI, AND C. LEEDER. 1991. A multivariate morphometric study and revision of *Aster* subg. *Doellingeria* sect. *Triplopappus* (Compositae: Astereae): the *Aster umbellatus* complex. Canadian Journal of Botany 69: 256-276.

SEMPLE, J.C., S.B. HEARD, AND C. XIANG. 1996. The asters of Ontario (Compositae Astereae): *Diplactis* Raf., *Oclemena* E.L. Greene, *Doellingeria* Nees and *Aster* L. (including *Canadanthus* Nesom, *Symphyotrichum* Nees, and *Virgulus* Raf.). University of Waterloo Biology Series. No. 38. Waterloo, Ontario.

SHELDON, J.C. 1974. The behaviour of seeds in soil. III. The influence of seed morphology and the behaviour of seedlings on the establishment of plants from surface-lying seeds. Journal of Ecology 62: 47-66.

SHELDON, J.C. AND F.M. BURROWS. 1973. The dispersal effectiveness of the achene-pappus units of selected Compositae in steady winds with convection. New Phytologist 72: 665- 675.

TANOWITZ, B.D., P.F. SALOPEK, AND B.E. MAHALL. 1987. Differential germination of ray and disc achenes in *Hemizonia increscens* (Asteraceae). American Journal of Botany 74: 303-312.

TOOLE, E.H., S.B. HENDRICKS, H.A. BORTHWICK, AND V.K. TOOLE. 1956. Physiology of seed germination. Annual Review of Plant Physiology 7: 299-324.

U.S. DEPARTMENT OF THE ARMY. 1987. Corps of Engineers Wetland Delineation Manual. U.S. Army corps of engineers, Washington, D.C. Wetland's Research Program Technical Report No. Y-87-1.

VENABLE, D.L. 1985. The evolutionary ecology of seed heteromorphism. American Naturalist 126: 577-595.

VENABLE, D.L. AND A. BURQUEZ. 1989. Quantitative genetics of size, shape, life history, and fruit characteristics of the seed-heteromorphic composite *Heterosperma pinnatum*. I. Variation within and among populations. Evolution 43: 113-124

VENABLE, D.L., E. DYERSON, AND E. MORALES. 1995. Population dynamic consequences and evolution of seed traits of *Heterosperma pinnatum* (Asteraceae). American Journal of Botany 82: 410-420.

VENABLE, D.L. AND D.A. LEVIN. 1985. Ecology of achene dimorphism in *Heterotheca latifolia*. II. Demographic variation within populations. Journal of Ecology 73: 743-755.

WEISS, P.W. 1980. Germination, reproduction and interference in the amphicarp annual *Emex spinosa* (L.) Campd. Oecologia 45: 244-251.

WETMORE, R.H. AND A.L. DELISLE. 1939. Studies in the genetics and cytology of two species in the genus *Aster* and their polymorphy in nature. American Journal of Botany 26: 1-12.

WILLIAMS, J.T. AND J.L. HARPER. 1965. Seed polymorphism and germination. I. The influence of nitrates and low temperatures on the germination of *Chenopodium album*. Weed Research 5: 869-875.

XIANG, C. AND J.C. SEMPLE. 1996. Molecular systematic study of *Aster* sensu lato and related genera (Asteraceae: Astereae) based on chloroplast DNA restriction site analyses and mainly North American taxa. Pp. 393-423 *in* D.J.N. Hind (editor-in-chief), Proceedings of the International Compositae Conference, Kew, 1994, vol. 1.

ZHANG, J. 1993. Seed dimorphism in relation to germination and growth of *Cakile edentula*. Canadian Journal of Botany 71: 1231-1235.

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# A Review of the Nomenclature in Witmer Stone's *The Plants of Southern New Jersey*

GERRY MOORE
*Brooklyn Botanic Garden, 1000 Washington Avenue, Brooklyn, New York 11225*
*gerrymoore@bbg.org*

ABSTRACT. In 1912, Witmer Stone's landmark work on the plants of southern New Jersey was published. This work is the only floristic treatment for southern New Jersey and it continues to be used today. However, its use is made difficult by the nomenclature, which included elements of the 1905 *International Code of Zoological Nomenclature* and the defunct American (Brittonian) code of botanical nomenclature. As a result, many of the names used by Stone are no longer in current use. Stone's authorship citations were often incomplete and confusing because he cited only basionym authors even for combinations and inconsistently used parentheses to indicate basionym authors in combinations. Also Stone did not clearly indicate the rank of the 60 trinomials he used. For this paper, all names employed by Stone in *The Plants of Southern New Jersey* have been reviewed, and it is concluded that Stone's trinomials should be regarded as validly published, unranked names. The 19 nomenclatural innovations published by Stone in *The Plants of Southern New Jersey* are discussed. A table comparing all of the accepted names in Stone's manuals with those in two currently used manuals is available from the author upon request.

## INTRODUCTION

Witmer Stone had a nearly lifelong association with the Academy of Natural Sciences of Philadelphia (Anonymous 1940). He assumed charge of the Academy's bird collections at the age of 22 and published on diverse topics of zoology including ornithology, mammalogy, and zoological nomenclature (see Anonymous 1940; Pennell 1940). He is best known for his contributions in ornithology, serving as editor of *The Auk* for over twenty years and publishing his very well-received *Bird Studies at Old Cape May* (1937). He was also a member of the International Commission on Zoological Nomenclature from 1927 until his death in 1939 (Melville 1995). As a result of his contributions to natural history, he received an honorary doctorate from the University of Pennsylvania in 1913 (Ledwell 2000).

Besides his interests in zoology, Stone also had research interests in botany, particularly the flora of southern New Jersey. He was an original member of the Philadelphia Botanical Club and published numerous papers on the local flora (1902, 1903a, 1903b, 1906, 1907a, 1907b, 1908a, 1908b, 1909, 1910a, 1910b, 1911, 1912b), culminating in 1912 with *The Plants of Southern New Jersey with Especial Reference to the Flora of the Pine Barrens and the Geographic Distribution of the Species.*[1] This is the only comprehensive floristic treatment for

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[1]The publication date of Stone's work has been variously cited as 1910 (the date given on the cover page of the *Annual Report of the New Jersey State Museum* in which Stone's work appeared), 1911 (the date given on the title page of Stone's work), and 1912. Pennell (1940) clearly indicated that the work was not effectively published until

southern New Jersey, and it continues to be used today. The keys, based on material from southern New Jersey, and the precise phenological information provided by Bayard Long make it an excellent field manual. Stone's detailed discussions on plant biogeography and his eloquent narratives of his experiences make for informative and pleasant reading when not in the field.

Harley H. Bartlett (1912), who was harshly critical of Stone's method of nomenclature, lauded his flora stating it was "safe to predict that none of the local floras now current will be longer held in esteem by botanists generally than this one of Mr. Stone's." Roland Harper (1912) regarded it as "one of the best local floras ever published." Merritt Fernald (1934a) clearly approved of Stone's work since he referred to it as "scholarly" (see Jones 1945 for a discussion of Fernald's use of the word "scholarly"). Fernald (*Gentiana stoneana* in *Rhodora* 41: 555; 1939) and Homer D. House (*Viola stoneana* in *Bulletin of the Torrey Botanical Club* 32: 253; 1903) have named taxa in Stone's honor (neither name is in current use). In naming the Pine Barrens gentian (now known as *G. autumnalis* L.) in honor of Stone, Fernald noted: "no plant could more appropriately commemorate Witmer Stone than this retiring and distinguished gentian, with its flowers of true blue."

In the preface of his work, Stone commented on the confusion surrounding botanical nomenclature during the early 1900s and noted, "the botanist in America, at least, is on the horns of a dilemma." He went on to note that two very different botanical codes were in use — the American (Brittonian) Code[2] (Arthur et al. 1907) and the Vienna (International) Code (Briquet 1906) — and stated that zoologists "will probably find it quite impossible to accept certain of the features of these codes which are at variance with the International Zoological Code [International Commission on Zoological Nomenclature 1905]."

Stone commented that the general problems of zoological and botanical nomenclature were identical and noted that the zoologists "have been 'playing the game' seriously longer than the botanists." He predicted that "men of the same intellectual ability will eventually adopt the same methods." Stone's prediction of a uniform code or at least unified methods has yet to come true and a current effort to gain acceptance of a harmonized biological code of nomenclature (Greuter 1996; Greuter and Nicolson 1996; Greuter et al. 1996; Orchard et al. 1996) has failed (Barrie and Greuter 1999).

Stone indicated that he would make no attempt to revise botanical nomenclature and would follow the Brittonian Code. This allowed Stone to use tautonyms (e.g., *Sassafras sassafras*), which are not permitted in current botanical nomenclature (Greuter et al. 2000) but are accepted in zoological nomenclature (I.C.Z.N. 1905; Ride et al. 1999).

However, an important exception Stone made in following the Brittonian Code was "in the treatment of species and sub-species in separate categories, a most pernicious rule which botanists will in all probability ultimately reject" (1912a, p. 35). This assignment of coordinate status to specific and infraspecific ranks is why Stone permitted older varietal epithets to displace later specific epithets at the rank of species, and it is also why Stone assigned specific and infraspecific names coordinate status in the index. This practice was harshly criticized

early in 1912, the first copies being distributed on 14 February. I have Lee Sowden's (an early member of the Philadelphia Botanical Club) copy of Stone's flora and in it is a note from Stone indicating that he gave the book to Mr. Sowden on 14 February 1912. This work was reprinted by Quarterman Publications in 1973 (reviewed by Stafleu 1973).

[2]Nicolson (1991) argued that the American Code should be called the Brittonian Code since not all American botanists embraced this code over the Vienna Code.

by botanists, most notably Harley H. Bartlett (1912) who found Stone's nomenclature "thoroughly objectionable."

Specific and infraspecific names having coordinate nomenclatural status has been a long-standing point of disagreement in biological nomenclature. This practice persists in zoological nomenclature (Ride et al. 1999), where specific and infraspecific ranks are part of the species group and the "[p]riority of the name of a nominal taxon is not affected by elevation or reduction in rank of the taxon within the family group, genus group, or species group" (Article 23.3.1). Zoological nomenclature (Ride et al. 1999) only recognizes one formal infraspecific rank, the subspecies (Article 45.6). Coordinate status for specific and infraspecific ranks was permitted in the original Brittonian Code (Arthur et al. 1904) but was abandoned in the 1907 version (Arthur et al. 1907). Contrary to Stone's prediction, the current botanical code (Greuter et al. 2000) still does not assign coordinate status to specific and infraspecific names.

Further complicating the use of Stone's work is the way in which Stone cited authorship. He followed the zoological tradition of only citing the basionym author, even when the name used is different in rank or position from that of the basionym. Bartlett (1912) regarded this a "useless and uncalled for violation of botanical tradition."

When Stone used a combination he usually cited the basionym author parenthetically, but I have noted at least 26 instances where Stone used a transfer name and cited the basionym author without parentheses. Included on this list are five Stone innovations (*Panicum commonsianum addisonii*, *Blephariglottis* ×*canbyi*, *Polygonum hydropiperoides opelousanum*, *Ammodenia peploides maritima*, *Rubus villosus enslenii*).

It could be argued that in the cases of transfers from specific to infraspecific rank, Stone did not regard these changes as nomenclatural innovations, since he gave the specific and subspecific rank coordinate nomenclatural status. However, there are numerous cases of Stone citing the basionym author parenthetically when a change from specific to infraspecific rank (or the inverse) was made, including nine Stone innovations (*Paspalum laeve circulare*, *Chaetochloa imberbis versicolor*, *Scleria reticularis torreyana*, *Dioscorea villosa glabrifolia*, *Polygonum eciliatum*, *Lespedeza oblongifolia*, *Acer rubrum carolinianum*, *Euthamia graminifolia nuttallii*, *Doellingeria umbellata humilis*). Thus, Stone's occasional failure to parenthetically cite the basionym author for these combinations must be regarded as simple errors.

Stone's inconsistent usage of parentheses in author citations combined with other errors of citation, such as citing only the transfer author in combinations (e.g., *Muhlenbergia foliosa*, *Eragrostis pectinacea spectabilis*, *Veronica americana*), using a basionym but citing its author parenthetically (e.g., *Carex interior capillacea*, *Oenothera biennis*, *Galium lanceolatum*), citing two authors in two separate sets of parentheses (e.g., *Sorghastrum nutans*), not citing an author at all (e.g., *Carex varia emmonsii*), and citing the wrong author (e.g., *Quercus palustris*, *Prunus maritima*, *Epilobum coloratum*, *Asclepias amplexicaulis*, *Utricularia cleistogama*) make his author citations difficult to follow. Also, the practice of citing only the basionym author makes it difficult to know when Stone effected a transfer. Indeed, in the 19 cases where Stone effected a nomenclatural innovation, there is no indication from his authorship citation that he did so. Bartlett (1912) viewed this as "a practice which cannot be too strongly condemned."

Perhaps the most difficult nomenclatural issue in Stone's work is his employment of trinomials with no clear indication of rank (e.g., subspecies, variety, form). Most of the nomenclatural innovations in *The Plants of Southern New Jersey* are trinomials. However, Stone when using trinomials used the terms "variety," "subspecies," and "form," almost interchangeably, thus making it difficult to ascertain at what rank the trinomials were published. For example, under *Osmunda cinnamomea* Stone discussed "var. *O. cinnamomea glandulosa*" and under *Panicum commonsianum addisonii*, he stated "it seems more reasonable to regard . . . [it] as a sub-species rather than as full species." He regarded *Rhynchospora glomerata leptocarpa* as a "more slender form" and when discussing *Viola palmata*, *V. palmata triloba*, and *V. palmata sororia*, he noted that "these three forms show all sorts of intergrades." In a paper on *Viola*, Stone (1903b) described but did not name an infraspecific taxon of *Viola papilionacea* Pursh and used the designation "subsp." after the specific epithet. In Stone and Cram's (1904) popular guide to the mammals of North America, the trinomials employed were referred to as "varieties."

Stone's general views on infraspecific rank can best be gleaned in the introductory comments in his work on *Viola* (1903b) where he stated:

> . . . the point that I would particularly emphasize is that we have in these forms, which grow often side by side, just as clearly differentiated races as the geographical sub-species of vertebrates, and that they can be designated by trinomials to better advantage than by the binomial method now generally in vogue, even though the grouping be admittedly arbitrary in some instances. The careless use of the trinomial or varietal name in botany for all sorts of variation, purely individual, albinistic, etc., of course acts as a prejudice against applying it to well-established racial forms of this kind, but with the tremendous increase in species that we have currently witnessed in some genera the benefits of the trinomial system should be apparent. Unless we are thoroughly familiar with the genus, it is impossible to tell in a strictly binomial system which forms are clearly defined species and which are slightly differentiated races of a well-known type, while the use of the trinomials indicates this at a glance.

Stone (1903c) took a similar position on the use of trinomials in an article in *Condor*. Stone's views on this subject are in close agreement with those put forth in the American Ornithologists' Union Code (Coues et al. 1886), the last American zoological code of nomenclature before the establishment of the International Commission on Zoological Nomenclature (see Melville 1995), which criticized the binomial system and advocated the use of "trinomina" for organisms "known now to intergrade in physical characters" but not for "those slightly distinct and scarcely stable forms . . ."

In *The Plants of Southern New Jersey*, Stone commented that "one authority, the authority of the specific or subspecific name has been given." However, most of the trinomial authors cited by Stone published their names at the rank of variety. The fact that Stone in *The Plants of Southern New Jersey* never consistently used one term to represent his infraspecific rank and used the terms subspecies, variety, and form seemingly interchangeably when he discussed trinomials makes it impossible to assign an infraspecific rank to them.

This has resulted in subsequent works inconsistently citing Stone's trinomial innovations as subspecies, varieties, or unranked infraspecific taxa. For example, in the *International Plant Names Index* (The Plant Names Project 1999), the trinomial *Paspalum laeve circulare* (Nash) W. Stone was simultaneously listed as being both a varietal and subspecific name. U.S.D.A. (2000) regarded *Paspalum laeve circulare* (Nash) W. Stone, *Polygonum hydropiperoides opelousanum* (Riddell ex Riddell) W. Stone, and *Euthamia graminifolia nuttallii* (Greene) W. Stone as having been published as varieties but treated *Carex leptalea harperi* (Fernald) W. Stone as a subspecies. Hitchcock and Chase (1951) treated Stone's three grass innovations — *Chaetochloa imberbis versicolor*, *Panicum commonsianum addisonii*, *Paspalum laeve circulare* — as having been published as an unranked trinomial, a subspecies, and a variety, respectively.

I have concluded that under the current botanical code (Greuter et al. 2000), Stone's nomenclatural innovations involving trinomials should be regarded as validly published unranked names (Article 35.3). As such, these names are inoperative in questions of priority except homonymy (Article 53.4). The lack of a clear indication of rank does not invalidate Stone's trinomials since they were published prior to 1953 (Article 35.1).

It could be argued (see Voss 1966) that the trinomials published in Stone's work should be regarded as subspecies, since this is the term that he used in the introductory comments of his work (Voss 1966, p. 35). However, this would, in effect, force one to regard all previously published varietal names recognized in Stone's work as trinomials as being transfers (from variety to subspecies). This would greatly increase the number of nomenclatural innovations in Stone's work, since all 60 trinomials would have to be regarded as innovations. Current nomenclatural indices (e.g., the International Plant Names Index) do not treat all of Stone's trinomials as innovations, but rather regard as innovations only those in which Stone was the first to publish the name as a trinomial.

Regarding Stone's trinomials as subspecific names would also contradict his statement in the preface, "the names given in Britton's Manual have been adopted except where changes have been suggested in subsequent publications." If Stone had intended for his trinomials to function as transfers from the rank of variety to subspecies, then in those cases where he used a trinomial to represent a varietal name that was also a basionym, he should have cited the basionym author parenthetically; however, he did not (e.g., *Panicum virgatum* var. *cubense*, *Panicum columbianum* var. *thinium*, *Cyperus filiculmis* var. *macilentus*, *Carex umbellata* var. *tonsa*). This seems to have been the practice of botanists working under the American Code, such as Pennell (1935) who commented: "In now adopting 'subspecies' for precisely the concept that has often been called 'variety,' I wish it clearly understood that only a superficial change of name is involved and that I do not consider the trinomials appearing in this study to be new combinations." However, unlike Pennell (1935), Stone did not consistently use the term "subspecies" when referring to his trinomials.

Also, recognizing the trinomials as subspecies in some cases (see later discussions under *Carex umbellata abdita* and *Ammodenia peploides maritima*) will result in a variety including the type of the correct name of a subspecies, but not including the type of the correct name of the species, having a different epithet than the subspecies. This is contrary to Recommendation 26A.1 of the current botanical code (Greuter et al. 2000).

It should be noted that the *International Plant Names Index* (hereafter abbreviated as *I.P.N.I.*) indicated that Stone published the combination "*Utricularia inflata* var. *radiata*" in his *Plants of Southern New Jersey*. However, while Stone printed that combination (see p. 693) he did not accept it as a distinct taxon and thus under the current botanical code (Greuter et al. 2000) the name is not validly published (Article 34.1).

## Nomenclatural Innovations

For each of Stone's 19 nomenclatural innovations a review of all pertinent original literature was made and a discussion on each innovation is provided below. A complete list of nomenclatural (i.e., homotypic or objective) synonyms is also provided for each innovation. With regards to trinomials, only those for which Stone was the first to publish the name as a trinomial are considered as innovations. Abbreviations of books, periodicals, and authors of botanical names follow Stafleu and Cowan (1976-1988), Lawrence et al. (1968) and Brummitt and Powell (1992), respectively.

**01.** ***Paspalum laeve*** **[unranked]** ***circulare*** **(Nash) W. Stone, Pl. So. New Jersey 187. 1912a.**

*Paspalum circulare* Nash in Man. Fl. N. States (ed. 1): 73. 1901.

*P. laeve* var. *circulare* (Nash) Fernald in Rhodora 36: 22. 1934.

Stone was the first author to transfer the name to the infraspecific level and Fernald (1934b) was the first to recognize this taxon at varietal rank. In 1934 (and again in 1935), Fernald did not indicate that he was effecting a transfer and attributed the name at the varietal level to Stone. However, Fernald (1950) later cited himself as the transfer author.

Hitchcock and Chase (1951), U.S.D.A. (1982), and Kartesz (1994) recognized this taxon as a variety of *Paspalum laeve*. Gleason and Cronquist (1991) and U.S.D.A. (2000) regarded *P. circulare* as a synonym of *P. laeve* Michx. Hitchcock and Chase (1951), Kartesz (1994), and U.S.D.A. (2000) incorrectly regarded Stone as the transfer author for the name *P. laeve* var. *circulare*, while U.S.D.A. (1982) regarded Fernald as the transfer author of this name.

**02.** ***Panicum commonsianum*** **[unranked]** ***addisonii*** **(Nash) W. Stone loc. cit. 205.**

*Panicum addisonii* Nash in Bull. Torrey Bot. Club 25(2): 83. Feb. 1898.

*P. commonsianum* var. *addisonii* (Nash) Fernald in Rhodora 37: 391. 1935; Pohl in Amer. Midl. Naturalist 38: 582. 1947 (isonym).

*P. ovale* var. *addisonii* (Nash) C.F.Reed in Phytologia 67(6): 452. 1989.

*Dichanthelium ovale* var. *addisonii* (Nash) Gould and C.A.Clark in Ann. Missouri Bot. Gard. 65: 1115. 1978.

*Panicum addisonii* Nash and *P. commonsianum* Ashe are two *Dichanthelium*-type panic grasses that occur in the eastern United States primarily in sandy soils on the Coastal Plain. In Ashe's (1898) treatment, *P. addisonii* and *P. commonsianum* were not close, being the 24th and 60th taxa, respectively. Despite their wide separation, Ashe's original description of *P. commonsianum* closely matched his description and Nash's (1898) original description of *P. addisonii*. In Ashe's key, the two taxa were separated by "leaves scattered on the stem, all except the lowest narrowed to the base" for *P. addisonii* vs. "leaves crowded near the base of the stem, upper not reduced" for *P. commonsianum*. Both names were typified by material from Cape May County, New Jersey (*P. addisonii*: *E.P. Bicknell s.n.*, 30–31 May 1897, Wildwood [NY]; *P. commonsianum*: *A. Commons 34*, June 1898, Cape May. [NCU]).

Subsequent works by Hitchcock and Chase (1910, 1951) and Hitchcock (1935) placed *Panicum addisonii* and *P. commonsianum* in the species-group *Columbiana*. The taxa were distinguished by spikelet size (2.0 mm.–2.1 mm. in *P. addisonii* vs. 2.2–2.4 mm. in *P. commonsianum*) and panicle characters (dense with ascending branches in *P. addisonii* vs. open with spreading branches in *P. commonsianum*). Unlike Ashe's treatment, the two taxa were treated as sister species and it was noted that *P. addisonii* closely resembled *P. commonsianum*. Other works during this time (Robinson and Fernald 1908; Britton and Brown 1913a; Deam 1929; Small 1933) also recognized the two taxa as distinct species.

Witmer Stone (1912a) was the first to regard *Panicum addisonii* and *P. commonsianum* as conspecific (but distinct at the infraspecific level) under *P. commonsianum*. Stone's use of *P. commonsianum* in this sense is incorrect because *P. addisonii* Nash (published Feb. 1898) has priority over *P. commonsianum* Ashe (in *J. Elisha Mitchell Sci. Soc.* 15: 55. Nov. 1898). Fernald (1935) perpetuated Stone's error by effecting the incorrect combination *P. commonsianum* var. *addisonii* (Nash) Fernald. The combination that Fernald should have published is "*P. addisonii* var. *commonsianum*"; this combination has yet to be effected.

In 1974, Gould elevated *Panicum* subgenus *Dichanthelium* Hitchcock and Chase to generic rank. Gould and Clark (1978) later recognized *P. addisonii* and *P. commonsianum* as convarietal under *Dichanthelium ovale* (Elliott) Gould & C.A.Clark. Gould and Clark (1978) recognized that *P. commonsianum* var. *addisonii* (Nash) Fernald was the earliest published varietal name but they did not indicate that Fernald's combination was incorrect. And working under the Leningrad Code's (Stafleu et al. 1978) Article 26 (autonyms — in this case *P. commonsianum* var. *commonsianum* — "are not to be taken into consideration for purposes of priority"), the combination *D. ovale* var. *addisonii* (Nash) Gould & C.A.Clark was effected. *D. ovale* var. *addisonii* was used by Kartesz and Kartesz (1980), Clewell (1985), Kartesz (1994), and U.S.D.A. (2000). Reed (1989) adopted Gould and Clark's species and varietal concepts but did not recognize the genus *Dichanthelium* and effected the transfer *P. ovale* var. *addisonii* (Nash) C.F.Reed.

Interestingly, the name *Dichanthelium ovale* var. *addisonii* (and *Panicum ovale* var. *addisonii*) is correct under the current botanical code (Greuter et al. 2000). The incorrect assumption that *P. commonsianum* has priority over *P. addisonii* and the change in how autonyms are treated with regards to priority (under the current code they are to be taken into consideration) effectively cancel each other out.[3]

However, all is not well regarding current usage since some currently used works do not recognize *Dichanthelium* as a distinct genus and did not follow Gould and Clark's (1978) species and varietal concepts. These works regard *Panicum addisonii* and *P. commonsianum* to be conspecific under *P. commonsianum* (Radford et al. 1968; Gleason and Cronquist 1991) or distinct varietally under the names *P. commonsianum* var. *commonsianum* and *P. commonsianum* var. *addisonii* (Fernald 1950; Gleason 1952a; Gleason and Cronquist 1963; U.S.D.A. 1982; Ownbey and Morley 1991). Barring conservation of *P. commonsianum* over *P. addisonii*, *P. commonsianum* would have to be replaced by *P. addisonii* and a new combination ("*P. addisonii* var. *commonsianum*") would have to be effected if the two taxa were to be considered distinct varietally under *P. addisonii*.[4]

However, conserving *Panicum commonsianum* over *P. addisonii* would force a disadvantageous nomenclatural change for those who currently follow the taxonomy of Gould and Clark (1978) since, under the current autonym rule (Article 11.6), the name *Dichanthelium ovale* var. *addisonii* would be incorrect and a new combination would be needed. Thus, as long as there remain differences of opinion regarding the taxonomic rank and position of *P. addisonii* and *P. commonsianum* a name change will need to be made for solely nomenclatural reasons, regardless of whether or not *P. commonsianum* is conserved over *P. addisonii*. This argues against formal conservation of *P. commonsianum*.

In the *I.P.N.I.* under the entry of "*Panicum commonsianum* subsp. *addisonii* (Nash) Stone," it was noted that "[e]ven though Stone did not state the rank of his infraspecific taxon, his discussion on the status of *P. commonsianum* and *P. addisonii* (p. 206, paragraph 1) indicates the rank to be subspecific." While Stone did use the term "sub-species" in his discussion of *P. commonsianum* var. *addisonii*, he (as discussed earlier) also used the terms "variety" and

[3]Of course not updating innovations effected prior to the Sydney Code (Meikle et al. 1983) has also resulted in names in current use being incorrect. An example is *Dichanthelium sabulorum* var. *patulum* (Scribner & Merrill) Gould & C.A. Clark in Ann. Missouri Bot. Gard. 65: 113. 1978. This name was circumscribed by Gould and Clark to include *Panicum nashianum* Scribner var. *nashianum* and *P. nashianum* var. *patulum* Scribner & Merrill and hence is incorrect. However, Gould and Clark's taxonomy and nomenclature have been adopted by Clewell (1985), Kartesz (1994) and U.S.D.A. (2000).

[4]The nomenclatural problem addressed in this paper is not relevant if the taxonomy of Lelong (1984) or Hansen and Wunderlin (1988) is followed; Lelong recognized *Panicum addisonii* and *P. commonsianum* to be synonyms of *P. ovale* var. *pseudopubescens* (Nash) Lelong and Hansen and Wunderlin recognized them as synonyms of *Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark var. *acuminatum*.

"form" when discussing some of his other taxa with trinominal names. Thus, I regard his use of the term "sub-species" in this case to be incidental. Other currently used works treat *P. commonsianum addisonii* (Nash) W. Stone as having been published at the rank of subspecies (Hitchcock and Chase 1951), variety (Kartesz 1994; U.S.D.A. 2000) or as an unranked trinomial (Hithcock 1935)

03. ***Chaetochloa imberbis*** **[unranked]** ***versicolor*** **(E.P. Bicknell) W. Stone loc. cit. 213.**

*Chaetochloa versicolor* E.P. Bicknell in Bull. Torrey Bot. Club 25: 105. 1898.

*Panicum versicolor* (E.P. Bicknell) Nieuwl. in Amer. Midl. Naturalist 2: 64. 1911, non Doell 1877. nom. illeg.

*Chaetochloa* Scribn. (in U.S.D.A. Div. Agrostol. Bull. 4: 38. 1897) is now recognized under *Setaria* P.Beauv. (in Ess. Agrostogr.: 51. 1812), which is conserved over *Setaria* Ach. ex Michx. (in *Fl. Bor.-Amer.* 2: 331. 1803). Bicknell's basionym as well as the two combinations based on it were not cited by Fernald (1950), U.S.D.A. (1982, 2000), Gleason and Cronquist (1991) or Kartesz (1994). *C. versicolor* has never been transferred into *Setaria*.

Bicknell's description most closely resembles that of *Setaria geniculata* (Lam.) P.Beauv. recognized in Fernald (1950), U.S.D.A. (1982, 2000), Gleason and Cronquist (1991), and Kartesz (1994). Hitchcock and Chase (1951) also regarded *Chaetochloa versicolor* and Stone's transfer based on it as synonyms for *S. geniculata*. Unlike *Pasaplum laeve circulare* and *Panicum commonsianum addisonii*, Hitchcock and Chase (1951) did not regard Stone's innovation as having been published at the varietal or subspecific rank but cited *C. imberbis versicolor* (E.P. Bicknell) W. Stone as an unranked trinomial in synonymy under *S. geniculata*. No currently used work (e.g., Fernald 1950; U.S.D.A. 1982, 2000; Gleason and Cronquist 1991; Kartesz 1994) cited Stone's trinomial in synonymy.

04. ***Scleria minor*** **W. Stone loc. cit. 283.**

*Scleria triglomerata* var. *gracilis* Britton in Ann. New York Acad. Sci. 3: 230. 1885, non *S. gracilis* Elliott 1824 nec Rich. 1792.

*S. triglomerata* var. *minor* Britton, Illus. Fl. (ed. 1) 1: 282. 1896. *nom. illeg.*

This taxon was originally named as *Scleria triglomerata* var. *gracilis*. However, upon learning that *S. gracilis* had already been published by Elliott in 1824 (which itself is a later homonym of *S. gracilis* Rich.), Britton published *S. triglomerata* var. *minor*. Britton's name is illegitimate, since it was nomenclaturally superfluous (the name *S. triglomerata* var. *gracilis* was available) when published (Article 52.1).

Britton (1913a) discussed nomenclature in the introduction of vol. 1 of the *Illustrated Flora* and provided 10 basic rules of nomenclature which were said to be derived from "the Code of Nomenclature devised by the Paris Botanical Congress in 1867, as modified by the rules adopted by the Botanical Club of the American Association for the Advancement of Sciences at the meetings held in Rochester, New York, in August 1892 and at Madison, Wisconsin in August, 1893." Rule 4 stated, "the original name is to be maintained, whether published as a species, subspecies, or variety." However, the Brittonian Code (Arthur et al., 1907) dropped this provision and names no longer had priority outside of their own rank.

When Stone recognized this taxon at specific rank, he used the name *Scleria minor* and he indicated that he was publishing a transfer of Britton's name by citing it as "*Scleria minor* (Britton)." However, Stone's innovation was not a new combination but rather a nomen novum. *S. minor* is a replaced synonym for, and is typified by, *S. triglomerata* var. *gracilis*. Therefore, the proper citation is *S. minor* W. Stone and not *S. minor* (Britton) W. Stone as in Fernald (1950) and U.S.D.A. (1982). Gleason and Cronquist (1991) also recognized this taxon as a species and correctly cited Stone as the author, but they incorrectly indicated that this taxon would be "perhaps better treated as *S. triglomerata* var. *minor* Britton." The correct name for this taxon when treated as a variety of *S. triglomerata* Michx. is *S. triglomerata* var. *gracilis* Britton.

05. ***Scleria reticularis*** **[unranked]** ***torreyana*** **W. Stone loc. cit. 283.**

*Scleria laxa* Torr. in Ann. Lyceum Nat. Hist. New York 3: 443. 1836, non R.Br. 1810. nom. illeg.
*S. muhlenbergii*[5] Steud., Nomencl. Bot. (ed. 2): 543. 1841 (nom. nov. for *S. laxa* Torr.).
*S. torreyana* Walp. in Ann. Bot. Syst. 3: 696. 1852–53 (nom. nov. for *S. laxa* Torr.). nom. illeg.

Torrey (1836) was the first to describe this taxon but his name is illegitimate because it is a later homonym of *Scleria laxa* R.Br. Steudel (1841) was the first to rename this taxon when he published *S. muhlenbergii*. Walpers also renamed Torrey's *S. laxa* but his name is illegitimate because Steudel had already published an avowed substitute for *S. laxa* Torr.

Stone adopted Walpers' name at the infraspecific level, legitimizing the name at this level in a fashion similar to the situation with *Scleria minor* W. Stone. (Article 58.1). However, no one has ever transferred this name to a distinct infraspecific rank.

The taxonomy of the *Scleria reticularis* complex is controversial. When Torrey first described his *S. laxa* he distinguished it from *S. reticularis* on the basis of *S. laxa*'s possessing pitted achenes "marked in a somewhat spiral manner with transverse hairy rugae." Britton added another hairy-fruited *Scleria* with his description of *S. reticularis* var. *pubescens* Britton (in *Ann. New York Acad. Sci.* 3: 232. 1884) and commented that it frequently grew with *S. laxa* Torr. from which it could be distinguished "by the absence of transverse or spiral ridges." Thus there are three morphological types of concern: 1) typical *S. reticularis* with glabrous achenes; 2) *S. muhlenbergii* (≡*S. laxa* Torr.) with pitted achenes marked in a spiral to transverse manner with hairy rugae; and 3) *S. reticularis* var. *pubescens*, which like *S. muhlenbergii* has pubescent achenes but lacks the spiral or transverse ridges.

Stone did not regard the two hairy-fruited types to be taxonomically distinct, citing *Scleria reticularis* var. *pubescens* as a synonym of *S. reticularis torreyana*. Rather than use Britton's varietal name, he transferred Walpers' name because (as discussed earlier) he believed that earlier specific epithets should displace later varietal epithets.

Current usage is divided on whether to recognize the hairy-fruited material as distinct from the glabrous-fruited material. Like Stone, no later work followed Britton in recognizing the two hairy-fruited types (i.e., *Scleria muhlenbergii*, *S. reticularis* var. *pubescens*) as taxonomically distinct. Fernald (1950), Kartesz (1994), and U.S.D.A. (2000) recognized *S. muhlenbergii* and cited *S. reticularis* var. *pubescens* as a synonym. U.S.D.A. (1982) and Fairey (1967) treated *S. muhlenbergii* as a synonym of *S. reticularis* var. *pubescens*. Gleason and Cronquist (1991) did not regard the hairy-fruited and glabrous-fruited types as taxonomically distinct and listed *S. muhlenbergii* and *S. reticularis* var. *pubescens* as taxonomic synonyms of *S. reticularis*. None of these works cited *S. reticularis torreyana* W. Stone in synonymy nor is it listed in the *I.P.N.I.*

[5]Steudel's original spelling was *Scleria muehlenbergii*. However, Henry Muhlenberg's father adopted the anglicized form (Muhlenberg) of the original family name (Mühlenberg). All of Henry Muhlenberg's letters were signed and all of his articles (except those edited by Willdenow) appeared under the name Henry Muhlenberg (not Mühlenberg; Merrill and Hu 1949). Therefore, I have treated Steudel's original spelling as an error to be corrected (Article 60.1).

**06. *Carex varia* [unranked] *emmonsii* (Dewey ex Torr. & A. Gray) W. Stone loc. cit. 304.**

*Carex davisii* Dewey in Amer. J. Sci. 10: 279. 1826, non Schwein. & Torr. 1825. nom. illeg.
*C. emmonsii* Dewey ex Torr. & A. Gray in Ann. Lyceum Nat. Hist. New York 3: 411. 1836 (nom. nov. for *C. davisii* ).
*C. novae-angliae* var. *emmonsii* (Dewey ex Torr. & A. Gray) J.Carey ex A. Gray, Manual (ed. 1): 556. 1848.
*C. lucorum* var. *emmonsii* (Dewey ex Torr. & A. Gray) Chapm., Fl. South. U.S. (ed. 1): 539. 1860.
*C. albicans* var. *emmonsii* (Dewey ex Torr. & A. Gray) J.Rettig in Sida 14: 133. 1990.

This taxon was originally described as *Carex davisii* by Dewey but this name is illegitimate because it is a later homonym of *C. davisii* Schwein & Torr. It was later renamed *C. emmonsii* in Torrey's (1836) *Monograph of North American Cyperaceae.* In Torrey's paper the name was attributed to Dewey but there was no accompanying statement that he contributed in any way to the paper other than providing specimens for examination. However, Torrey did acknowledge "most valuable aid" provided by Asa Gray and stated "the Synopsis of North American *Carices*, I wish to have considered as our joint performance." Hence the proper citation should be *Carex emmonsii* Dewey ex Torr. & A. Gray. More recent authors either cited the basionym authorship as "Dewey" (Fernald 1950, U.S.D.A. 1982) or "Dewey ex Torr." (Kartesz 1994, U.S.D.A. 2000).

Stone, like other early authors (e.g., Robinson and Fernald 1908), misapplied the name *Carex varia* Muhl. ex Schkuhr to this taxon. Also, Stone did not cite any author after his *C. varia emmonsii* trinomial and below this entry he incorrectly cited the basionym as "*Carex varia* var. *emmonsii* 'Dewey,'[6] Torr."

Rettig (1989) originally recognized *Carex emmonsii*, even though it was considered to be conspecific with the earlier *C. albicans* Willd. ex Spreng. (*Syst. Veg.* 3: 818. 1826). *C. albicans* was not used because it had been " 'widely and persistently' used for the taxon now known as C. *emmonsii* var. *emmonsii*," even though the type of *C. albicans* "belongs to *C. emmonsii* var. *muhlenbergii*." Rettig never proposed to formally reject this name and later (1990) adopted it and recognized *C. emmonsii* as a variety of *C. albicans*. Currently used works either recognized this taxon as a species (Fernald 1950, U.S.D.A. 1982) or as a variety of *C. albicans* (Gleason and Cronquist 1991, Kartesz 1994, U.S.D.A. 2000). None of these works nor the *I.P.N.I.* cited *C. varia emmonsii* (Dewey ex Torr. & A. Gray) W. Stone in synonymy.

**07. *Carex umbellata* [unranked] *abdita* (E.P. Bicknell) W. Stone loc. cit. 305.**

*Carex umbellata* var. *brevirostris* Boott, Illustr. Carex 2: 99. 1860, non *C. brevirostris* Cedestr. 1857 nec Blytt 1857.
*C. umbellata* var. *brachyrhina* Piper in Contr. U.S. Nat. Herb. 11: 175. 1906 (nom. nov. for *C. umbellata* var. *brevirostris*). nom. illeg.
*C. abdita* E.P. Bicknell in Bull. Torrey Bot. Club 25: 492. 1908 (nom. et stat. nov. for *C. umbellata* var. *brevirostris*).

Bicknell in his discussion of *Carex umbellata* Schkuhr var. *umbellata* for Nantucket stated:

> This plant agrees so well with Schkuhr's illustration of *Carex umbellata* that there can be little doubt that it is definitely typical, although a form with longer-beaked more pubescent perigynia

[6]In *The Plants of Southern New Jersey*, Stone used quotation marks around an author's name to indicate that this author had a plant name ascribed to him by another author.

would seem to have been commonly understood in that sense. The plant here in view, notwithstanding its comparatively short beak is not the var. *brevirostris* Boott. The latter plant or one which must be referred to it on the basis of descriptions, is frequent on Long Island, N.Y., where the typical plant seems to be rare, the prevailing form being the var. *tonsa* Fernald. The var. *brevirostris* often occurs with the latter and differs from it constantly in definite characters. It commonly forms larger, closer tufts and has much longer, narrower, more erect and less rigid leaves and more slender culms, some of which are capillary and elongated and bear a slender-pedicelled, bracteate fertile spike near the base of the staminate one; the perigynia are mostly pubescent and only 2.5–3 mm long, with the short beak only 0.5–1 mm., the achene pale brown, rather shining and about 1.5 mm. long by 1 mm. thick. I have long regarded this plant as a distinct species and have deposited specimens from Richmond Hill, Long Island in the herbarium of the N.Y. Botanical Garden labeled *Carex abdita*.

Based on the passage above, I have concluded that *Carex abdita* was published as a nomen et status novon for *C. umbellata* var. *brevirostris* Boott (non *C. brevirostris* Cedestr.). This conclusion is based on Bicknell's statement that, based on descriptions, the material in question from Long Island must be referred to *C. umbellata* var. *brevirostris* and the fourth sentence in the above passage which links the name *C. umbellata* var. *brevirostris* to the description. However, since Bicknell stated that he had regarded this plant to be a distinct species, it could be argued that *C. abdita* was published as a species novum (typified by the Richmond Hill, Long Island material).

Stone incorrectly indicated that Bicknell had published the name as *Carex umbellata* var. *abdita*. Most recent works (U.S.D.A. 1982, 2000; Gleason and Cronquist 1991; Kartesz 1994) regard *Carex abdita* as a taxonomic synonym of *C. umbellata*. Fernald (1950) recognized *C. abdita* as a distinct species. None of these works cited *C. umbellata abdita* (E.P. Bicknell) W. Stone in synonymy. The *I.P.N.I.* listed Stone's trinomial as having been published at the rank of subspecies.

This case represents an example of how recognizing Stone's trinomials as subspecies could have the disadvantageous effect of a varietal name including the type of the correct name of a subspecies, but not including the type of the correct name of the species, having a different epithet than the subspecies name. If Stone's trinomials were regarded as subspecies then the correct name for this taxon at the rank of subspecies would be *Carex umbellata* subsp. *abdita* (E.P. Bicknell) W. Stone. However, the correct name for the same taxon at the rank of variety would be *C. umbellata* var. *brevirostris* Boott. Such a situation (i.e., the name of the variety is different from the name of the subspecies even though the name of the variety is typified by the type of the subspecies but not the type of the correct name of the species) is possible under the current botanical code (Greuter et al. 2000) but is contrary to Recommendation 26A.1.

**08. *Carex leptalea* [unranked] *harperi* (Fernald) W. Stone loc. cit. 305.**

*Carex harperi* Fernald in Rhodora 8: 181. 1906
*C. leptalea* var. *harperi* (Fernald) Weath. & Griscom in Rhodora 36: 39. 1934.
*C. leptalea* subsp. *harperi* (Fernald) Cald. & Tayl. in Canad. J. Bot. 43: 1391. 1965.

This taxon was originally described by Fernald (1906), who commented that the plant was similar to *Carex leptalea*, but could be distinguished on the basis of its perigynia (longer and more strongly overlapping), scales (whitish and acuminate), and achenes (puncticulate, sharply angled). Currently used works treated *Carex harperi* as a taxonomic synonym of *C. leptalea* (U.S.D.A. 1982; Gleason and Cronquist 1991) or as a variety (Fernald 1950) or subspecies of *C. leptalea* (Kartesz 1994; U.S.D.A. 2000). Recognizing this taxon as a variety of *C. leptalea*, Fernald (1950) attributed the transfer to Stone. Kartesz (1994) and U.S.D.A. (2000) recognized this taxon at subspecific rank and also attributed the transfer at this rank to Stone. U.S.D.A. (1982) treated this name as a synonym of *Carex leptalea* and cited "*Carex leptalea* var. *harperi* (Fernald) Fernald ex W. Stone" as a synonym. This exemplifies the undesirable result that can occur when the basionym author is cited but not parenthetically. In this case Stone published "*C. leptalea harperi* Fernald." This was later interpreted by U.S.D.A. (1982) to indicate that Stone was ascribing the transfer to Fernald, when all he was actually doing was citing the basionym author. Bartlett (1912) regarded this practice as "falsely branding" the basionym author as the author of a new combination. This issue indicates a potential problem with adopting the zoological practice of author citation when parentheses are inadvertently left out. It also highlights how this practice would allow transfers to be effected in an ambiguous fashion.

Since Stone cannot be regarded as having published the name at the varietal level the question of course is who was the first person to recognize this taxon as a variety and hence effect the transfer. This appears to be Weatherby and Griscom (1934; see Voss 1966), who incorrectly ascribed the transfer to Stone. Thus, the correct citation should be *Carex leptalea* var. *harperi* (Fernald) Weatherby & Griscom. The *I.P.N.I.* treated Stone's trinomial as having been published at the rank of subspecies.

09. ***Dioscorea villosa*** **[unranked]** ***glabrifolia*** **(Bartlett) W. Stone loc. cit. 358.**

*Dioscorea paniculata* var. *glabrifolia* Bartlett in U.S.D.A. Bur. Pl. Industr. Bull. 189: 1915. 1910.
*D. villosa* var. *glabrifolia* (Bartlett) Blake in Rhodora 20: 49. 1918.
*D. villosa* forma *glabrifolia* (Bartlett) Fernald in Rhodora 39: 401. 1937.

Bartlett (1910) displaced the name *Dioscorea villosa* L. with *D. paniculata* Michx. on the grounds that *D. villosa* L. was being misapplied and that the earliest name available for this taxon was *D. paniculata* Michx. However, Stone did not accept Bartlett's interpretation and transferred Bartlett's name as *D. villosa glabrifolia*. Blake (1918) also did not accept Bartlett's views on this matter and recognized Bartlett's name as a variety of *D. villosa*. Fernald (1937) later recognized this taxon as a form of *D. villosa*.

Two later works (U.S.D.A. 1982; Gleason and Cronquist 1991) did not recognize Bartlett's name at any level and did not even cite his name in synonymy. Bartlett's plant would key to *Dioscorea villosa* in Gleason and Cronquist. Fernald (1950) continued to recognize this taxon as a form of *D. villosa*. Kartesz (1994) and U.S.D.A. (2000) recognized this name as a synonym of *D. quaternata* J.F.Gmel. None of these works cited *D. villosa glabrifolia* (Bartlett) W. Stone in synonymy. The *I.P.N.I.* listed Stone's trinomial as having been published at the rank of subspecies.

10. ***Blephariglottis ×canbyi*** **(Ames) W. Stone loc. cit. 368.**

*Habenaria canbyi* Ames in Rhodora 10: 70. 1908.
*Platanthera ×canbyi* (Ames) Luer, Native Orchids Florida: 151. 1972.

Stone made this combination in the discussion under *Blephariglottis blephariglottis*. This nothotaxon is the result of crossing between *Habenaria blephariglottis* (Willd.) Hook. and *H. cristata* (Michx.) R.Br. In all recent works the fringed orchids were placed in either *Habenaria* Willd. or *Platanthera* Rich.

**11. *Gyrostachys beckii* (Lind.) W. Stone loc. cit. 375.**

*Spiranthes beckii* Lindl., Gen. Sp. Orchid. Pl.: 472. 1840.
*Ibidium beckii* (Lindl.) House in Muhlenbergia 1: 128. 1906. nom. invalid.
*Triorchis beckii* (Lindl.) House in Amer. Midl. Naturalist 6: 206. 1920. nom. invalid.

The transfers listed above were not due to disagreements over generic level taxonomy but as to what the earliest published name was for this genus of plants. The name *Ibidium* was first published as a nomen nudum by Salisbury (in *Trans. Hort. Soc. London* 1: 291. 1812). This name was later validated with a description by Small (*Fl. Southeast U.S.* (ed. 2): 318. 1913). Before Small published his validating description, House made "transfers" into *Ibidium*, including Lindley's name. However, these "combinations" are not valid since they were published before Small's validating description. Also, House's (1920) publication of the name "*Triorchis beckii*" is not valid because *Triorchis* Petiver is pre-Linnaean and hence invalid.

The genus name *Gyrostachys* was first published (as *Gyrostachis*) by Persoon (*Syn. Pl.* 2: 511. 1809) but it was invalid at the time of publication because it was not accepted by Persoon. Blume (*Coll. Orchid.*: 127. 1859; *Fl. Javae Nov. Ser.*: 107. 1859) later validated this name by accepting it as a genus. However, by this time the name *Spiranthes* had been validly published by L.C. Richard (*De Orchid Eur.*: 20, 28, 36. 1837).

*Spiranthes* is conserved over the nomenclatural synonym *Orchiastrum* Ség. (*Pl. Veron.* 3: 252. 1754). It is not conserved over *Aristotelea*, *Ibidium*, *Gyrostachys*, and *Helictonia* Ehrh. *Aristotelea* Lour. (*Fl. Cochinch.*: 522. 1790) is an earlier name and is homotypic with *Spiranthes*. However, *Aristotelea* Lour. should be regarded as a parahomonym (Article 53.3) of *Aristotelia* L'Hér. (*Stirp. Nov.* 31: 16. 1785), which is conserved over *Aristotela* Adans. (*Fam.* 2: 125. 1763). The valid publication date of *Spiranthes* predates the valid publication dates of *Ibidium* and *Gyrostachys*; *Helictonia* Ehrh. is invalid.

The taxonomic limits of this taxon have been controversial as have been the application of names in *Spiranthes*. The taxon in question has been recognized under three different basionyms and combinations based on them: *S. simplex* A. Gray (1867), non Grisebach 1864 (≡*S. grayi* Ames), *S. beckii* Lind. and *S. tuberosa* Raf. The recognition of this taxon under *S. beckii* (and combinations based on it) was due to the misapplication of this name to material now considered to be conspecific with *S. gracilis* (Bigelow) Beck (Correll 1950, Luer 1975). Gray described *S. simplex* (*Manual* (ed. 5): 506. 1867) for this taxon believing that *S. tuberosa* Raf. also applied to *S. gracilis*.

Ames (1947) regarded *Spiranthes tuberosa* to be comprised of more than one species and, in view of the lack of a type specimen, chose to abandon it and use *S. grayi* and *S. gracilis* var. *floridana* (Wherry) Correll for the two elements involved. Fernald (1946) disagreed stating, "as to the identity of *Spiranthes tuberosa* Raf. . . . there is certainly no doubt" and applied the name to the only small-flowered taxon in the eastern United States that possesses a tuber. Correll (1950) followed Ames' views on application and recognized this taxon as *Spiranthes grayi*. All other currently used works followed Fernald's views (Fernald 1950; Luer 1975; U.S.D.A. 1982, 2000; Gleason and Cronquist 1991; Kartesz 1994).

**12. *Polygonum hydropiperoides* [unranked] *opelousanum* (Riddell) W. Stone loc. cit. 422.**

*Polygonum opelousanum* Riddell, New Orleans Med. Surg. J. 9: 611. 1853 (as nom. nud. by Riddell in New Orleans Med. Surg. J. 8: 760. 1852).
*Polygonum hydropiperoides* var. *opelousanum* (Riddell) Gleason, Illus. Fl. vol. 2: 82. 1952.
*Persicaria opelousana* (Riddell) Small, Fl. Southeast. U.S. (ed. 1): 378. 1903.

This epithet was originally published by Riddell as a nomen nudum in 1852. Riddell validated his name with a description in 1853. This second publication is not cited by the major nomenclatural indices such as the *I.P.N.I.* Thus, some Riddell names in these indices are given incorrect author citations. For example in *I.P.N.I.* the citation for this Riddell name is *Polygonum opelousanum* Riddell ex Small. In light of this overlooked publication, Riddell entries in these indices need to be reviewed and updated.

Stone was the first to recognize this taxon at the infraspecific level under *Polygonum hydropiperoides*. Gleason (1952b) was the first to recognize this taxon as a variety and cited Stone as the transfer author at this rank.

Fernald (1950) recognized *Polygonum opelousanum*. Gleason and Cronquist (1991) recognized this taxon as a variety of *P. hydropiperoides* and cited Stone as the transfer author. U.S.D.A. (1982, 2000) and Kartesz (1994) treated *P. opelousanum* as a taxonomic synonym of *P. hydropiperoides* and in synonymy cited "*P. hydropiperoides* var. *opelousanum* (Riddell ex Small) Riddell ex W. Stone." Besides incorrectly citing Stone as the transfer author at the rank of variety, these works incorrectly cited Small as the validating author of the basionym due to the overlooked status of Riddell's 1853 publication (cited above). They also incorrectly cited Riddell as an ascribed author of the transfer, because Stone cited Riddell without parentheses after *P. hydropiperoides opelousanum*. This is another instance of the "false branding" problem that Bartlett (1912) discussed. The *I.P.N.I.* lists Stone's trinomial as having been published at the rank of subspecies.

**13. *Polygonum eciliatum* (Small) W. Stone loc. cit. 423.**

*Polygonum punctatum* var. *eciliatum* Small in Bull. Torrey Bot. Club 20: 214. 1893.

Small distinguished this from typical *Polygonum punctatum* by its "glossy appearance . . . perfectly smooth and eciliate ochreae, and the slightly narrower and more reticulated achene." In Stone's key to the Polygonaceae, *P. punctatum* and *P. eciliatum* are separated based on the ochreae (fringed with cilia vs. naked).

In Stone's discussion of this plant he stated, "This handsome *Polygonum* was first discovered by Mr. Alexander McElwee 11 September 1892 at Wildwood. He proposed to describe it as new, but for some reason did not do so and his manuscript description is still attached to the specimen at the Philadelphia Academy herbarium." Stone went on to state that the "pink flowers are quite showy." This is similar to Small's statement in his original description that "the color of the flowers and racemes . . . is very striking." Further evidence that Small recognized the material examined by Stone as belonging to his *P. punctatum* var. *eciliatum* (holotype: *Pringle 4213*, Valley of Toluca, Mexico State, Mexico [NY]) is that he mentioned New Jersey in the range of this plant in his *Flora of the Southeastern United States* (1933).

No works in current use recognize Small's taxon, nor do they cite *P. punctatum* var. *eciliatum* Small or *P. eciliatum* (Small) W. Stone anywhere in synonymy. Small's plant closely matches the descriptions of *Polygonum punctatum* in Fernald (1950) and Gleason and Cronquist (1991).

**14. *Ammodenia peploides* [unranked] *maritima* (Raf.) W. Stone loc. cit. 441.**

*Adenarium maritimum* Raf., New Fl 1: 62. 1836.

*Ammodenia maritima* (Raf.) E.P. Bicknell in Bull. Torrey Bot. Club 37: 58. 1910.

*Arenaria peploides* var. *robusta* Fernald in Rhodora 11: 114. 1909 (*nom. et stat. nov.* for *Adenarium maritimum* Raf.).

*Honckenya peploides* subsp. *robusta* (Fernald) Hultén, Fl. Aleut. Isl.: 173. 1937.
*Honkenya peploides* var. *robusta* (Fernald) House in New York State Mus. Bull. 243/244: 56. 1923.
*Minuartia peploides* subsp. *robusta* (Fernald) Mattf. in Bot. Jahrb. Syst. 57: 27. 1921.

The name *Ammodenia* was not accompanied by a description when it was published by J.G. Gmelin (ascribed to Patrin, *Fl. Sibir.* 4: 160. 1769) so it was an invalid name at the time of Ehrhart's publication of *Honkenya* (in *Beitr. Naturk.* 2: 180. 1788, non Willd. ex Cothen. 1790), which also predated *Adenarium* Raf. (in *Amer. Monthly Mag. & Crit. Review* 2: 266. 1818).

*Honkenya* Ehrh. (1788) was named in honor of Gerhard August Honckeny. This led Bartling to change the spelling to *Honckenya* (in *Ord.* 305. 1830). Most recent works also spelled the name *Honckenya* (Gleason and Cronquist 1991; Kartesz 1994; U.S.D.A. 2000).

However, before Bartling's correction of *Honkenya* Ehrh to *Honckenya*, Willdenow had published *Honckenya* (in Usteri, *Del. Opusc. Bot.* 2: 200. 1793) to replace *Honkenya* Willd. ex Cothen. (*Disp.* 19. 1790; ≡*Clappertonia* Meisn. 1837) in the *Tiliacae*. In my opinion, *Honkenya* Willd. ex Cothen. and all orthographic variants based on it (*Honckenya*; *Honckenia* Pers., Syn. 1: 416. 1805; *Honckeneya* Steud., *Nomencl. Bot.* (ed. 2) 1: 774. 1840) should be treated as later homonyms of *Honkenya* Ehrh. (Article 53.3).

Rafinesque was the first to distinguish this taxon from *Arenaria peploides* on the basis of its entire leaves (vs. subserrate in *A. peploides*) and referred to this taxon as *Adenarium maritimum*. This was later transferred into *Ammodenia* by E.P. Bicknell (1910).

Fernald (1909) chose not to regard these maritime plants as generically distinct from *Arenaria* and regarded *Adenarium maritimum* as a variety of *Arenaria peploides*. However, "since the name *maritima* has since been twice used for species in the genus *Arenaria* and as a varietal designation would be quite meaningless for a local variation of a uniformly maritime species," Fernald introduced the name *Arenaria peploides* var. *robusta*.

Stone was aware of Fernald's varietal name but used Rafinesque's name in his transfer because of his belief that specific and infraspecific names have coordinate nomenclatural status. Fernald's variety was transferred to *Honkenya peploides* by House (1923). It was also later transferred to subspecific rank under *H. peploides* by Húlten (1937) and under *Minuartia peploides* by Mattfeld (1921). More recent works either treated this taxon as *H. peploides* ssp. *robusta* (U.S.D.A. 1982, 2000; Kartesz, 1994), *H. peploides* var. *robusta* (Gleason and Cronquist 1991), or *Arenaria peploides* var. *robusta* (Fernald 1950). None of these works cited *Ammodenia peploides maritima* (Raf.) W. Stone in synonymy. The *I.P.N.I.* listed Stone's trinomial as having been published at the rank of subspecies.

This is an example of the disadvantageous effect of recognizing Stone's trinomials as subspecies. If *Ammodenia peploides maritima* (Raf.) W. Stone is recognized as a subspecies then the recently used names *Honckenya peploides* subsp. *robusta* (Fernald) Hultén and *Minuartia peploides* subsp. *robusta* (Fernald) Mattf. are incorrect since Stone's name would have priority at the subspecific rank and new combinations in *Honckenya* and *Minuartia* would have to be effected. The earliest name at the rank of variety would be *Arenaria peploides* var. *robusta*. Thus, like the *Carex umbellata abdita* example discussed earlier, this is a case where recognizing Stone's trinomials as subspecies would have the disadvantageous effect of a varietal name including the type of the correct name of a subspecies, but not including the type of the correct name of the species, having a different epithet than the subspecies name.

**15. *Rubus villosus* [unranked] *enslenii* (Tratt.) W. Stone loc. cit. 480.**

*Rubus enslenii* Tratt., Rosac. Monog. 3: 63. 1823.

Stone misapplied the name *Rubus villosus* Aiton for a taxon that is properly known as *R. flagellaris* Willd. (Bailey 1943) and he recognized *R. enslenii* at the infraspecific level under this taxon. No other author has recognized *R. enslenii* at a distinct infraspecific rank under either *R. villosus* or *R. flagellaris*. All current works either recognize *R. enslenii* as a distinct species (Fernald 1950; U.S.D.A. 1982; Gleason and Cronquist 1991) or as a taxonomic synonym of *R. flagellaris* (Kartesz 1994; U.S.D.A. 2000). None of these works cited Stone's trinomial in synonymy. Bailey (1943) recognized *R. enslenii* and cited Stone's trinomial as a synonym and recognized it as having been published at the rank of variety. The *I.P.N.I.* recognized Stone's trinomial as having been published at the rank of subspecies.

**16. *Lespedeza oblongifolia* (Britton) W. Stone loc. cit. 509.**

*Lespedeza hirta* var. *oblongifolia* Britton in Trans. New York Acad. Sci. 12: 66. 1893.

When Britton described this taxon he regarded it as "very well-marked" and placed it under *Lespedeza hirta* "on account of its long peduncles." Stone regarded this taxon as a species and distinguished it from *L. hirta* on the basis of its oblong leaflets. Stone stated that this plant was "not common." Neither author discussed any fruit characters.

Britton and Brown (1913b), under *Lespedeza hirta* stated "[a] plant known as *Lespedeza hirta oblongifolia* may be a hybrid with *L. angustifolia* (Pursh) Ell. We do not know its fruit." Fernald (1941, 1950) regarded *L. hirta* var. *longifolia* (DC.) Torr. & A. Gray (*Fl. N. Am.* 1:368. 1840.) and *L. hirta* var. *oblongifolia* to be convarietal under *L. hirta* var. *longifolia*. All other currently used works (Gleason and Cronquist 1991; Clewell 1966; Kartesz 1994; U.S.D.A. 1982, 2000) recognized *L. longifolia* DC. and *L. oblongifolia* to be distinct hybrids, *L.* × *longifolia* (*L. capitata* × *L. hirta*) and *L.* × *oblongifolia* (*L. angustifolia* × *L. hirta*). In the *I.P.N.I.* this name was listed as *L. oblongifolia* Stone; however, there seems to be no basis for not listing Britton as the author of the basionym.

**17. *Acer rubrum* [unranked] *carolinianum* (Walter) W. Stone loc. cit. 544.**

*Acer carolinianum* Walter, Fl. Carol.: 250. 1788.

*Rufacer carolinianum* (Walter) Small, Fl. S.E. U.S.: 826. 1933.

Under *Acer rubrum*, Stone stated the following: "The Red Maples of our region are puzzling in their variability. We have a form with very small three-lobed leaves, usually tomentose beneath, which is common in the Pine Barrens, which I have referred to *carolinianum*, while through the Middle district there is a tree with rather larger leaves, rarely tomentose beneath which may be referable to true *rubrum*. . . . The division of specimens . . . is arbitrary, but the differences between the extremes is striking." Stone's *A. rubrum carolinianum* with its small three-lobed leaves is undoubtedly equivalent to *A. rubrum* var. *tridens* A.W.Wood and *A. rubrum* var. *trilobum* Torr. & A. Gray ex K.Koch. Most currently used works (Fernald 1950; U.S.D.A. 1982, 2000; Gelderen et al. 1994; Kartesz 1994) recognized this taxon under the name *A. rubrum* var. *trilobum*. Gleason and Cronquist (1991) regarded the *A. rubrum* complex as ". . . variable, but indivisible." None of these works cited Stone's trinomial in synonymy. The *I.P.N.I.* listed Stone's trinomial as having been published at the rank of subspecies.

**18. *Euthamia graminifolia* [unranked] *nuttallii* (Greene) W. Stone loc. cit. 752.**

*Euthamia nuttallii* Greene in Pittonia 5: 73. 1902.
*E. graminifolia* (Greene) var. *nuttallii* Sieren in Rhodora 83: 564. 1981.
*Solidago graminifolia* var. *nuttallii* (Greene) Fernald in Rhodora 10: 92. 1908.
*S. nuttallii* (Greene) Bush in Amer. Midl. Naturalist 5: 168. 1918. pro syn., nom. invalid.
TAXONOMIC SYNONYMS
*Euthamia floribunda* Greene in Pittonia 5: 74. 1902, non *Solidago floribunda* Phil. 1894.
*E. graminifolia* var. *polycephala* (Fernald) Moldenke in Revista Sudamer. Bot. 6: 29. 1939.
*Solidago polycephala* Fernald in Rhodora 10: 93. 1908 (nom. nov. for *E. floribunda* Greene).
*S. graminifolia* var. *polycephala* (Fernald) Fernald in Rhodora 17: 12. 1915.
*S. floribunda* (Greene) Bush in Am. Midl. Naturalist 5: 167. 1918, non Phil. 1894) pro syn., nom. invalid.

Greene (1902) described two closely related taxa of *Euthamia* from the *E. graminifolia* complex, *E. floribunda* and *E. nuttallii*. They were distinguished from typical *E. graminifolia* on the basis of their pubescent leaves and inflorescence. *E. floribunda* was distinguished from *E. nuttallii* on the basis of its tiny involucre (3–3.5 mm. long) and its appressed deltoid green tips of the bracts.

Currently used works either treat these plants as *Solidago* L. (Fernald 1950) or retain them in the segregate genus *Euthamia* Nutt. as interpreted by Strother 2000 (U.S.D.A. 1982, 2000; Kartesz 1994; Gleason and Cronquist 1991). Fernald (1950) recognized *E. floribunda* and *E. nuttallii* as varieties of *S. graminifolia*. U.S.D.A. (1982) regarded Greene's two names as synonyms of *E. graminifolia*. Gleason and Cronquist (1991) regarded "var. nuttallii" as a hirtellous phase of *E. graminifolia*. Kartesz (1994) and U.S.D.A. (2000) recognized *E. floribunda* and *E. nuttallii* as convarietal under *E. graminifolia* var. *nuttallii*. Gleason and Cronquist (1991), Kartesz (1994), and U.S.D.A. (1982, 2000) incorrectly cited Stone's trinomial as having been published at the rank of variety. However, Stone did not effect a transfer at the varietal rank and it appears that this combination (*E. graminifolia* var. *nuttallii*) was first published by Sieren (1981; see also Voss 1996). The *I.P.N.I.* index listed Stone's trinomial as having been published at the rank of subspecies, although it incorrectly ascribed the combination to Stone.

**19. *Doellingeria umbellata* [unranked] *humilis* (Willd.) W. Stone loc. cit. 763.**

*Aster humilis* Willd. in Sp. Pl. 3: 2038. 1804.
*Aster umbellatus* var. *humilis* (Willd.) Britton et al., Prelim. Catalogue New York, 27. 1888.
*Doellingeria humilis* (Willd.) Britton in Illus. Fl. 3: 392. 1898.

Stone cited this plant as occurring in "open swamps in the Pine Barrens; not common." In their review of *Aster* in the Willdenow Herbarium, Jones and Hiepko (1981) stated "at the rank of variety, the name *A. humilis* is to be placed in synonymy under *A. umbellatus* var. *latifolius* A. Gray." In currently used works, Stone's *Doellingeria umbellata humilis* is referable to either *A. umbellatus* (Fernald 1950; Gleason and Cronquist 1991), *A. umbellatus* var. *latifolia* (U.S.D.A. 1982; Kartesz 1994) or *Doellingeria seriocarpoides* Small (U.S.D.A. 2000). However, none of these work cited Stone's trinomial in synonymy. The *I.P.N.I.* listed Stone's trinomial as having been published at the rank of subspecies.

A table has been prepared that provides full authorship citations for the names used in *The Plants of Southern New Jersey* and compares Stone's nomenclature with that in Fernald (1950) and Gleason and Cronquist (1991), two commonly used field manuals for the northeastern United States. Copies of it can be obtained by writing to the author.

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## LITERATURE CITED

AMES, M. 1947. Commentaries on *Spiranthes*. I. Botanical Museum Leaflet, Harvard University 13: 17-31.

ANONYMOUS. 1940. In memoriam Witmer Stone. Proceedings of the Academy of Natural Sciences of Philadelphia 91: 415-418.

ARTHUR, J. C., J. H. BARNHART, N. L. BRITTON, S. BROWN, F. E. CLEMENTS, O. F. COOK, J. M. COULTER, F. V. COVILLE, F. S. EARLE, A. W. EVANS, T. E. HAZEN, A. HOLLICK, M. A. HOWE, F. H. KNOWLTON, G. T. MOORE, E. L. MORRIS, W. A. MURRILL, H. H. RUSBY, C. L. SHEAR, W. TRELEASE, L. M. UNDERWOOD, D. WHITE, AND W. F. WIGHT. 1904. Code of botanical nomenclature. Bulletin of the Torrey Botanical Club 31: 249-261.

ARTHUR, J. C., J. H. BARNHART, N. L. BRITTON, F. CLEMENTS, O. F. GOOD, F. V. COVILLE, F. S. EARLE, A. W. EVANS, T. E. HAZEN, A. HOOLICK, M. A. HOWE, F. H. KNOWLTON, G. T. MOORE, H. H. RUSBY, C. L. SHEAR, L. M. UNDERWOOD, D. WHITE, AND W. F. WIGHT. 1907 American code of botanical nomenclature. Bulletin of the Torrey Botanical Club 34: 167-178.

ASHE, W. W. 1898. The dichotomous group of *Panicum* in the eastern United States. Journal of the Elisha Mitchell Science Society 15: 22-62.

BAILEY, L. H. 1943. Species Batorum Boreali-Americana V. Flagellares. Gentes Herbarium 5: 229-422.

BARRIE, F. R. AND W. GREUTER. 1999. XVI International Botanical Congress: preliminary mail votes and report of Congress action on nomenclatural proposals. Taxon 48: 771-784.

BARTLETT, H. H. 1912. A flora of the New Jersey Pine Barrens. Rhodora 14: 94-96.

BRIQUET, J. 1906. Règles Internationales de la Nomenclature Botanique Adoptées par le Congrès International de Botanique de Vienne 1905. G. Fischer, Jena. 99 pp.

BRITTON, N. L. AND A. BROWN. 1913a. An Illustrated Flora of the Northern United States, Canada, and the British Possessions. vol 1. Chas. Scribner's Sons, New York. 680 pp.

BRITTON, N. L. AND A. BROWN. 1913b. An Illustrated Flora of the Northern United States, Canada, and the British Possessions. vol 2. Chas. Scribner's Sons, New York. 735 pp.

BRUMMITT, R. K. AND C. E. POWELL. 1992. Authors of Plant Names. Royal Botanic Gardens, Kew. 732 pp.

CLEWELL, A. F. 1966. Native North American species of *Lespedeza* (Leguminosae) Rhodora 68: 359-405.

CLEWELL, A. F. 1985. Guide to the Vascular Plants of the Florida Panhandle. Florida State University Press, Tallahassee. 605 pp.

CORRELL, D. S. 1950. Native Orchids of North America North of Mexico. Chronica Botanica Co., Waltham, Massachusetts. 399 pp.

COUES, E. J. ALLEN, R. RIDGWAY, W. BREWSTER, AND H. W. HENSHAW. 1886. The Code of Nomenclature and Check-list of North American Birds Adopted by the American Ornithologists' Union. American Ornithologists' Union, New York. 392 pp.

DEAM, C. C. 1929. Grasses of Indiana. Indiana Department of Conservation, Division of Forestry Publication 82. 365 pp.

FAIREY, J. E. 1967. The genus *Scleria* in the southeastern United States. Castanea 32: 37-71.

FERNALD, M. L. 1934a. Realignments in the genus *Panicum*. Rhodora 36: 61-87.

FERNALD, M. L. 1934b. Some transfers in *Digitaria* and *Paspalum*. Rhodora 36: 19-23.

FERNALD, M. L. 1935. Midsummer vascular plants of southeastern Virginia. Rhodora 37: 378-413.

FERNALD, M. L. 1941. Another century of additions to the flora of Virginia. Rhodora 43: 585.

FERNALD, M. L. 1946. Technical studies on North American plants. Rhodora 48: 160: 5-16.

FERNALD, M. L. 1950. Gray's Manual of Botany (8th ed.). American Book Co., New York. 1,632 pp.

GELDEREN, J. M., P. C. DE JONG, AND H. J. OTERDOM. 1994. Maples of the World. Timber Press, Portland, Oregon. 458 pp.

GLEASON, H. A. 1952a. Illustrated Flora of the Northeastern United States and Adjacent Canada. vol 1. New York Botanical Garden, Bronx. 482 pp.

GLEASON, H. A. 1952b. Illustrated Flora of the Northeastern United States and Adjacent Canada. vol 2. New York Botanical Garden, Bronx. 655 pp.

GLEASON, H. A. AND A. CRONQUIST. 1963. Manual of the Vascular Plants of the Northeastern United States and Adjacent Canada. D. Van Nostrand Co., New York. 810 pp.

GLEASON, H. A. AND A. CRONQUIST. 1991. Manual of Vascular plants of Northeastern United States and Adjacent Canada (2nd ed.). New York Botanical Garden, Bronx. 910 pp.

GOULD, F. W. 1974. Nomenclatural changes in the Poaceae. Brittonia 26: 59-60.

GOULD, F. W. AND C. A. CLARK. 1978. *Dichanthelium* (Poaceae) in the United States and Canada. Annals of the Missouri Botanical Garden 65: 1088-1132.

GREUTER, W. 1996. On a new *BioCode*, harmony and expediency. Taxon 45: 291-294.

GREUTER, W. AND D. H. NICOLSON. 1996. Introductory comments on the *Draft BioCode*, from a botanical point of view. Taxon 45: 343-348.

GREUTER, W., J. MCNEILL, F. R. BARRIE, H. M. BURDET, V. DEMOULIN, T. S. FILGUEIRAS, D. H. NICOLSON, P. C. SILVA, J. E. SKOG, P. TREHANE, N. J. TURLAND, AND D. L. HAWKSWORTH. 2000. International Code of Botanical Nomenclature (Saint Louis Code) Adopted by the Sixteenth International Botanical Congress, St. Louis, Missouri, July-August 1999. Regnum Vegetabile 138. 474 pp.

GREUTER, W. , D. L. HAWKSWORTH, J. MCNEILL, M.A. MAYO, A. MINELLI, P. H. A. SNEATH, B. J. TINDALL, P. TREHANE, AND P. TUBBS. 1996. Draft BioCode: the prospective international rules for the scientific names of organisms. Taxon 45: 349-372.

HANSEN, B. F. AND R. P. WUNDERLIN. 1988. Synopsis of *Dichanthelium* (Poaceae) in Florida. Annals of the Missouri Botanical Garden 75: 1637-1657.

HARPER, R. M. 1912. Stone's flora of southern New Jersey. Torreya 12: 216-225.

HITCHCOCK, A. S. 1935. Manual of the Grasses of the United States. U.S.D.A. Miscellaneous Publication 200. 1,040 pp.

HITCHCOCK, A. S. AND A. CHASE. 1910. The North American species of *Panicum*. Contributions of the U.S. National Herbarium 15: 1-396.

HITCHCOCK, A. S. AND A. CHASE. 1951. Manual of the Grasses of the United States. U.S.D.A. Miscellaneous Publication 200 (2nd ed.). 1,051 pp.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE. 1905. Règles Internationales de la Nomenclature Zoologique. F. R. de Rudeval, Paris. 57 pp.

JONES, A. G. AND P. HIEPKO. 1981. The genus *Aster* s. l. (*Asteraceae*) in the Willdenow Herbarium at Berlin. Willdenowia 11: 343-360.

JONES, G. J. 1945. Flora of Illinois: a reply to M.L. Fernald. American Midland Naturalist. 34: 271-284.

KARTESZ, J. 1994. A Synonymized Checklist of the Vascular Flora of the United States, Canada and Greenland (2nd ed.) vol 1. Timber Press, Portland, Oregon. 622 pp.

KARTESZ, J. AND R. KARTESZ. 1980. A Synonymized Checklist of the Vascular Flora of the United States, Canada, and Greenland. Timber Press, Portland, Oregon. 498 pp.

LAWRENCE, G. H. M., A. F. GÜNTHER BUCHHEIM, G. S. DANIELS, AND H. DOZEAL. 1968. Botanico-periodicum-huntianum. Hunt Botanical Library, Pittsburgh. 1,063 pp.

LEDWELL, J. 2000. Penn commencement. Honorary degree recipients. http:// www.upenn.edu/ commencement/hist/honorary.html> (accessed 7 December 2000).

LELONG, M. G. 1984. New combinations for *Panicum* subgenus *Dichanthelium* (Poaceae) of the southeastern United States. Brittonia 36: 262-273.

LUER, C. A. 1975. The Native Orchids of the United States and Canada excluding Florida. New York Botanical Garden, Bronx. 361 pp.

MEIKLE, D. H. NICOLSON, R. C. ROLLINS, P. C. SILVA, AND W. GREUTER. 1983. International Code of Botanical Nomenclature Adopted by the Thirteenth International Botanical Congress, Sydney August 1981. Regnum Vegetabile 111. 472 pp.

MELVILLE, R. V. 1995. Towards Stability in the Names of Animals; a History of the International Commission on Zoological Nomenclature. International Trust for Zoological Nomenclature, London. 104 pp.

MERRILL, E. D. AND S. HU. 1949. Work and publications of Henry Muhlenberg, with special attention to unrecorded or incorrectly recorded binomials. Bartonia 25: 1-66.

NASH, G. V. 1898. New or noteworthy American grasses. Bulletin of the Torrey Botanical Club 25: 83-89.

NICOLSON, D. 1991. A history of botanical nomenclature. Annals of the Missouri Botanical Garden 78: 33-56.

ORCHARD, A. E., W. R. ANDERSON, M. G. GILBERT, SEBSEBE D., W. T. STEARN, AND E. G. VOSS. 1996. Harmonized bionomenclature — a recipe for disharmony. Taxon 45: 287-290.

OWNBEY, G. B. AND T. MORLEY. 1991. Vascular Plants of Minnesota. University of Minnesota Press, Minneapolis. 307 pp.

PENNELL, F. W. 1935. The Scrophulariaceae of eastern temperate North America. Academy of Natural Sciences of Philadelphia Monograph 1: 1-650.

PENNELL, F. W. 1940. The botanical works of Witmer Stone. Bartonia 20: 33-37.

PLANT NAMES PROJECT. 1999. International Plant Names Index <http://www.ipni.org> (accessed 26 November 2000-07 December 2000).

RADFORD, A. E., H. A. AHLES, AND C.R. BELL. 1968. Manual of the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill. 1,183 pp.

REED, C. F. 1989. New combinations required for the flora of central eastern United States III. Phytologia 67: 451-453.

RETTIG, J. H. 1989. Nomenclatural changes in the *Carex pensylvanica* group (section *Acrocystis, Cyperaceae*) of North America. Sida 13: 449-452.

RETTIG, J. H. 1990. Correct names for the varieties of *Carex albicans/Carex emmonsii*. Sida 14: 132-133.

RIDE, W. D. L., H. G. COGGER, C. DUPUIS, O. KRAUS, A. MINELLI, F. C. THOMPSON, P. TUBBS, 1999. International Code of Zoological Nomenclature. International Commission on Zoological Nomenclature, London. 306 pp.

ROBINSON B. L. AND M. L. FERNALD. 1908. Gray's New Manual of Botany (7th ed.). American Book Co., New York. 926 pp.

SMALL, J. K. 1933. Flora of the Southeastern United States. Science Press, Lancaster, Pennsylvania. 1,554 pp.

STAFLEU, F. A. 1973. Witmer Stone and his "Plants of southern New Jersey." Taxon 22: 467-468.

STAFLEU, F. A. AND R. S. COWAN. 1976-1988. Taxonomic Literature (2nd ed.) 7 vols. Bohn, Scheltma & Holkema, Utrecht. Regnum Vegetabile 94, 98, 105, 110, 112, 115, 116.

STAFLEU, F. A., DEMOULIN, W. GREUTER, P. HIEPKO, I. A. LINCZEVSKI, R. MCVAUGH, R. D. MEIKLE, R. C. ROLLINS, R. ROSS, J. M. SCHOPF, AND E. G. VOSS. 1978. International Code of Botanical Nomenclature, Adopted by the Twelfth International Botanical Congress, Leningrad, July 1975. Regnum Vegetabile 97. 457 pp.

STONE, W. 1902. *Viola renifolia* in the Pennsylvania Alleghanies. Torreya 2: 75.

STONE, W. 1903a. *Arisaema pusillum* in Pennsylvania and New Jersey. Torreya 3: 171-172.

STONE, W. 1903b. Racial variation in plants and animals with especial reference to the violets of Philadelphia and vicinity. Proceedings of the Academy of Natural Sciences of Philadelphia 55: 656-699.

STONE, W. 1903c. The significance of trinomials. Condor 5: 43-45.

STONE, W. 1906. Certain plant "species" in relation to the mutation theory. Science 2: 701-702.

STONE, W. 1907a. Some new plants for southern New Jersey. Torreya 7: 39-40.

STONE, W. 1907b. The life areas of southern New Jersey. Proceedings of the Academy of Natural Sciences of Philadelphia 59: 452-459.

STONE, W. 1908a. *Rynchospora rariflora* in southern New Jersey. Torreya 8: 16-17.

STONE, W. 1908b. Recent additions to our knowledge of the flora of southern New Jersey. Proceedings of the Academy of Natural Sciences of Philadelphia 60: 457-459.

STONE, W. 1909. The coastal strip of New Jersey and the rediscovery of *Lilaeopsis*. Bartonia 1: 20-24.

STONE, W. 1910a. New plants for southern New Jersey. Bartonia 2: 26.

STONE, W. 1910b. *Brachiaria digitarioides* from New Jersey. Bartonia 2: 26-27.

STONE, W. 1911. *Corema conradii* in Ocean Co., N. J. east of the Plains. Bartonia 3: 26.

STONE, W. 1912a. The plants of southern New Jersey with especial reference to the flora of the Pine Barrens and the geographic distribution of the species. Annual Report of the New Jersey State Museum for 1910 (pt. 2): 21-828.

STONE, W. 1912b. *Abama americana* (Ker) Morong. Bartonia 4: 1-5.

STONE, W. 1937. *Bird Studies at Old Cape May*. 1937. Intelligencer Printing Co., Lancaster, Pennsylvania. 941 pp.

STONE, W and W. E. Cram. 1904. American Animals: a Popular Guide to the Mammals of North America North of Mexico, with Intimate Biographies of the More Familiar Species. Doubleday, New York. 318 pp.

STROTHER, J. L. 2000. Who named *Euthamia* (Compositae: Astereae) and when? Sida 19: 217-218.

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE. 1982. National List of Scientific Plant Names. vol 2. Soil Conservation Technical Publication 159. 438 pp.

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE.. 2000. The PLANTS database. National Plant Center. Baton Rouge, La. <http://plants.usda.gov/plants> (accessed 26 November 2000-07 December 2000).

VOSS, E. G. 1966. Nomenclatural notes on monocots. Rhodora 68: 435-463.

VOSS, E. G. 1996. Michigan Flora. vol 3. University of Michigan Herbarium, Ann Arbor. 622 pp.

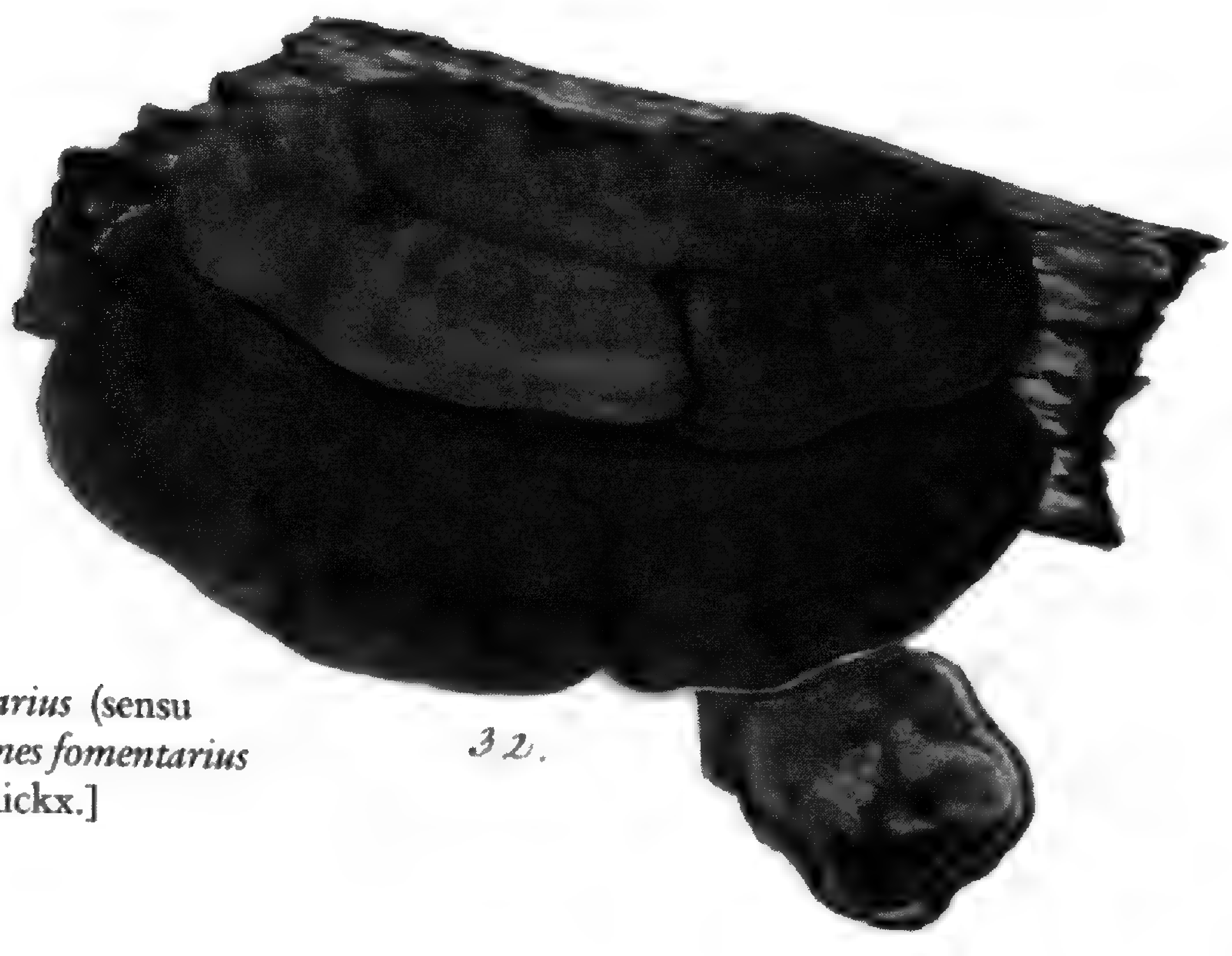
VOSS, E. G., H. M. BURDET, W. G. CHALONER, V. DEMOULIN, P. HIEPKO, J. MCNEILL, R. D. MEIKLE, D. H. NICOLSON, R. C. ROLLINS, P. C. SILVA AND W. GREUTER. 1983. International Code of Botanical Nomenclature, Adopted by the Thirteenth International Botanical Congress, Sydney, August 1981. Regnum Vegetabile 111. 472 pp.

*Agaricus* subsect. *Gymnopus fertilis* (sensu Schweinitz) [=*Entoloma olivacebrunneum* (L.) Kumm.]

266.

53.

*Boletus frondosus* (sensu Schweinitz) [= *Grifola frondosa* (Dickson:Fr.) S.F. Gray]



32.

*Boletus fomentarius* (sensu Schweinitz) [= *Fomes fomentarius* (L.:Fr.) Kickx.]

Bartonia No. 61: 48–53, 2002

# Lewis David von Schweinitz's Mycological Illustrations

David Hewitt*
*Academy of Natural Sciences of Philadelphia, 1900 Benjamin Franklin Parkway, Philadelphia PA 19103-1195*
*dhewitt@oeb.harvard.edu*

ABSTRACT. The early nineteenth-century mycologist, Lewis David von Schweinitz, is known to have produced seven bound volumes of paintings of fungi; four of these are at the Academy of Natural Sciences of Philadelphia and one each are at the University of North Carolina at Chapel Hill, University of Michigan, and the Farlow Herbarium at Harvard University. The volumes in Philadelphia and Chapel Hill together form a single set; the volume in Michigan and the volume at Harvard are not part of that set.

## Introduction

Lewis David von Schweinitz (1780-1834), "the mycological father of us all" (Rogers 1977), was the first American to focus his botanical efforts on fungi (Johnson 1835; Benedict 1935; Pennell 1935; Rogers 1977). Born and educated in Bethlehem, Pennsylvania, Schweinitz also lived and studied in Silesia, where, in 1805, he and Johannes Baptista von Albertini published their seminal work, *Conspectus Fungorum in Lusatiae superioris agro Nieskiensi Crescentium e methodo Persooniana* [*Conspectus*]. This 412-page volume contains descriptions and illustrations of fungi from Lusatia, a region along the Neisse River in what is now eastern Germany and western Poland, and includes the descriptions and illustrations of 93 new species (Benedict 1935). Included in the *Conspectus* are 12 color plates, and on each of these, except for plate XI, is written either "v. S." or "L. v. S.," indicating that Schweinitz prepared the illustrations. Schweinitz returned to the United States in 1812, and for the rest of his life collected cryptogams and phanerogams, painting them and writing about them and corresponding with the pantheon of botanists who lived and worked in early nineteenth-century Europe and the United States. Upon Schweinitz's death, his herbarium was deposited at the Academy of Natural Sciences of Philadelphia (PH), forming the basis of its nascent Botany Department, and much of his correspondence and manuscript materials have since been deposited in the archives at the Academy.

Schweinitz was a prodigious illustrator, and bound volumes of his paintings of fungi, his *Icones Fungorum*, have been deposited at a number of institutions. Seven of these volumes, each different from the others and none ever published, are known to exist. There are four volumes at the Academy and one volume each at the University of North Carolina at Chapel Hill, University of Michigan, and the Farlow Herbarium at Harvard University. All told, in the seven volumes over 2,000 fungi are illustrated. In addition, there are 81 unbound plates of botanical illustrations in the Academy archives; 18 of these depict fungi (Table 1) and the rest are of vascular plants.

Manuscript submitted 6 November 2000, revised 30 March 2001.
**Current address*: Farlow Herbarium, Harvard University, Cambridge, MA 02138

TABLE 1. Index to the Academy of Natural Sciences of Philadelphia's unbound mycological illustrations by Lewis David von Schweinitz. All are line drawings plus watercolor, except for plate no. 48, which is just in pencil. Plates 18 through 47 are of vascular plants.

| Plate | Fungus Illustrated |
|---|---|
| 1 | *Phallus* sp. |
| 2 | *Phallus coccineus*. Salem |
| 3 | *Amanita caesarea* Salem |
| | *Boletus calopus*. Salem |
| | *Boletus floccosus* Salem |
| 4 | *Agaricus Lact. Indigo*. Salem |
| | *Agaricus cinabarinus* [!] |
| | [unnamed (*Agaricus*?)] |
| 5 | *Agaricus Myc. nigripes* S[r?] Salem |
| | *Arachnion candidum* S[r?] Sal. |
| | *Agaricus* P[?] *lamellosus* S[r?] Salem |
| | *Agaricus Gym. Rhodoxanthus* S[r?] Salem |
| | *Merulius olivaceus* S[r?] Salem |
| | *Boletus merulioides* S[r?] Salem |
| 6 | *Agaricus niger* S[r?] Salem |
| | *Leotia marcida* Salem |
| | [unnamed (*Agaricus*?)] |
| | [unnamed (*Sphaeria*?)] |
| | *Agaricus* P[?] *pectinatus*. Salem |
| 7 | *Dacryomyces pellucidus*. Salem |
| | *Agaricus Gym. illudens* Salem |
| 8 | *Amanita ampla* Salem |
| 9 | *Agaricus. Micromph. venosus* Sal |
| | *Boletus Betula* s[r?] Salem |
| | *Merisma fastidiosum* |
| | *Agaricus Myc. siccus* s[r?] Salem. |
| 10 | [unnamed (*Sphaeria*?)] |
| 11 | *Sphaeria nigripes* |
| | *Sphaeria teres* |
| | *Sphaeria capreolatae* |
| | *Sphaeria radicalis* |
| 12 | *Sphaeria lenta* |
| | *Sphaeria lobata* |
| | *Sphaeria ochracea* |
| | *Sphaeria pocula* |
| | *Sphaeria atropurpurea* |
| | *Sphaeria macula* |
| | *Sphaeria ceratosperma* |
| 13 | *Sphaeria Persicaria* |
| | *Sphaeria capitata* |
| | *Sphaeria Geoglossum* |
| | *Sphaeria subterranea* |
| 14 | *Sphaeria friabilis* |
| | *Sphaeria Diaspyri* [!] |
| | *Sphaeria smilacicola* |
| | *Sphaeria discincola* |
| | *Sphaeria Viburni* |
| | *Sphaeria olivaceo-nigro ad undulat* |
| | *Sphaeria grisea* |
| | *Sphaeria spissa* |
| 15 | *Sphaeria Sacculus* |
| | *Sphaeria molliuscula* |
| | *Sphaeria enteroleuca* |
| | *Sphaeria annulata* |
| | *Sphaeria (melograma) turbinulute* [!] |
| 16 | *Sphaeria protracta* P. |
| | *Sphaeria Scirpi* |
| | *Sphaeria Yuccae glorios.* |
| | *Sphaeria Aristidae* |
| | *Sphaeria Sarraceniae* |
| | *Sphaeria Typhae.* |
| | *Sphaeria Tetragonathecae* |
| 17 | *Sphaeria acervulata* |
| | *Sphaeria gregalis* |
| | *Sphaeria cohortina* |
| | *Sphaeria hydnicola* |
| | *Sphaeria caulina* |
| | *Sphaeria horrida* |
| 48 | Gilled mushroom |

The bound volumes at the Academy, titled the *Fungorum Nieskiensium Icones*, are volumes 1, 2, 3, and 5 of apparently a single series. They are designated, respectively, on their title pages: "Pars I," "Pars II," "Pars III," and "Pars V" and contain plates numbered 1-273, 350-453 (excluding numbers 33, 40, 44, 45, 46, 47, 50, 51). The Chapel Hill *Icones* is volume 4 of this series (Phillips and Phillips 1963). Eugene A. Rau, who deposited the bulk of the

Schweinitz materials in the Academy archives, said that he had seen six or seven volumes of *Icones* (Krieger 1940; Phillips and Phillips 1963) and so it was believed for decades that there were volumes 6 and 7 still unaccounted for.

## Results and Discussion

I recently came across evidence that refutes the existence of volumes 6 and 7 of the Academy/Chapel Hill *Icones*. In the manuscript collection of the American Philosophical Society, there is microfilm of letters from Schweinitz to John E. LeConte. In a letter dated 25 June 1820, Schweinitz writes: "The following is the Contents of my V volumes of fungi – Vol. I From Sphaeria to Phallus exclus. of the latter II Agarici only III Boleti to the Byssocladium or Naematelia excl. vol IV Supplement to I, V Suppl to II and III . . . " Schweinitz is surely referring to the Academy/Chapel Hill *Icones*: (1) The contents that he lists correspond to those in the Academy *Icones*. (2) If volume 5 is a supplement to volumes 2 and 3, it would be expected that there would be an overlap in genera treated in the volumes. This is the case: 14 of the 16 genera treated in volume 3 are treated in volume 5; 3 of the 3 genera treated in volume 2 are treated in volume 5 (Table 2). (3) There is no five-volume mycological work in the Schweinitz bibliography appended to Walter R. Johnson's 1835 obituary of Schweinitz, nor have I seen any reference elsewhere for such a work; thus there is no other known work that Schweinitz could have been referring to.

And so, there are most probably only five volumes of the Academy/Chapel Hill *Icones*. The possibility remains that Schweinitz painted additional supplements and they are the volume(s) to which Rau referred. Could the Michigan or Farlow *Icones* be such volumes?

A 1938 letter from Dr. E. B. Mains of the University of Michigan, tucked into volume 1 of the Academy *Icones*, states that the volume at University of Michigan "is entitled Icones Fungorum on the back . . . There is no title page." This is unlike the Academy *Icones*, all of which have title pages upon which are written *Fungorum Nieskiensium Icones*. "Clearly not a part of the Fungorum Nieskensium Icones series of ANSP" is handwritten at the bottom of Mains' letter. The letter is addressed to Willman Spawn, but according to his wife, Carol Spawn, former Academy archivist, the note is not in Willman Spawn's handwriting (C. Spawn, pers. comm.). It is unknown who wrote this note, and its author did not explain why the Michigan *Icones* is "clearly not a part" of the Academy *Icones*. Krieger (1940) describes the Michigan *Icones* as "about 8 cm thick, with boards measuring 20 by 30 cm . . . Stamped in gold on the back are the words 'Icones Fungorum.' " The Academy *Icones* are not as thick, their other dimensions are greater (23.5 cm × 37.5 cm (vols 1, 2, 3; vol. 5 is 23.2 cm wide)), and they are not stamped in such a manner. Thus the Michigan *Icones* is most probably not a part of the Academy/Chapel Hill *Icones*.

A recent trip to the Farlow Library yielded the following information about the Farlow *Icones*. The cover measures 18.5 cm × 25.5 cm, while the interior pages measure 18 cm × 25 cm. The interior pages were apparently cut to their present size after the illustrations were done, as some of the illustrations and captions are cropped. The cover is red cloth with *Icones Fungorum Nieskiensium* printed in gold leaf. The Farlow volume contains 50 plates, and according to a listing prepared by Dr. Donald Pfister, curator of the Farlow Herbarium, it contains 248 illustrations. *Mesenterica grisea*, a species illustrated in the Farlow *Icones*, is in Dana Lynch's list of species illustrated in the Academy *Icones* that were also newly described in Albertini and Schweinitz's *Conspectus* (Lynch 1996). The known provenance of the Farlow *Icones* is incomplete. According to Dr. Pfister, this volume came

TABLE 2. Index to the genera of fungi illustrated in Lewis David von Schweinitz's *Fungorum Nieskiensium Icones* at the Academy of Natural Sciences of Philadelphia.

| PAGE(S) | GENUS NAME |
|---|---|
| **Pars I** | |
| 64-67 | *Aecidium* |
| 57 | *Arcyria* |
| 42 | *Bovista* |
| 75 | *Conoplea* |
| 59 | *Cribraria* |
| 76-77 | *Cyathus* |
| 52 | *Diderma* |
| 41 | *Geastrum* |
| 26-28 | *Hysterium* |
| 60 | *Licea* |
| 49 | *Lycogala* |
| 62-63 | *Mucor* |
| 34 | *Naemaspora* |
| 53-54 | *Physarum* |
| 36 | *Pilobolus* |
| 72-73 | *Puccinia* |
| 48 | *Scleroderma* |
| 37-39 | *Sclerotium* |
| 29 | *Stilbospora* |
| 58 | *Stemonitas* |
| 36 | *Sphaerobolus* |
| 1-25 | *Sphaeria* |
| 55-56 | *Trichia* |
| 74 | *Trichoderma* |
| 35 | *Tubercularia* |
| 61 | *Tubulina* |
| 43 | *Tulostoma* |
| 68-71 | *Uredo* |
| 30-32 | *Xyloma* |
| **Pars II** | |
| | *Agaricus* |
| 127-131 | *Coprinus* |
| 90-102 | *Cortinaria* |
| 103-120, 161 | *Gymnopus* |
| 138-143 | *Lactifluus* |
| 83-89 | *Lepiota* |
| 121-126 | *Mycena* |
| 152-161 | *Omphalia* |
| 162-168 | *Pleuropus* |
| 132-137 | *Pratella* |
| 144-151 | *Russula* |
| 78-82 | *Amanita* |
| 169-174 | *Merulius* |
| **Pars III** | |
| 273 | *Aegerita* |
| 267 | *Ascobolus* |
| 176-196 | *Boletus* |
| 221-227 | *Clavaria* |
| 175 | *Daedalea* |
| 228 | *Geoglossum* |
| 268-269 | *Helotium* |
| 231-232 | *Helvella* |
| 201-207 | *Hydnum* |
| 229-230 | *Leotia* |
| 220 | *Merisma* |
| 238-266 | *Peziza* |
| 197-200 | *Sistotrema* |
| 270-272 | *Stilbum* |
| 208-219 | *Thelephora* |
| 233-237 | *Tremella* |
| **Pars V** | |
| | *Agaricus* |
| 371 | *Coprinus* |
| 356-358 | *Cortinaria* |
| 359-369 | *Gymnopus* |
| 352-355 | *Lepiota* |
| 370 | *Mycena* |
| 374-375 | *Omphalia* |
| 376-378 | *Pleuropus* |
| 372 | *Pratella* |
| 373 | *Russula* |
| 351 | *Amanita* |
| 425 | *Ascobolus* |
| 428 | *Ascophora* |
| 382-392 | *Boletus* |
| 434 | *Botrytis* |
| 429 | *Ceratium* |
| 405-409 | *Clavaria* |
| 381 | *Daedalea* |
| 438-442 | *Dematium* |
| 427 | *Epichysium* |
| 443-445 | *Erineum* |
| 410 | *Geoglossum* |
| 419, 425, 109b | *Helotium* |
| 414 | *Helvella* |
| 449-450 | *Himantia* |
| 394-399 | *Hydnum* |
| 431-433 | *Isaria* |
| 411 | *Leotia* |
| 379-380 | *Merulius* |
| 404 | *Merisma* |
| 452-453 | *Mesenterica* |
| 435-437 | *Monilia* |
| 413 | *Morchella* |
| 430 | *Periconia* |
| 416-424 | *Peziza* |
| 350 | *Phallus* |
| 446-448 | *Racodium* |
| 451 | *Rhizomorpha* |
| 393 | *Sistotrema* |
| 412 | *Spathularia* |
| 426 | *Stilbum* |
| 400-403 | *Thelephora* |
| 415 | *Tremella* |

to the Farlow via Maselio Schaechter, a member of the Boston Mycological Club, who bought it at a bookseller's in Bungay, England, and then donated it to the Farlow. Maselio Schaechter's story of this volume can be found on pages 102 and 103 of his book, *In the Company of Mushrooms*, Harvard University Press, 1997 (Pfister, pers. comm.). On the inside front cover of the Farlow *Icones*, there is a tag in the upper left corner on which is printed: "W. Webster/ Bookseller & Stationer/ Late G. Fell/ 60 Piccadilly". Also on the inside front cover is a bookplate on which is printed "*ORA E SEMPRE/* Sir Francis Denys Bart." Written in ink, on an interior page, is "Catherine Eliza Perceval/ Philadelphia/ March 8th 1826."

The *Icones* at the Farlow is not part of the series at the Academy. The Farlow volume differs from the series at the Academy as follows: (1) it is much smaller in format than the volumes at the Academy (18.5 cm × 25.5 cm vs. 23.5 cm × 37.5 cm (Academy vols 1, 2, 3; vol. 5 is 23.2 cm wide)); (2) it does not have a title page; (3) its plates are numbered 1-50, these plate numbers are duplicated in volume 1 of the *Icones* at the Academy, and the "missing" volumes (6 or 7) would contain plates with higher numbers; (4) many of its plates, in addition to painted illustrations with names and numbers written in ink, also have numbers and names and sketches which are written and drawn in pencil. The Academy *Icones* contain nearly exclusively painted illustrations with names and numbers written in ink.

## CONCLUSION

The volumes of Schweinitz's paintings at the Academy and Chapel Hill form a single set, and the volumes at Michigan and the Farlow are not part of that set. The Michigan and Farlow *Icones* are different in format from each other and from the Academy/Chapel Hill *Icones* and the letter from Schweinitz to LeConte strongly suggests that the *Fungorum Nieskiensium Icones* was only intended to be a five-volume set.

## ACKNOWLEDGMENTS

This paper is dedicated to Donald P. Rogers (1908-2002), biographer of Lewis David von Schweinitz. Dr. Rogers reviewed an earlier manuscript of this paper, and I am grateful for his many helpful comments.

I thank Dr. A. E. Schuyler of the Academy of Natural Sciences of Philadelphia and Dr. Donald Pfister of the Farlow Herbarium for their generous contributions of information, advice, and encouragement. I thank the staff of the Archives of the Ewell Sale Stewart Library for allowing me to examine the Academy's set of Schweinitz's *Icones* (Collection 437). I thank the staff of the Farlow Reference Library of Cryptogamic Botany for allowing me to examine the Farlow's volume of Schweinitz's *Icones*.

## LITERATURE CITED

BENEDICT, D. M. 1935. Lewis David von Schweinitz, the mycologist. Bartonia 32: 12-14

JOHNSON, W. R. 1835. A memoir of the late Lewis David von Schweinitz, P. D. with a sketch of his scientific labors. Read before the Academy of Natural Sciences of Philadelphia, 12 May 1835. William P. Gibbons, Philadelphia.

KRIEGER, L. C. C. 1940. Unpublished color plates of fungi by Lewis David von Schweinitz. Bartonia 20: 28-29.

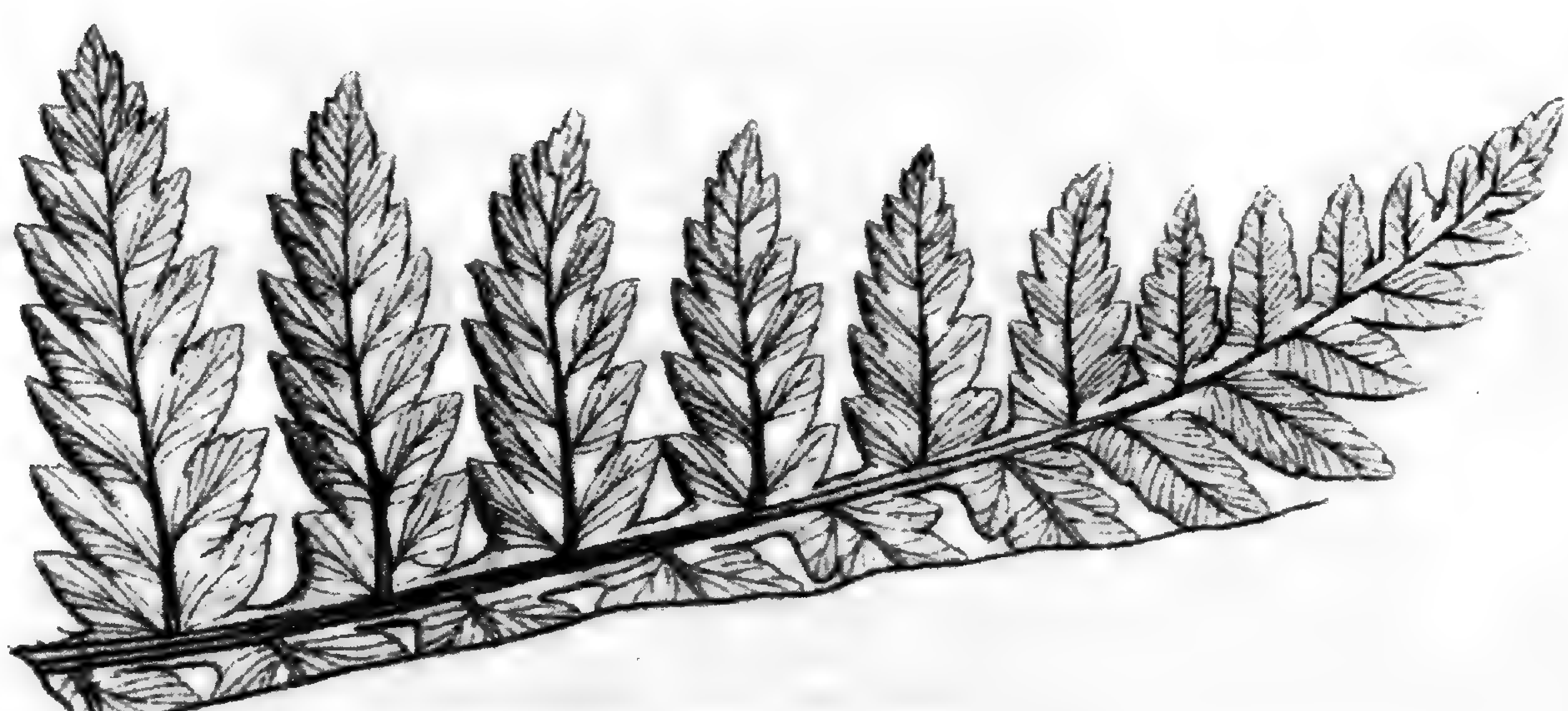
LYNCH, D. M. 1996. Paintings of fungi by Lewis David von Schweinitz in the archives of the Academy of Natural Sciences of Philadelphia. Bartonia 59: 125-128.

PENNELL, F. W. 1935. The botanist Schweinitz and his herbarium. Bartonia 16: 1-8

PHILLIPS, V. T. AND M. E. PHILLIPS. 1963. Guide to the manuscript collections in the Academy of Natural Sciences of Philadelphia. Special Publ. No. 5, Academy of Natural Sciences of Philadelphia.

ROGERS, D. P. 1977. L. D. de Schweinitz and early American mycology. Mycologia 69: 223-245.


Original figure of ANSP 3854 taken from Lesquereux (1879: pl. 55, fig. 3). (Note that Lesquereux obliterated Mansfield's catalogue number and replaced it with his own.)



*Sphenopteris goniopteroides* Lesquereux, Lectotype, ANSP 3854 (Lesquereux #90, PAGS #11163).

Bartonia No. 61: 54–80, 2002

# A Catalogue of the Type Specimens of the Taxa Erected by Leo Lesquereux in the *Coal Flora* (1879, 1880, 1884)

JAMES LENDEMER
*Academy of Natural Sciences of Philadelphia, 1900 Benjamin Franklin Parkway, Philadelphia PA 19103-1195*

ABSTRACT. Leo Lesquereux's *Coal Flora* has long been considered the basis for American Carboniferous paleobotany and is a monument to his idominable will to succeed under trying conditions. Throughout the four volumes that make up the *Coal Flora*, 247 new species are introduced. The type specimens upon which these species are based are known to be scattered throughout the collections of numerous institutions. A catalogue of these specimens has never been compiled although one was begun by Watt in 1974. This paper provides, for the first time, a catalogue of the type specimens of all of the *Coal Flora* taxa.

## INTRODUCTION

Darrah (1969: 1) noted of Lesquereux's *Coal Flora* "It is a paradox that Leo Lesquereux, who performed prodigious work under trying conditions, on one hand provided a magnificent panorama of the 'Coal Flora' and on the other, left a trail of unsettled details that remain to this day extremely difficult to interpret." Lesquereux's *Coal Flora* (1879, 1880, 1884) can be considered the "foundation of American Carboniferous paleobotany" (Darrah 1969: 2). Many of the newly erected species throughout its pages were based on specimens from the collections of R.D. Lacoe of Pittston, Pennsylvania and I.F. Mansfield of Cannelton, Pennsylvania. However, the collections of J.H. Britts, Professor Eugene A. Smith, S.S Strong, William Lorenz, and many others, also were utilized by Lesquereux. The importance of the *Coal Flora* lies partially in its broad coverage. The taxa described within its pages were not limited to Pennsylvania but also included those from as far west as Arkansas, Missouri, Iowa and Illinois. This broad coverage also allowed Lesquereux to draw valuable conclusions on the relationships of various Carboniferous floras of the United States, as well as relationships between the coal floras of America and those of Europe.

A relatively small number of specimens described in the *Coal Flora* were retained by Lesquereux. These were given by him to the Second Geological Survey of Pennsylvania and were intended to form a portion of the "State Geological Museum." A catalogue of these specimens was prepared by Lesquereux and published in *The Catalogue of the Geological Museum* (Lesquereux 1889: 99-122). Although the collection contains 550 specimens, only a few of these are figured or types. However those that are have gone unrecognized as such since the transfer of the collection to the Pennsylvania Geological Survey in 1889.

All of the specimens originally held for the "Geological Museum" were kept in dead storage at the Academy of Natural Sciences in Philadelphia (= ANSP). The collection was later transferred to the Pennsylvania State Museum (William Penn Memorial Museum) in Harrisburg. However, a small portion of Lesquereux's collection was apparently retained at

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ANSP. These specimens were rediscovered by Darrah who simply identified them as "Lesquereux's Coal Flora types." The collection as a whole has been overlooked by apparently every author with the exception of Darrah who identified one holotype (= lectotype) from the material. The small portion of the collection held at ANSP has recently been extensively studied and the types reported by Spamer and Lendemer (2000; a revision of Spamer, 1988).

## Repositories of Lesquereux's *Coal Flora* Types

Lesquereux's *Coal Flora* types are deposited mainly at two institutions, Harvard and the United States National Museum. This is because many of Lesquereux's species were based either upon specimens from the collection of R.D. Lacoe or were later bought by him. The majority of Lesquereux's early specimens from Lacoe's collection were given to Harvard. However, by far the majority of Lesquereux's *Coal Flora* types were still in Lacoe's possession when his collection was donated to the National Museum.

Smaller collections identified and described by Lesquereux in the *Coal Flora* can be found in a number of other museums. These are listed below with the institutional acronym that is used here: ANSP — Academy of Natural Sciences of Philadelphia; AGS SM — Alabama Museum of Natural History (Tuscaloosa); CP — Pratt Museum of Natural History (Amherst, Massachusetts); HU — The Botanical Museum, Harvard University (Cambridge, Massachusetts); ISM — Illinois State Museum (Springfield); LC- Lafayette College (Easton, Pennsylvania); USNM — National Museum of Natural History (Washington, D.C.); SMP — Pennsylvania State Museum (William Penn Memorial Museum; Harrisburg); UP — Chicago Field Museum.

Of the 247 taxa erected in the *Coal Flora,* 37 currently are not represented by any known type specimens. Some of these may be at Harvard. However, the author has been unable to examine the collections there. A list of these taxa is provided below (Appendix A) to facilitate later workers in locating or verifying specimens which may be suspected as type, or for designating neotypes. However, this is not intended as the final word on the matter as some or all of the types may be found at a later time.

## Arrangement of the Catalogue

The species in this catalogue are listed alphabetically by their specific epithet (and indexed by genus in Appendix B). Each of the binomials are the original nomenclatural combinations given by Lesquereux and only primary types (holotypes, isotypes, lectotypes, and syntypes) are listed here. In the case of some species, it could not be determined whether Lesquereux had only a single specimen (a holotype) or a suite of specimens (syntypes) in his possession when the species was described. Thus, a single specimen is treated as a holotype only when it is known to have been the only specimen upon which the species was described. Otherwise, a single specimen is treated as a syntype. Catalogue numbers that are linked by an addition sign (+) are either contiguous pieces of one specimen or part and counterpart (in cases of the latter it is indicated which is the part and which is the counterpart). Finally, no systematic changes or revisions are made here. The names used are in their original state as given by the author at the time of description (this includes the original orthography). This is meant to place them in their proper historical context and avoid the ambiguity that often arises from the changes made by later authors. For the majority of the species listed here notes on synonomy and current usage are not included.

## Designation of Lectotypes

Relatively few lectotypes have been designated for Lesquereux's *Coal Flora* taxa. Merrill (1907), Carluccio et al. (1966), Darrah (1969), and Goubet et al. (2000) are, in fact the only previous authors to have done such, and Merrill (1907) did so inadvertently. Under the advice of H.W. Pfefferkorn and E.E. Spamer (pers. comm.), the author has kept with this trend. Only one lectotype is designated in this paper, for the taxon *Sphenopteris goniopteroides* Lesquereux. *S. goniopteroides* is not well understood and the only known type specimens were recovered by the author during the preparation of the catalogue of type specimens at ANSP. This paper does, however provide a review of the few lectotypes that have been designated previously.

## Citations and Publication Dates of the *Coal Flora*

The manner in which the descriptions of the taxa erected in the *Coal Flora* are cited has changed almost as often as the names themselves. Darrah (1969) treated all of the taxa described in the *Text* volumes (1880) with indication to the *Atlas* (1879) as having been erected by name and figure(s) in the *Atlas*. More recently however, these same taxa are considered to have been erected in the *Text* with indication to the figures in the *Atlas*, this is how these taxa are cited in this paper. Volume three of the *Coal Flora* (1884) is considered separately from the first two volumes.

## Catalogue

**abbreviata, Odontopteris** Lesq.
Lesquereux (1879: pl. 21, fig. 7; 1880: 138-139). Holotype, USNM 14827. Carbon Hill shaft, "C. vein," Pittston, Pennsylvania.

**abnormalis, Rhabdocarpus** Lesq.
Lesquereux (1884: 818-819, pl. 110, figs. 48, 49). Syntypes, USNM 26370. Cannelton, Beaver County, Pennsylvania; collected by I.F. Mansfield.

Both of the illustrated specimens are preserved on the same rock.

**adamsii, Trigonocarpus** Lesq.
Lesquereux (1884: 820, pl. 110, figs. 51-57). Syntypes, USNM 26727-26733 (figs. 51-57 respectively; all of the specimens carry Lacoe #957). Stark County, Illinois.

**agassizi, Neuropteris** Lesq.
Lesquereux (1879: pl. 17, figs. 1-4; 1880: 117-118). Syntypes, HU 5822+5824+5826+5827+USNM 10050 (fig. 1), HU 5833 (fig. 2), HU 5843 (fig. 3), HU 5853 (fig. 4). Mount Hope coal mines, Portsmith, Rhode Island.

The specimens in figs. 1-3 were "communicated" to Lesquereux by Mr. J.H. Clark of Newport. Fig. 4 was copied from Teschmacher (Boston Journal of Natural History 5: 34).

**aldrichi, Callipteridium** Lesq.
Lesquereux (1879: pl. 39, figs. 1-3; 1880: 171-172). Syntypes, USNM 11238 (fig. 1), USNM 12087 (fig. 2), USNM 11242 (fig. 3). Black Creek Seam, Jefferson mines, Alabama; collected by T.H. Aldrich.

**ambigua, Alethopteris** Lesq.
Lesquereux (1879: pl. 31, figs. 1-4; 1880: 182-183). Syntypes, USNM 13066 (fig. 1), USNM 41056 (fig. 2), USNM 41057 (fig. 3), HU 7465 (fig. 4). Henry County, Missouri.

**ampullaeformis, Trigonocarpus** Lesq.
Lesquereux (1884: 823, pl. 109, figs. 18-20, 21?). Syntypes, USNM 26536, Washington County, Arkansas; USNM 26538, USNM 26537, Tracy City, Tennessee; communicated by F.L. Harvey; donated by R.D. Lacoe.

All of the specimens carry Lacoe #975 The specimens are figured as follows: fig. 18 is USNM 26538, fig. 19 is USNM 26536, and fig. 21 is USNM 26537. The specimen in fig. 20 is currently unlocated.

**anceps, Stemmatopteris**
Lesquereux (1884: 838).Syntype, USNM 17139 (part) + 17140 (counterpart; Lacoe #611). Cannelton, Beaver County, Pennsylvania; donated by R.D. Lacoe.

Lesquereux erected this taxon as a questionable new species.

**andrewsi, Lepidodendron** Lesq.
Lesquereux (1879: pl. 64, fig. 6; 1880: 389-390). Holotype, USNM 15430+15431. Mazon Creek, Grundy County, Illinois.

**angularis, Lepidocystis** Lesq.
Lesquereux (1879: pl. 69, figs. 16, 17; 1880: 456). Syntype, USNM 25255+25256 (fig. 17). Campbells Ledge, Port Griffith?, Pennsylvania; donated by R.D. Lacoe.

The specimen in fig. 16 is currently unlocated.

**angustata, Stemmatopteris** Lesq.
Lesquereux (1879: pl. 59, fig. 5; 1880: 339). Holotype, USNM 17078. Cannelton, Beaver County, Pennsylvania; collected by I.F. Mansfield.

**anomala, Neuropteris** Lesq.
Lesquereux (1879: pl. 7, fig. 1; 1880: 118-120). Syntype, HU 5860 (MCZC 430). Gray roof shale of Morris, Illinois; collected by Joseph Evan.

**apiculatus, Rhabdocarpus** Lesq.
Lesquereux (1884: 819, pl. 110, fig. 50). Holotype, USNM 26756 (Lacoe #979). Stanton Mine, Wilkes-Barre, Pennsylvania; donated by R.D. Lacoe.

**apiculatus, Cordaicarpus** Lesq.
Lesquereux (1880: 551). Syntype, USNM 25322. Cannelton, Beaver County, Pennsylvania; collected by I.F. Mansfield.

This taxon is not erected in the *Atlas* as Lesquereux noted in the errata of volumes one and two. Instead the taxon is erected in volume two with indication to the figures in the *Atlas* (Lesquereux 1879: pl. 83, figs. 6, 6a). The explanation of the plates in the *Atlas* identifies the figures as " *Cordaicarpus gutbieri.*" Lesquereux later also emended the reidentification of the figures as "*Cordaicarpus apiculatus* sp. nov." to " *C. ovalis* sp. nov." (Lesquereux 1880: errata).

**arborescens, Lycopodites** Lesq.
Lesquereux (1884: 778-779, pl. 106, fig. 1). Syntype (Holotype?), USNM 15559 (Lacoe #257). Privett's coal bank, Washington County, Arkansas; communicated by F.L. Harvey; donated by R.D. Lacoe.

**aspera, Neuropteris** Lesq.
Lesquereux (1879: pl. 13, figs. 10-12; 1880: 121). Syntype, HU 5862. Cannelton, Beaver County, Pennsylvania; collected by I.F. Mansfield.
One of the two missing syntypes may be SMP 11101 (Lesquereux #28).

**biformis, Neuropteris** Lesq.
Lesquereux (1879: pl. 13, fig. 7; 1880: 121). Holotype, AGS-SM 34. Coal Measures, Tuscaloosa, Alabama; collected by Professor Eugene A. Smith.
Goubet et al. (2000) moved this taxon into the genus *Neuralethopteris* Cremer *ex* Laveine.

**brevifolia, Calamostachys** Lesq.
Lesquereux (1884: 718, pl. 89, figs. 5, 5a). Holotype, USNM 18358. Cannelton, Beaver County, Pennsylvania; collected by I.F. Mansfield.

**brevifolium, Taeniophyllum** Lesq.
Lesquereux (1884: 788-789, pl. 108, figs. 3, 3a). Syntype, USNM 19276+19277 (Lacoe #774). Cannelton, Beaver County, Pennsylvania; donated by R.D. Lacoe.

**brittsii, Lepidodendron** Lesq.
Lesquereux (1879: pl. 63, fig. 1, 2). Syntype, USNM 15482 (fig. 1). Clinton Coal, Missouri; collected by Dr. J.H. Britts.
The specimen in fig. 2 is currently unlocated.

**brittsii, Sphenopteris** Lesq.
Lesquereux (1879: pl. 55, fig. 2; 1880: 277-278). Syntype, USNM 14953 (fig. 2). Clinton, Missouri; collected by Dr. J.H. Britts.

**broadheadi, Conostrichus** Lesq.
Lesquereux (1879: pl. B, figs. 1, 2; 1880: 15-16). Holotype, USNM 10250. Vernon County, Missouri. Pottsville Group, Pennsylvanian.

**butleri, Lepidostrobus** Lesq.
Lesquereux (1884: 840-841). Syntype, USNM 16175 (Lacoe #681). Butler Mine, near Pittston, Pennsylvania; donated by R.D. Lacoe.

**butlerianus, Carpolithes** Lesq.
Lesquereux (1884: 824-825, pl. 111, fig. 19). Holotype, USNM 26355 (Lacoe #990). Butler Mine, Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**callosa, Neuropteris** Lesq.
Lesquereux (1879: pl. 16, figs. 1-8; 1880: 115). Syntypes, HU 5796 (fig. 1), New Philadelphia, Pennsylvania; HU 5798 (fig. 2), HU 5800-5802 (figs. 3-5). Pomeroy, Ohio; HU 5797 (fig. 6), HU 5799 (fig. 7), Wilkes-Barre, Pennsylvania; HU 5803+5804 (fig. 8), Pomeroy, Ohio.
Darrah (1969: 97) noted, "I would exclude from this species the two cyclopterid pinnules, figs. 6 and 7, and include questionably the cyclopterid pinnule, fig. 8." Stockmans (1933: pl. 10, figs. 2-5) later refigured the specimens in Lesquereux's figs. 2, 3, 4, and 8 (respectively). The specimen in fig. 1 was refigured by Darrah (1969: pl. 72, fig. 1).

**campbellianum, Lepidophyllum** Lesq.
Lesquereux (1884: 786, pl. 107, figs. 6, 7). Syntypes, USNM 16377 (fig. 7), USNM 16376 (fig. 6), USNM 16378-16380. Campbells Ledge, Pittston, Luzerne County, Pennsylvania.

**cheathami, Eremopteris** Lesq.
Lesquereux (1884: 770-771, pl. 104, figs. 2-4). Syntypes, USNM 15009 (fig. 2), Washington County, Arkansas; USNM 15025 (fig. 3), USNM 15026 (fig. 4), Tracy, Tennessee; donated by R.D. Lacoe.
All of the specimens carry Lacoe #1038.

**circularis, Cardiocarpus** Lesq.
Lesquereux (1884: 812, pl. 110, fig. 10). Holotype, USNM 25592 (Lacoe #963). Vermilion County, Indiana.

**clarkii, Pecopteris** Lesq.
Lesquereux (1879: pl. 41, fig. 10; 1880: 261-262). Holotype, HU 7390. Mount Hope Coal mines, Rhode Island; collected by Mr. J.H. Clark.

**clavatum, Trochophyllum** Lesq.
Lesquereux (1879: pl. 3, figs. 21-23; 1880: 65). Holotype, USNM 16643. In a bed of friable black shale in the barren measures, about one hundred feet lower than the Pittsburgh Coal, between Irwin Station and Pittsburgh, Pennsylvania; collected by W.D. Moore.

**clintoni, Pecopteris** Lesq.
Lesquereux (1879: pl. 42, figs. 1-5; 1880: 251-252). Syntypes, USNM 13172 (fig. 3), USNM 30857 (fig. 1), USNM 13173 (fig. 5).
The specimens in figs. 2 and 4 have not been located.

**communis, Macrostachya** Lesq.
Lesquereux (1879: pl. 3, figs. 17, 18; 1884: 828-829). Syntypes, USNM 17740 (fig. 17), USNM 17751 (fig. 18), USNM 10974, Cannelton, Beaver County, Pennsylvania; 17742, Olyphant, Lackawanna County, Pennsylvania.

**communis, Sphenopteris** Lesq.
Lesquereux (1884: 762-763, pl. 104, figs. 1, 1a). Syntypes, USNM 14340 (fig. 1), USNM 14345, USNM 14346 (all of the specimens carry Lacoe #442). Arkansas; Dade, Georgia; Tracy, Tennessee; donated by R.D. Lacoe.

**compacta, Knorria** Lesq.
Lesquereux (1884: 839-840). Syntypes, USNM 15800-15802 (all of the specimens carry Lacoe #816). Thayer, Kansas; donated by R.D. Lacoe.

**conglobatus, Cardiocarpus** Lesq.
Lesquereux (1884: 810-811, pl. 109, figs. 10, 11). Syntype, USNM 25565 (fig. 11). Washington County, Arkansas.

**conicus, Carpolithes** Lesq.
Lesquereux (1884: 824, pl. 109, fig. 17). Holotype, USNM 26483 (Lacoe #959). Shamokin, Pennsylvania; donated by R.D. Lacoe.

**corrallum, Rhacophyllum** Lesq.
Lesquereux (1879: pl. 57, fig. 4, 4a; 1880: 317). Syntype, USNM 19469 (fig. 4). Mazon Creek, Grundy County, Illinois.

**coriaceum, Lepidophyllum** Lesq.
Lesquereux (1884: 787, pl. 107, fig. 10). Lectotype, USNM 15908 (fig. 10; Lacoe #672). Cannelton, Beaver County, Pennsylvania; donated by R.D. Lacoe.
USNM 15908 was designated as the lectotype of *Lepidophyllum coriaceum* Lesquereux, by Merrill (1907: 210).

**cornuta, Odontopteris** Lesq.
Lesquereux (1879: pl. 22, figs. 7-9; 1880: 128-129). Syntypes, USNM 10348 (fig. 9), USNM 10345 (fig. 7), USNM 10346 (fig. 8). Cannelton, Beaver County, Pennsylvania; donated by I.F. Mansfield.

**cornutum, Rhacophyllum** Lesq.
Lesquereux (1879: pl. 57, fig. 3; 1880: 317-318). Holotype, HU 7708. Cannelton, Beaver County, Pennsylvania.

**cornutus, Rhabdocarpus** Lesq.
Lesquereux (1879: pl. 85, fig. 15; 1880: 583). Syntype, HU 8019 (fig. 15; Lesquereux #T. 29). Mazon Creek, Grundy County, Illinois.

**crassa, Volkmannia** Lesq.
Lesquereux (1884: 719-720, pl. 90, fig. 1). Syntypes, USNM 18091 (Lacoe #851), USNM 18091. Dade County, Georgia.
The figured type is USNM 18091. The second syntype is currently unfigured.

**crassus, Cardiocarpus** Lesq.
Lesquereux (1884: 812, pl. 109, fig. 12; pl. 110, figs. 6-9). Syntypes, USNM 25598-25602 (all of the specimens carry Lacoe #963). Campbells Ledge, Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.
The specimens are figured as follows: fig. 6 is USNM 25599, fig. 7 is USNM 25600, fig. 8 is USNM 25601, fig. 9 is USNM 25602.

**cuspidata, Annularia** Lesq.
Lesquereux (1884: 725, pl. 92, figs. 7, 7a). Holotype, USNM 17851 (Lacoe #788). Rushville, Ohio; Allegheny Group, Pennsylvanian; donated by R.D. Lacoe.

**cuspidatum, Lepidodendron** Lesq.
Lesquereux (1879: pl. 64, fig. 7). Holotype, USNM 15437. "Plymouth E vein," Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**cyclostigma, Lepidodendron** Lesq.
Lesquereux (1879: pl. 62, fig. 5; 1880: 394-395). Syntype, USNM 15501 (fig. 5). Clinton, Missouri; donated by Dr. J.H. Britts.

**cyclostigma, Stemmatopteris** Lesq.
Lesquereux (1880: 341). Syntypes, USNM 11050, USNM 17188, USNM 17089. Olyphant, Pennsylvania.

**decipiens, Neuropteris** Lesq.
Lesquereux (1880: 93). Syntypes, USNM 10621, USNM 10623. Mazon Creek, Grundy County, Illinois.
Both specimens consist of a part and a counterpart. Lesquereux noted that he also had specimens from the Centralia coal shaft in Illinois. These specimens have yet to be located.

**dentata, Megalopteris** Lesq.
Lesquereux (1884: 833-834). Syntypes, USNM 11448-11450 (all of the specimens carry Lacoe #783). Rushville, Ohio; donated by R.D. Lacoe.

**denticulata, Archaeopteris** Lesq.
Lesquereux (1884: 774). Syntype, USNM 17008. Rushville, Ohio.

**dichotomum, Dicranophyllum** Lesq.
Lesquereux (1880: 553-554, pl. 87, fig. 9). Syntype, USNM 25108 (fig. 9). Cannelton, Beaver County, Pennsylvania; collected by I.F. Mansfield.

**dichotomus, Cordaianthus** Lesq.
Lesquereux (1879: pl. 76, fig. 6; 1880: 546-547). Holotype, USNM 19212. Henry County, Missouri.

**dilatatus, Cardiocarpus** Lesq.
Lesquereux (1884: 806-807, pl. 110, fig. 2). Syntype, USNM 25384 (fig. 2; Lacoe #961). Washington County, Arkansas; donated by R.D. Lacoe.

**dilatatus, Lepidophloios** Lesq.
Lesquereux (1879: pl. 68, figs. 6, 7; 1884: 781-782, pl. 105, figs. 1-4). Syntypes, USNM 15947 (fig. 6), Clinton, Henry County, Missouri; USNM 15941+15942 (fig. 7), Cannelton, Beaver County, Pennsylvania; USNM 15944 (fig. 1), Clinton, Henry County, Missouri; USNM 15945 (fig. 2), USNM 15956 (fig. 3), USNM 15943 (fig. 4); syntypes(?) ANSP 3721 (Lesquereux 3 [11076] (Lesquereux, 1889: 99)]), SMP 11107 (Lesquereux 34 [Lesquereux 1889: 101]), Cannelton, Beaver County, Pennsylvania.

The specimen in fig. 3 is currently unlocated. USNM 15941 and 15942 are part and counterpart. ANSP 3721 and USNM 15943 are currently unfigured. *L. dilatatus* was erected in the third volume of the Coal Flora (1884: 781-783). In the description, Lesquereux placed the two figures from the Atlas (1879: pl. 86, figs. 6, 7) under this name. The specimens from Cannelton were sent to Lesquereux by I.F. Mansfield. Spamer and Lendemer (2000) reported that ANSP 3721 was the counterpart of the specimen in fig. 2. This however, is in error. The specimen figured was from Missouri while the ANSP specimen was from Cannelton, Pennsylvania. It is, nonetheless an unfigured, questionable syntype.

**diminutivus, Cardiocarpus** Lesq.
Lesquereux (1879: pl. 85, fig. 48; 1880: 570). Holotype, USNM 26418. Sub-conglomerate of Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**dimorpha, Pseudopecopteris** Lesq.
Lesquereux (1879: pl. 35, figs. 1-6; 1880: 201). Syntype, CP 481 (fig. 6). Coal of Mount Hope, near Newport Rhode Island; donated by J.H. Clark.

**diplotesta, Cardiocarpus** Lesq.
Lesquereux (1884: 812-813, pl. 110, fig. 13). Holotype, USNM 25672 (Lacoe #272). Campbells Ledge, Pittston, Luzerne County, Pennsylvania.

**divergens, Cardiocarpus** Lesq.
Lesquereux (1884: 811, pl. 110, fig. 4). Syntype, USNM 2551 (fig. 4; Lacoe #964). "E vein," Pittston, Luzerne County, Pennsylvania.

**ebracteatus, Cordaianthus** Lesq.
Lesquereux (1884: 844). Holotype, USNM 19216. "Coal A," Boston Mine, Pittston, Luzerne County, Pennsylvania.

**elegans, Lepidophyllum** Lesq.
Lesquereux (1884: 787-788, pl. 107, fig. 11). Holotype, USNM 16230+16231 (Lacoe #737). Mazon Creek, Grundy County, Illinois; donated by R.D. Lacoe.
USNM 16230+16231 are part and counterpart.

**elrodi, Neuropteris** Lesq.
Lesquereux (1879: pl. 13, fig. 4; 1880: 107-108). Syntype, USNM 11839 (fig. 4), Black Warrior Basin, Alabama; syntype(?), SMP 11587 (Lesquereux #514 [11587] (Lesquereux 1889: 121)]), Whetstone Quarries, Indiana.
Lesquereux found USNM 11839 in the collection of the Alabama State Geological Survey without labels. Gastaldo (pers. comm.) has observed the specimen and noted that the lithology and preservation corresponds to that of the Black Warrior Basin of Alabama. Lesquereux noted that he also had specimens from the Montevallo Seam, Alabama (via T.H. Aldrich) and the Whetstone Grit of Orange County, Indiana (via E.T. Cox). Goubet et al. (2000: 15) placed USNM 11839 in synonomy with *Neuralethopteris schlehanii* (Stur). Goubet et al. (2000: 27) also placed all of the specimens later figured by Lesquereux as *Neuropteris elrodi* into synonomy with *Neuralethopteris biformis* (Lesquereux).

**emarginata, Stemmatopteris** Lesq.
Lesquereux (1880: 337-338). Lectotype, USNM 17142. Cannelton, Beaver County, Pennsylvania; donated by I.F. Mansfield.
USNM 17142 was designated as the lectotype by Merrill (1907: 324). Lesquereux did not give an enumeration of the specimens upon which he based this species. The description is not clear as to whether one specimen was used or a suite of specimens was used. Thus, we treat the specimen as a syntype that was designated as the lectotype by Merrill.

**emersoni, Annularia** Lesq.
Lesquereux (1880: 50-51). Syntype, USNM 17841. St. Clairsville, Ohio; Monongahela Formation, Pennsylvanian.

**emersoni, Danaeites** Lesq.
Lesquereux (1879: pl. 28, figs. 1-3; 1880: 157-158). Syntypes, USNM 12711 (fig. 1), USNM 12710 (fig. 2). Shale above the Coal, St. Clairsville, Ohio.
The specimens were sent to Lesquereux by Mr. P.W. Emerson of St. Clairsville. The specimen in fig. 3 is currently unlocated.

**evansii, Alethopteris** Lesq.
Lesquereux (1884: 834). Syntypes, USNM 11886-11890 (all of the specimens carry Lacoe #1013). Tracy City and Rockwood, Tennessee; donated by R.D. Lacoe.

**expansum, Rhacophyllum** Lesq.
Lesquereux (1879: pl. 57, fig. 6; 1880: 323-324). Holotype, USNM 19435. Olyphant, Pennsylvania; donated by R.D. Lacoe.

**fallax, Lepidophyllum** Lesq.
Lesquereux (1884: 786, pl. 107, figs. 4, 5). Syntypes, USNM 15897 (fig. 5; Lacoe #892), Cannelton, Beaver County, Pennsylvania; 15896 (fig. 4; Lacoe #892a), Rhode Island; donated by R.D. Lacoe.
Merrill (1907: 210) included USNM 15898 as one of the type specimens. However, the description was based upon only two specimens, those that were figured. Thus, USNM 15898 is not part of the type suite.

**fasciculata, Megalopteris** Lesq.
Lesquereux (1879: pl. 24, fig. 2; 1880: 150-151). Holotype, USNM 11704. Lower beds of the coal measures of Illinois; collected by Mr. J.H. Southwell.

**fasciculatus, Asterophyllites** Lesq.
Lesquereux (1879: pl. 3, figs. 1-4; 1880: 41-42). Syntypes, USNM 18292+HU 8075 (fig. 2), USNM 18291 (fig. 1), USNM 18297 (fig. 3), Clinton, Henry County, Missouri.
The specimen in fig. 4 is currently unlocated.

**fasciculatus, Cardiocarpus** Lesq.
Lesquereux (1879: pl. 85, figs. 30, 3a; 1880: 570). Syntype, USNM 25775. Campbells Ledge, Pittston, Luzerne County, Pennsylvania.

**fertilis, Volkmannia** Lesq.
Lesquereux (1884: 720-721, pl. 90, fig. 4). Syntypes, USNM 17772 (fig. 4), Roof of "coal B," Archbald, Pennsylvania; USNM 17773-17775, Stark County, Illinois.

**flexuosus, Cordaianthus** Lesq.
Lesquereux (1884: 802, pl. 109, fig. 2). Syntypes, USNM 19217 (fig. 2), USNM 19218 (both specimens carry Lacoe #846). Campbells Ledge, Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**fucoideum, Rhacophyllum** Lesq.
Lesquereux (1879: pl. 58, fig. 6, 7; 1880: 325). Syntypes, USNM 19443 (fig. 7), USNM 19442 (fig. 6). Mazon Creek, Grundy County, Illinois; collected by S.S. Strong.

**georgiana, Pecopteris** Lesq.
Lesquereux (1884: 759-760, pl. 98, figs. 6, 6a). Syntypes, USNM 12420+12421 (fig. 6; Lacoe #855), USNM 12422 (Lacoe #855a). Dade County, Georgia; donated by R.D. Lacoe.

**gibsoni, Alethopteris** Lesq.
Lesquereux (1879: pl. 28, figs. 4-6; 1880: 183-184). Syntype, USNM 11964 (fig. 4). Danville, Illinois.
The specimens in figs. 5 and 6 are currently unlocated.

**giffordi, Caulopteris** Lesq.
Lesquereux (1879: pl. 60, figs. 1, 2; 1880: 343-344). Holotype, UP 422. Coal measures near Alta, Peoria County, Illinois; donated by William Gifford.

**giffordi, Trigonocarpus** Lesq.
Lesquereux (1879: pl. 85, figs. 5, 6; 1880: 592-593). Holotype, USNM 26755. Lower coal measures, near Alta, Peoria county, Illinois; donated by William Gifford.

**goniopteroides, Sphenopteris** Lesq.
Lesquereux (1879: pl. 55, figs. 3, 4). Lectotype [designated here!], ANSP 3854 (Lesquereux #90 [11163] (Lesquereux 1889: 104)]). Cannelton, Beaver County, Pennsylvania; collected by I.F. Mansfield.
The specimen in fig. 3 (ANSP 3854) is now partially broken, with a small triangular fragment now missing. Also, at one time in the past, the specimen has been broken in two and glued back together. The identification which Lesquereux (1889: 104) gave for the specimen was *Pseudopecopteris newberryi* Lesquereux. This is in error. Both Lesquereux's and Lesley's catalogue numbers match. Furthermore, a comparison of the specimen with the protologue has found that the specimen matches it in every respect. This proves that either Lesquereux was in error or that he reidentifed the specimen before the it was sent to the Pennsylvania Geological Survey.

**gracile, Lepidophyllum** Lesq.
Lesquereux (1884: 786-787, pl. 107, fig. 8). Holotype, USNM 16245 (Lacoe #894). Campbells Ledge, Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**gracilis, Calamites** Lesq.
Lesquereux (1879: pl. 75, fig. 17; 1880: 29-30). Holotype, HU 4479. Upper coal strata, Western Kentucky.

**gracilis, Equisetites** Lesq.
Lesquereux (1884: 729-730, pl. 90, fig. 5). Holotype, USNM 18236 (Lacoe #938). Dade County, Georgia; donated by R.D. Lacoe.

**grand'euryi, Sigillaria** Lesq.
Lesquereux (1884: 795-797). Syntypes, USNM 16399, USNM 16400. Cannelton, Beaver County, Pennsylvania; donated by R.D. Lacoe

Both specimens carry Lacoe #735.

**grandis, Lesleya** Lesq.
Lesquereux (1879: pl. 25, figs. 1-3; 1880: 143). Syntype, ISM 8654 (fig. 2). Soft shaly sandstone, base of the Chester Limestone.

The two remaining specimens were cited by Watt (1974) as being at Harvard. However, no catalogue numbers were given. All of the specimens were communicated to Lesquereux by Prof. A.H. Worthen.

**grandis, Trigonocarpus** Lesq.
Lesquereux (1884: 821, pl. 111, figs. 1-3). Syntypes, USNM 26020 (fig. 3), USNM 26018 (fig. 1), USNM 26019 (fig. 2; all of the specimens carry Lacoe #973). Stark County, Illinois; donated by R.D. Lacoe.

**griffithii, Neuropteris** Lesq.
Lesquereux (1884: 737-738, pl. 95, figs. 3-8). Syntypes, USNM 10806+10807 (fig. 3), USNM 10808-10812 (figs. 4-8 respectively). "E vein," Port Griffith, near Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

All of the specimens carry Lacoe #417.

**hamulosum, Rhacophyllum** Lesq.
Lesquereux (1879: pl. 58, fig. 3; 1880: 321). Holotype, USNM 19445. Clinton, Missouri; collected by Dr. J.H. Britts.

**harveyi, Cardiocarpus** Lesq.
Lesquereux (1884: 808, pl. 109, figs. 22, 23). Syntypes, USNM 26159 (fig. 23), USNM 26158 (fig. 22; both specimens carry Lacoe #299). Privatt's Bank, Washington County, Arkansas; donated by R.D. Lacoe.

**harveyi, Sphenopteris** Lesq.
Lesquereux (1884: 766, pl. 103, figs. 7, 7b). Syntypes, USNM 14386 (fig. 7), USNM 2664, USNM 41229 (all of the specimens carry Lacoe #370). Sub-conglomerate, Arkansas; collected by F.L. Harvey; donated by R.D. Lacoe.

**hirsuta, Stemmatopteris** Lesq.
Lesquereux (1879: pl. 59, fig. 1; 1880: 337). Holotype, HU 7717.

**hispida, Pseudopecopteris** Lesq.
Lesquereux (1884: 755, pl. 98, fig. 3). Holotype, USNM 13737. Cannelton, Beaver County, Pennsylvania.

**ichthyoderma, Lepidophloios** Lesq.
Lesquereux (1879: pl. 68, fig. 10; 1880: 426-427). Holotype, USNM 15974. Roof shale of Morris Coal, Illinois; donated by S.S. Strong.

**ineaquale, Callipteridium** Lesq.
Lesquereux (1879: pl. 33, figs. 2-5). Syntypes, USNM 11916-11919 (figs. 2-5 respectively). Cannelton, Beaver County, Pennsylvania.

It should be noted that there are a number of specimens at SMP and ANSP which are from the type locality and were identified by Lesquereux.

**inaequilateralis, Sphenopteris** Lesq.
Lesquereux (1884: 765-766, pl. 103, figs. 4-5a). Syntype, USNM 41164 (fig. 4). Washington County, Arkansas; collected by F.L. Harvey.

**incertus, Lepidostrobus** Lesq.
Lesquereux (1879: pl. 69, fig. 25; 1880: 442-443). Holotype, HU 8086. Shale above the coal, Morris, Illinois.

**inflatus, Rhabdocarpus** Lesq.
Lesquereux (1884: 815, pl. 110, fig. 36). Syntypes, USNM 26116 (fig. 26), USNM 26117 (both specimens carry Lacoe #991). Cannelton, Beaver County, Pennsylvania.

**insignis, Rhabdocarpus** Lesq.
Lesquereux (1879: pl. 85, fig. 26; 1880: 575). Holotype, USNM 41068. Seneca Mine, "coal seam F," Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**integrifolia, Whittleseya** Lesq.
Lesquereux (1879: pl. 4, fig. 2; 1880: 524). Holotype, AGS-SM 30. (Tuscaloosa, Alabama)?

This specimen was sent to Lesquereux by Prof. Eugene A. Smith in the same lot as the holotype of *W. undulata* Lesquereux (Harvard 7731).

**intermedium, Spirangium** Lesq.
Lesquereux (1880: 521). Syntypes, USNM 19626-19630. Campbells Ledge, Pittston, Luzerne County, Pennsylvania.

**kansaseanus, Trigonocarpus** Lesq.
Lesquereux (1884: 822). Syntypes, USNM 26999-27002 (all of the specimens carry Lacoe #791). Osage, Kansas; donated by R.D. Lacoe.

**lacoei, Caulopteris** Lesq.
Lesquereux (1880: 344). Lectotype, USNM 17106, Syntype, USNM 11051. "Coal #1," Olyphant, Pennsylvania.

USNM 17106 was designated by Merrill (1907) as the lectotype.

**lacoei, Cordaites** Lesq.
Lesquereux (1880: 535, pl. 87, figs. 2-4). Syntypes, USNM 18917 (fig. 2), USNM 18918 (fig. 3), USNM 18920 (fig. 4). Shale above "coal E," Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

A fourth (unfigured) syntype is currently unlocated.

**lacoei, Lycopodites** Lesq.
Lesquereux (1884: 780-781, pl. 107, fig. 1). Holotype, USNM 10219 (Lacoe #524). "No. 1 vein," Olyphant, Pennsylvania; donated by R.D. Lacoe.

**lacoei, Sigillaria** Lesq.
Lesquereux (1879: pl. 72, fig. 12; 1880: 499-500). Syntype, USNM 16806 (fig. 12). "F vein," Plymouth, Pennsylvania; donated by R.D. Lacoe.

**lanceolata, Calamostachys** Lesq.
Lesquereux (1884: 715-717, pl. 91, figs. 1, 2; pl. 93, fig. 1). Syntypes, USNM 18063 (pl. 93, fig. 1; Lacoe #558b), USNM 18276 (pl. 911, fig. 2), Dade County, Georgia; USNM 18062 (pl. 91, fig. 1; Lacoe #558a), Arkansas; donated by R.D. Lacoe.

**late-alatus, Cardiocarpus** Lesq.
Lesquereux (1879: pl. 85, figs. 46, 47; 1880: 568-569). Syntypes, USNM 25684, USNM 25685 (fig. 46). Campbells Ledge, Pittston, Luzerne County, Pennsylvania.

**late-costatus, Rhabdocarpus** Lesq.
Lesquereux (1884: 815, pl. 110, figs. 34, 35). Syntypes, USNM 25830 (fig. 34), USNM 25831 (fig. 35; both specimens carry Lacoe #969). Campbells Ledge, Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**latifolium, Lepidodendron** Lesq.
Lesquereux (1879: pl. 63, figs. 7, 8; 1880: 370). Holotype, HU 8200. Coal mines of Olyphant, Pennsylvania.

The specimen was presented to Lesquereux by Mr. Edward Jones in 1860(?). The specimen also carries Lesquereux's personal catalogue number L. 20.

**latior, Cardiocarpus** Lesq.
Lesquereux (1884: 811, pl. 110, figs. 5, 11, 12). Syntypes, USNM 25585 (fig. 11), USNM 25586 (fig. 12; both specimens carry Lacoe #977). Rockwood, Tennessee; donated by R.D. Lacoe

**latior, Carpolithes** Lesq.
Lesquereux (1884: 826, pl. 110, figs. 69, 70). Syntypes, USNM 15964 (fig. 69), USNM 15965, USNM 15966 (all of the specimens carry Lacoe #286). Campbells Ledge, Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**leptoderma, Sigillaria** Lesq.
Lesquereux (1879: pl. 72, fig. 10; 1880: 489-490). Syntype, USNM 16779 (fig. 10). "F vein," Plymouth, Pennsylvania; donated by R.D. Lacoe.

**leveretti, Sigillaria** Lesq.
Lesquereux (1884: 800-801, 108, figs. 4, 5). Syntypes, USNM 16445 (fig. 4), USNM 16446 (fig. 5; both specimens carry Lacoe #480). Spring Run, Augusta Township, Des Moines County, Iowa; donated by R.D. Lacoe.

**linearifolium, Lepidophyllum** Lesq.
Lesquereux (1879: pl. 69, fig. 39). Holotype, USNM 16067. Wilkes-Barre lower coal bed, Pennsylvania.

**lineatus, Cordaicarpus** Lesq.
Lesquereux (1884: 805, pl. 109, fig. 16). Holotype, USNM 25345 (Lacoe #983). Cannelton, Beaver County, Pennsylvania.

**lineatus, Lepidocystis** Lesq.
Lesquereux (1879: pl. 69, fig. 4; 1880: 454-455). Holotype, USNM 25254. South Salem vein of Port Carbon, Pennsylvania; collected by William Lorenz.

**longicollis, Cardiocarpus** Lesq.
Lesquereux (1884: 808-809, pl. 109, figs. 24, 25). Syntypes, USNM 26165 (figs. 24, 25), USNM 26166 (both specimens carry Lacoe #798). Dade County, Georgia; donated by R.D. Lacoe.

**macilenta, Archaeopteris** Lesq.
Lesquereux (1884: 773, 775). Lectotype, USNM 16965 (on the same rock as 16964); isotypes, 16962-16964, USNM 16968-16972, USNM 16978; syntypes, USNM 11320, USNM 16967b, USNM 16973, USNM 16974, USNM 16976 (unlocated), USNM 16977, USNM 16979, USNM 196966, Meshoppen, Pennsylvania; donated by R.D. Lacoe.

The suite carries Lacoe # 830. The lectotype was designated by Carluccio (1966). USNM 16965, 16971, and 16974 each consists of a part and a counterpart. USNM 16977 is the counterpart only; the part is currently missing.

**macrocystis, Lepidostrobus** Lesq.
Lesquereux (1879: pl. 69, figs. 1, 2). Syntypes, USNM 42298 (fig. 1), Mercer County, Illinois; USNM 16130 (fig. 2), Coal Creek, West Virginia.

The specimen in fig. 1 was presented to Lesquereux by Dr. Salisbury. The species was later raised to a subgeneric rank by Lesquereux (1880: 443) to accommodate three new species; *L. salisburyi* Lesq. (erected upon the same figures as *L. macrocystis*), *L. quadratus* Lesq., and *L. mansfieldi* Lesq. Chaloner & Boureaux (1967: 675-676) noted that this taxon merely represents a preservational form of *Stigmaria ficoides* (Sternberg), in which the root structure has collapsed and the surrounding tissue has folded into sections which, coupled with the compressed xylem, gives the appearance of a cross-sectioned cone.

**mamillatus, Rhabdocarpus** Lesq.
Lesquereux (1884: 816-817, pl. 110, figs. 39-42). Syntypes, USNM 26762-5 (figs. 39-42 respectively; all of the specimens carry Lacoe #665). Stark County, Illinois.

**mansfieldi, Callipteridium** Lesq.
Lesquereux (1879: pl. 27, figs. 1, 2; 1880: 166). Syntypes, USNM 11930 (fig. 1), USNM 11931+11932 (fig. 2); syntype(?), SMP 11331 (Lesquereux #258 [11331 (Lesquereux 1889: 111)]), Cannelton, Beaver County, Pennsylvania; collected by I.F. Mansfield.

**mansfieldi, Caulopteris** Lesq.
Lesquereux (1879: pl. 60, fig. 3; 1880: 346-347). Syntype, USNM 17118 (fig. 3). Cannelton, Beaver County, Pennsylvania; collected and donated by I.F. Mansfield.

**mansfieldi, Halonia** Lesq.
Lesquereux (1879: pl. 69, fig. 2; 1880: 414-416). Syntype, USNM 15808 (fig. 2). Cannelton, Beaver County, Pennsylvania.

**mansfieldi, Lepidophyllum** Lesq.
Lesquereux (1879: pl. 69, fig. 34; 1880: 449-450). Syntype, USNM 15918 (fig. 34). Cannelton, Beaver County, Pennsylvania; collected by I.F. Mansfield.

**mansfieldi, Rhabdocarpum** Lesq.
Lesquereux (1879: pl. 84, fig. 21). Holotype, USNM 15977. Cannelton, Beaver County, Pennsylvania; collected by I.F. Mansfield.

This species was erected by name and figure only in the *Atlas* and was not included in the text of the *Coal Flora.*

**marginata, Megalopteris? Lesq.**
Lesquereux (1879: pl. 24, fig. 4; 1880: 152-153). Holotype, USNM, 11700. Port Byron, Illinois; collected by Mr. Southwell.

**marginata, Sigillaria Lesq.**
Lesquereux (1879: pl. 71, fig. 5; 1880: 498-499). Holotype, USNM 16798 (Lacoe 460). Plymouth, Pennsylvania; donated by R.D. Lacoe.

**membranaceum, Callipteridium Lesq.**
Lesquereux (1879: pl. 27, figs. 4-8; 1880: 172-173). Syntypes, USNM 13181-13183 (figs. 4-6 respectively), USNM 13187. Clinton, Henry County, Missouri.
The specimen in fig. 8 is currently unlocated and White (1899: 120, pl. 38, figs. 4, 5) placed USNM 13181, 13183 into synonomy with *Pecopteris clintoni* Lesq. The other specimens, however were retained in this species.

**membranaceum, Rhacophyllum Lesq.**
Lesquereux (1879: pl. 58, figs. 1, 2). Syntypes, USNM 19465 (fig. 1), USNM 19466 (fig. 2). Clinton, Henry County, Missouri.

**microphylla, Eremopteris Lesq.**
Lesquereux (1879: pl. 52, figs. 6, 7; 1880: 296). Syntypes, USNM 40110 (fig. 6), HU 7704 (fig. 7). Helena coal mines, Alabama; collected by Eugene A. Smith.

**microphylla, Lesleya Lesq.**
Lesquereux (1884: 831-832). Lectotype, USNM 11744 (Lacoe #314). Osage, Kansas; donated by R.D. Lacoe.
USNM 11744 was designated as the lectotype by Merrill (1907: 213).

**microphylla, Whittleseya Lesq.**
Lesquereux (1884: 843). Syntypes, USNM 18880-18882. Washington County, Arkansas; communicated by F.L. Harvey.

**microstigma, Stemmatopteris Lesq.**
Lesquereux (1884: 838). Syntypes, USNM 17134-17137 (all of the specimens carry Lacoe #612). Cannelton, Beaver County, Pennsylvania; donated by R.D. Lacoe.

**mimica, Stemmatopteris Lesq.**
Lesquereux (1879: pl. 59, fig. 4; 1880: 341-342). Holotype, USNM 17141. Cannelton, Beaver County, Pennsylvania.

**minor, Macrostachya Lesq.**
Lesquereux (1884: 829, pl. 3, figs. 19, 19a). Lectotype, USNM 18301 (fig. 19; Lacoe #212). Campbells Ledge, Pittston, Luzerne County, Pennsylvania.
The lectotype was designated by Merrill (1907: 218).

**minutum, Lepidophyllum Lesq.**
Lesquereux (1884: 787, pl. 107, fig. 9). Holotype, USNM 16243 (Lacoe #673). Archbald, Lackawanna County, Pennsylvania; donated by R.D. Lacoe.

**missouriensis, Eremopteris** Lesq.
Lesquereux (1879: pl. 53, fig. 8, 8a; 1880: 295). Holotype, USNM 30853. Clinton, Missouri; collected by Dr. J.H Britts.

**missouriensis, Neuropteris** Lesq.
Lesquereux (1879: pl. 7, figs. 5, 6; 1880: 104). Syntype, USNM 30861 (fig. 6). Clinton, Henry County, Missouri; communicated by J.H. Britts.
The specimen fig. 5 is currently unlocated.

**monstruosa, Odontopteris** Lesq.
Lesquereux (1884: 741-742, pl. 97, figs. 1-3). Syntypes, USNM 14831 (fig. 2), USNM 19358 (fig. 3). Cannelton, Beaver County, Pennsylvania.
The specimen in fig. 1 is currently unlocated.

**morrisianum, Lepidophyllum** Lesq.
Lesquereux (1879: pl. 69, figs. 40, 41; 1880: 448-449). Syntypes, USNM 15917 (fig. 40), USNM 15916 (fig. 41). Shale over the coal of Morris, Illinois; collected by S.S. Strong.

**multiplicatum, Spirangium** Lesq.
Lesquereux (1879: pl. 75, fig. 11; 1880: 520-521). Syntype, USNM 19675 (fig. 11). Mazon Creek, Grundy County, Illinois; collected by S.S. Strong.

**neuropteroides, Callipteridium** Lesq.
Lesquereux (1879: pl. 27, fig. 3; 1880: 166-167). Holotype, USNM 11878+11879. Mazon Creek, Grundy County, Illinois.

**oblongifolia, Neuropteris** Lesq.
Lesquereux (1884: 732-733, pl. 94; fig. 3, pl. 95, fig. 2). Syntypes, USNM 10070 (pl. 94, fig. 3), USNM 10071 (pl. 95, fig. 2), USNM 10072 (all of the specimens carry Lacoe #951). Cannelton, Beaver County, Pennsylvania; donated by R.D. Lacoe.

**ophioglossoides, Sorocladus** Lesq.
Lesquereux (1879: pl. 48, fig. 11). Holotype, USNM 14270. Clinton County, Missouri; collected by Dr. J.H Britts.

**ornata, Pecopteris** Lesq.
Lesquereux (1884: 760, pl. 111, figs. 30-30b). Syntypes, USNM 13387+13388, USNM 13385 (all of the specimens carry Lacoe #1008). Mazon Creek, Grundy County, Illinois; donated by R.D. Lacoe.

**ovalis, Cardiocarpus** Lesq.
Lesquereux (1884: 810, pl. 109, figs. 8, 9). Syntypes, USNM 25517, USNM 25516 (fig. 9). Washington County, Arkansas.

**ovalis, Cordaicarpus** Lesq. nom. nov. pro. *C. apiculatus* Lesq.
[See *Cordaicarpus apiculatus* Lesq.]

**ovalis, Sigillaria** Lesq.
Lesquereux (1879: pl. 71, figs. 7, 8; 1880: 495). Syntype, USNM 16553 (fig. 7). "F vein," Plymouth, Pennsylvania; donated by R.D. Lacoe.
The specimen in fig. 8 is currently unlocated.

**ovatus, Cordaianthus** Lesq.
Lesquereux (1880: 545-546, pl. 76, figs. 5, 5a). Lectotype, SMP 11340. Cannelton, Beaver County, Pennsylvania.

The lectotype was designated by Darrah (1969: 84) by assumption of a holotype. Darrah (1969: 84) provided a detailed comparison between the lectotype and the original figure (drawn by A.M. Rickey) which is reproduced below. (The words within the brackets were added by the author.)

> "The sketch indicates the correct number, arrangement and symmetry of the strobili. The overall size is reduced approximately 20 percent although the precise limits of the specimen, having the same monochrome black color of the matrix, are difficult to determine. Minor details have been idealized or omitted from [the] drawing. The reliability of the illustration without the description and original specimen is very poor."

**pachytesta, Cardiocarpus** Lesq.
Lesquereux (1880: 565). Syntypes, USNM 35482-25486. Campbells Ledge, Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**pachytesta, Rhabdocarpus** Lesq.
Lesquereux (1884: 816, pl. 110, figs. 37, 38). Syntypes, USNM 26796+26797 (fig. 37), USNM 26798 (fig. 38; both specimens carry Lacoe #989). Mazon Creek, Grundy County, Illinois; donated by R.D. Lacoe.

**pardei, Callipteridium** Lesq.
Lesquereux (1879: pl. 26, figs. 2, 3). Syntypes, LC uncatalogued (destroyed?).

Both specimens may have been destroyed in a fire at Lafayette College. However, this has not been confirmed and specimens from the collections of Lafayette College are known to exist in other institutions. Additionally, at least part of the LC herbarium ended up in ANSP. The Paleobotany collection at ANSP was searched for the specimens; however they were not found.

**patens, Cardiocarpus** Lesq.
Lesquereux (1884: 807, pl. 110, fig. 3). Holotype, USNM 25504. Washington County, Arkansas; communicated by F.L. Harvey.

**patens, Odontopteris** Lesq.
Lesquereux (1884: 740-741, pl. 97, fig. 7). Syntypes, USNM 11274 (fig 7), USNM 11275, USNM 11276 (all of the specimens carry Lacoe #890). Rhode Island.

**pectinatus, Lepidocystis** Lesq.
Lesquereux (1879: pl. 69, fig. 3; 1880: 454). Holotype, USNM 25252 (Lacoe #432). Subconglomerate of Campbells Ledge, Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**pendulus, Lycopodites** Lesq.
Lesquereux (1879: pl. 62, fig. 2; 1880: 357). Holotype, HU 7722. Shale of Morris coal, Illinois.

The specimen also carries Lesquereux's personal catalogue number Ly. 11.

**perpusillus, Carpolithes** Lesq.
Lesquereux (1884: 825, pl. 111, figs. 22-24). Syntypes, USNM 25950, USNM 25951, USNM 25952 (all of the specimens carry Lacoe #980). Campbells Ledge, Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**perpusillus, Trigonocarpus** Lesq.
Lesquereux (1884: 820-821, pl. 110, figs. 58-61). Syntypes, USNM 26985, USNM 26982-26984 (all of the specimens carry Lacoe #971). Stark County, Illinois; donated by R.D. Lacoe.

**pittstoniana, Sigillaria** Lesq.
Lesquereux (1879: pl. 71, fig. 4; 1880: 493). Syntype, USNM 16709 (fig. 4). Plymouth, Pennsylvania; donated by R.D. Lacoe.

**planus, Sporocystis** Lesq.
Lesquereux (1879: pl. 69, fig. 15; 1880: 458-459). Syntypes, ANSP 980 (Lesquereux #420 [11493] (Lesquereux 1889: 117)]), USNM 25196 - 25199; Syntypes(?), SMP 11492 (Lesquereux #419c [Lesquereux 1889: 117]), SMP 11463 (Lesquereux 390a [Lesquereux 1889: 116]). Inter conglomerate, Pittston, Luzerne County, Pennsylvania.

While Watt (1974) gave USNM 25196 as the figured specimen, this must be an error. The figure is so generalized that no one specimen can be discerned as the type. In fact, Spamer and Lendemer (2000) remarked of ANSP 980 that "the illustration by which this species was erected by name and figure only is so generalized that the identity of this specimen as one of those used to figure the species is uncertain." Thus, here I include the specimens at USNM as well as those at ANSP and SMP in the type series simply because all are known to have been in the possession of Lesquereux at the time of publication.

**polita, Stemmatopteris** Lesq.
Lesquereux (1879: pl. 59, fig. 6; 1880: 342). Holotype, USNM 17096. Cannelton, Beaver County, Pennsylvania; collected by I.F. Mansfield.

**praelongus, Lepidostrobus** Lesq.
Lesquereux (1880: 433). Holotype, ANSP 3727 (Lacoe #559, Lesquereux #62 [11135] (Lesquereux 1889: 102)]) + (?) USNM 41140. "C vein," Everhart's colliery, near Pittston, Luzerne County, Pennsylvania.

Lesquereux's citation (1889: 102) for this specimen lists the locality as Cannelton, Beaver County, Pennsylvania. Despite this difference in data the specimen seems to be that upon which the description was based. The lithology of the specimen also corresponds more with the Pittston locality than that of Cannelton. There is also a specimen in the National Museum (USNM 41140) that is listed as being the type of this species. The specimen has not been examined and was not listed by Merrill (1907).

**pusillus, Cardiocarpus** Lesq.
Lesquereux (1884: 815, pl. 110, figs. 31-33). Syntypes, USNM 25862 (fig. 31), USNM 25923 (fig. 32), USNM 25924 (fig. 33; all of the specimens carry Lacoe #967), Coal "E and F," Wilkes-Barre, Pennsylvania; donated by R.D. Lacoe.

**quadratifolia, Pecopteris** Lesq,
Lesquereux (1880: 234). Lectotype, USNM 12702; isotypes(?), SMP 11175 (Lesquereux #125 [11195] (Lesquereux 1889: 106)]), SMP 11175 (Lesquereux #102b [11175)] (Lesquereux 1889: 105)]), SMP 11185 (Lesquereux #112a [11185] (Lesquereux 1889: 105)]), Cannelton, Beaver County, Pennsylvania.

The lectotype was designated by Merrill (1907).

**radiatus, Cordaites** Lesq.
Lesquereux (1880: 540, pl. 87, figs. 5-7). Syntypes, USNM 18907 (fig. 5), USNM 18908 (fig. 6); syntype(?) SMP 11501. Cannelton, Beaver County, Pennsylvania.

The specimens were collected and sent to Lesquereux by I.F. Mansfield. The third, unlocated figured syntype (fig. 7) may be SMP 11501 (Lesquereux #428) which is currently in the William Penn Museum in Harrisburg, Pennsylvania. A fourth specimen (unfigured) also remains unlocated.

**ramosum, Dictyophytum** Lesq.
Lesquereux (1884: 827). Syntypes, SMP 11317 (Lesquereux #244). Head of Hill Creek, Charlestown township, Tioga County, Pennsylvania, Upper Devonian; collected by Mr. Sherwood, July 1873.

SMP 11317 consists of twelve specimens. Lesquereux noted fifteen specimens however, upon examination of the collection in 1889 only twelve were found (Lesquereux 1889: 110).

**rigidum, Callipteridium** Lesq.
Lesquereux (1884: 746-747, pl. 99, figs. 1-2a). Syntypes, USNM 13602 (fig. 1), USNM 13601 (fig. 2; both specimens carry Lacoe #716). Olyphant, Pennsylvania.

**rigidum, Lepidodendron** Lesq.
Lesquereux (1884: 839). Syntypes, USNM 15515-15517 (all of the specimens carry Lacoe #918). Dade Mine, Georgia; donated by R.D. Lacoe.

**robusta, Alethopteris** Lesq.
Lesquereux (1884: 835). Syntypes, USNM 12174-12177 (all of the specimens carry Lacoe #743). Cannelton, Beaver County, Pennsylvania; donated by R.D. Lacoe.

**robusta, Pecopteris** Lesq.
Lesquereux (1879: pl. 39, figs. 7, 8; 1880: 229-230). Syntypes, USNM 12524 (fig. 8), USNM 12523 (fig. 7). Subconglomerate ledge, Pittston, Luzerne County, Pennsylvania.

**rotundifolium, Idiophyllum** Lesq.
Lesquereux (1879: pl. 23, fig. 11). Holotype, USNM 10258. Mazon Creek, Grundy County, Illinois.

**royi, Sphenopteris** Lesq.
Lesquereux (1884: 768, pl. 104, figs. 7-10). Syntypes, USNM 19853 (fig. 7), USNM 19852 (fig. 8), USNM 19851 (fig. 9), Rockwood, Tennessee; USNM 19854 (fig. 10), USNM 19855, Washington County, Arkansas; donated by R.D. Lacoe.
All of the specimens carry Lacoe #1037.

**rugosus, Cordaianthus** Lesq.
Lesquereux (1884: 803-804). Syntypes, USNM 19214 (Lacoe #929), "Coal C," Shamokin, Pennsylvania; USNM 19211 (Lacoe #943), Mazon Creek, Grundy County, Illinois; donated by R.D. Lacoe.

**salisburyi, Lepidostrobus** Lesq. nom. nov. pro. *L. macrocystis* Lesq.
Lesquereux (1880: 443-444). Syntypes, USNM 42298, Mercer County, Illinois; USNM 16130, Coal Creek, West Virginia.
The specimen in fig. 1 was presented to Lesquereux by Dr. Salisbury. This species was erected with indication to the same figures upon which Lesquereux had based *Lepidostrobus macrocystis*. When he raised the species to subgeneric status he proposed the name *L. salisburyi* to replace *L. macrocystis*. Thus, *L. salisburyi* Lesquereux, is treated here as a *nomen novum* for *L. macrocystis*. See the entry for *L. macrocystis* for notes on the synonomy provided by Chaloner & Boureaux (1967: 675-676).

**scutatum, Lepidodendron** Lesq.
Lesquereux (1879: pl. 63, fig. 6; 1880: 369-370). Syntype, USNM 15448 (fig. 6). Clinton, Missouri; collected by Dr. J.H Britts.

**serpillifolia, Pecopteris** Lesq.
Lesquereux (1879: pl. 46, figs. 1-3; 1880: 237-238). Syntypes, USNM 13929 (fig. 1), USNM 13190 (fig. 2), USNM 13931 (fig. 3). Mazon Creek, Grundy County, Illinois.
It may be worth noting that Lesquereux sent a series of specimens of this species to Adolphe Brongniart. However, Brongniart never gave Lesquereux his views on the species. I have not been able to locate these specimens (though if they still exist they are most likely in the Natural History Museum of Paris).

**serrata, Megalopteris Lesq.**
Lesquereux (1884: 834). Syntypes, USNM 11463, USNM 11464 (both specimens carry Lacoe #798). Rushville, Ohio; donated by R.D. Lacoe.

**sigillarioides, Lepidophloios Lesq.**
Lesquereux (1879: pl. 68, fig. 8; 1880: 13-14). Holotype, USNM 6173. Clinton, Missouri.
Lesquereux cited Mr. I.H. Britts as the donator of the specimen. This is, however in error. The specimen were sent to Lesquereux by Mr. J.H. Britts.

**simplex, Asterophycus Lesq.**
Lesquereux (1879: pl. B, figs. 7, 8; 1880: 13-14). Syntypes, USNM 10255. Beaver County, Pennsylvania.
Both of the illustrated specimens are preserved on the same rock.

**simplex, Cardiocarpus Lesq.**
Lesquereux (1879: pl. 85, figs. 49, 50; 1880: 569). Syntypes, USNM 15630 (fig. 49), USNM 15631 (fig. 50). Campbells Ledge, Pittston, Luzerne County, Pennsylvania.

**simplex, Lycopodites Lesq.**
Lesquereux (1884: 779-780, pl. 106, fig. 2). Holotype, USNM 15552 (Lacoe 258). Campbells Ledge, Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**smithsii, Neuropteris Lesq.**
Lesquereux (1879: pl. 13, figs. 1-3; 1880: 106). Lectotype, AGS-SM 25c. Black Creek vein, New Castle Coal, Alabama, collected by Eugene A. Smith.
Of the three specimens upon which Lesquereux based this species, only this single representative has been found (it is illustrated in Lesquereux's fig. 2). The lectotype was designated by Goubet et al. (2000: 19). Lesquereux (1880: 106) cited page 76 of the 1876 Geological Report of Alabama as the location of the original description for this species; however, it is a *nomen nudum* there. Thus, by default, the place of publication shifts to the next available date which is the *Atlas* to the Coal Flora. Goubet et al. (2000: 19-23) also provide a review of the systematic placement of this taxon in which it is placed into the genus *Neuralethopteris* Cremer *ex* Laveine.

**smithsii, Taeniopteris Lesq.**
Lesquereux (1879: pl. 25, fig. 7; 1880: 153-154). Holotype, AGS-SM 78, Alabama Coal Fields, Helena Coal Mines, Alabama; from Professor Eugene A. Smith (locality inferred by Lesquereux (1880: 154)).

**solida, Sphenopteris Lesq.**
Lesquereux (1884: 769, pl. 101, fig. 3). Holotype, USNM 14213 + 14214. Mazon Creek, Grundy County, Illinois; communicated by F.T. Bliss.
The specimens are part and counterpart.

**southwelli, Megalopteris Lesq.**
Lesquereux (1879: pl. 24, fig. 1; 1880: 158-149). Syntype, USNM 41171 (fig. 1). Lower bed of the Coal Measures, sub-conglomerate, near Port Byron, Illinois; collected by Mr. J.H. Southwell.

**speciosa, Pseudopecopteris Lesq.**
Lesquereux (1879: pl. 51, fig. 1; 1880: 216-217). Holotype, USNM 41170. Helena coal mines, Alabama; collected by Professor Eugene A. Smith.

**specious, Cardiocarpus Lesq.**
Lesquereux (1884: 807-808, pl. 110, fig. 1). Holotype, USNM 26205. Cannelton, Beaver County, Pennsylvania; collected by I.F. Mansfield.

**spectabilis, Lepidostrobus** Lesq.
Lesquereux (1880: 435). Syntypes, USNM 16059, USNM 16060. Cannelton, Beaver County, Pennsylvania.

**sphenophyllifolia, Archaeopteris** Lesq.
Lesquereux (1884: 773, 775). Syntypes, USNM 16980-16982 (all of the specimens carry Lacoe #829). Meshoppen, Pennsylvania; donated by R.D. Lacoe.

**sphenopterioides, Odontopteris** Lesq.
Lesquereux (1879: pl. 21, figs. 3, 4; 1880: 139-140). Syntypes, USNM 13531 (fig. 3), Mazon Creek, Grundy County, Illinois; USNM 13532 (fig. 4), Clinton County, Missouri.
The specimen in fig. 3 was communicated to Lesquereux by Dr. J.H. Britts.

**spicatus, Cordaianthus** Lesq.
Lesquereux (1884: 802-803, pl. 109, fig. 3). Syntype, USNM 19226 (fig. 3; Lacoe #940). Campbells Ledge, Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**spinosum, Rhacophyllum** Lesq.
Lesquereux (1879: pl. 58, fig. 4, 5; 1880: 320-321). Syntype, USNM 19436 (fig. 4). Clinton, Missouri; collected by Dr. J.H. Britts.
The specimen in fig. 5 is currently unlocated.

**squamiferum, Lepidodendron** Lesq.
Lesquereux (1879: pl. 62, fig. 3; 1880: 376-377). Holotype, AGS-SM 18. Helena coal mines, Alabama; donated by Professor Eugene A. Smith.

**squamosa, Rachiopteris** Lesq.
Lesquereux (1884: 838-839). Syntypes, USNM 19608-19610 (all of the specimens carry Lacoe #456). Cannelton, Beaver County, Pennsylvania; donated by R.D. Lacoe.

**squamosa, Stemmatopteris** Lesq.
Lesquereux (1879: pl. 59, fig. 2; 1880: 339). Holotype(?), USNM 17073 (fig. 2). Cannelton, Beaver County, Pennsylvania, donated by I.F. Mansfield.

**stantoni, Lepidophyllum** Lesq.
Lesquereux (1884: 841). Syntypes, USNM 16221-16223 (all of the specimens carry Lacoe #657). Stanton Mine, Wilkes-Barre, Pennsylvania; donated by R.D. Lacoe.

**starkianus, Trigonocarpus** Lesq.
Lesquereux (1884: 822, pl. 111, figs. 7-13). Syntypes, USNM 26983, USNM 26982, USNM 26984, USNM 26985 (all of the specimens carry Lacoe #972). Stark County, Illinois; donated by R.D. Lacoe.

**striata, Dechenia** Lesq.
Lesquereux (1879: pl. 67, fig. 3). Holotype, USNM 10259. Alta, Illinois; donated by R.D. Lacoe(?).

**subcrenulata, Pseudopecopteris** Lesq.
Lesquereux (1879: pl. 37, figs. 7, 8). Syntype, HU 6236 (fig. 7), HU 6237 (fig. 8). Mazon Creek, Grundy County, Illinois.

**subcrenulata, Odontopteris** Lesq.
Lesquereux (1879: pl. 21, figs. 5, 6). Syntypes, USNM 35317 (fig. 5), USNM 10378 (fig. 6). Mazon Creek, Grundy County, Illinois; donated by R.D. Lacoe(?).

**subcylindricus, Trigonocarpus** Lesq.
Lesquereux (1879:pl. 84, figs. 9, 10). Holotype, HU 8035. Locality unknown.

**subfalcata, Neuropteris** Lesq.
Lesquereux (1879: pl. 13, figs. 5, 6; 1880: 102-103). Syntypes, AGS-SM 32 (lot consists of two specimens). Gray shale, Helena coal mine?, Alabama; communicated by Professor Eugene A. Smith.

**sub-globosus, Rhabdocarpus** Lesq.
Lesquereux (1884: 817, pl. 110, figs. 43-45, 62). Syntypes, USNM 26331, USNM 26330 (fig. 43), USNM 26332 (fig. 44; all of the specimens carry Lacoe #978), Butler Dam, near Pittston, Luzerne County, Pennsylvania.
The specimen in fig. 45 is currently unlocated.

**tenax, Rhabdocarpus** Lesq.
Lesquereux (1884: 818, pl. 110, figs. 25, 26). Syntypes, USNM 26458, USNM 26459. Cannelton, Beaver County, Pennsylvania.

**timidum, Lepidophyllum** Lesq.
Lesquereux (1880: 448). Syntype, USNM 16218 (Lacoe #565). Wilkes-Barre, Pennsylvania; donated by R.D. Lacoe.

**tracyana, Sphenopteris** Lesq.
Lesquereux (1884: 766-76, pl. 101, fig. 2). Holotype, USNM 14132 (Lacoe #930). Tracy City, Tennessee.

**transsectus, Carpolithes** Lesq.
Lesquereux (1884: 826, pl. 111, figs. 27-27b). Syntypes, USNM 25810, USNM 25811 (both specimens carry Lacoe #279). Washington County, Arkansas; communicated by F.L. Harvey.

**trichoideum, Rhacophyllum** Lesq.
Lesquereux (1880: 322). Syntypes, USNM 19453, USNM 19454. Oakwood colliery, Wilkes-Barre, Pennsylvania.

**truncata, Taeniopteris** Lesq.
Lesquereux (1884: 743-744, pl. 94, fig. 8). Holotype, USNM 11699 (Lacoe #860). Campbells Ledge, Pittston, Luzerne County, Pennsylvania; donated by R.D. Lacoe.

**truncatum, Rhacophyllum** Lesq.
Lesquereux (1879: pl. 50, fig. 7; 1880: 311-312). Holotype, USNM 19414. Red shale of the Vespertine on the bluffs of the Susquehanna River above Pittston, Coxten Narrows, Luzerne County, Pennsylvania.

**undulata, Whittleseya** Lesq.
Lesquereux (1879: pl. 4, fig. 3; 1880: 525). Holotype, HU 7731. (Tuscaloosa, Alabama)(?)
The specimen was sent to Lesquereux by Prof. Eugene A. Smith in the same lot as the holotype of *W. integrifolia* Lesquereux.

**vestita, Pecopteris** Lesq.
Lesquereux (1879: pl. 43, figs. 1-7; 1880: 252-253). Syntypes, USNM 13127 (fig. 1), USNM 13160 (fig. 3). Clinton, Henry County, Missouri.
All specimens with the exceptions of those in figs. 1 and 3 are currently unlocated.

**williamsi, Sigillaria** Lesq.
Lesquereux (1880: 488-489). Syntypes, USNM 16745 (Lacoe #719), USNM 16746 (Lacoe #536). Olyphant, Pennsylvania.

**zonulatus, Cardiocarpus** Lesq.
Lesquereux (1879: pl. 85, figs. 44, 45; 1880: 568). Syntypes. USNM 25678 (fig. 44), USNM 25679+27680 (fig. 45). Subconglomerate, Pittston; donated by R.D. Lacoe.

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## LITERATURE CITED

CARLUCCIO, L. M., HUEBER, F. M., AND BANKS, H. P. 1966. *Archaeopteris macilenta*, anatomy and morphology of its frond. American Journal of Botany 54: 719-730.

CHALONER, W.G. & BOUREAUX, E. 1967. *Lycophyta*, in (E. Boureaux, Editor) Traite de Paleobotanique 2: 435-782.

DARRAH, W. C. 1969. A Critical Review of the Upper Pennsylvanian Floras of [the] Eastern United States with Notes on the Mazon Creek Flora of Illinois. W.C. Darrah, Gettysburg. 220 pp.

GOUBET, P., PFEFFERKORN, H., GILLESPIE, W. 2000. Neuralethopterids (Trigonocarpalean Pteridosperms) from the Early Pennsylvanian of Eastern North America. PaleoBios 20: 11-37.

LESQUEREUX, L. 1879. Atlas to the Coal Flora of Pennsylvania, and the Carboniferous Formation Throughout the United States. Board of Commissioners, *for* Second Geological Survey, Harrisburg. Second Geological Survey of Pennsylvania, Report of Progress. 85 pp. P1-P18, pls. A, B.

LESQUEREUX, L. 1880. Description of the Coal Flora of the Carboniferous Formation in Pennsylvania and Throughout the United States. Board of Commissioners, *for* Second Geological Survey, Harrisburg. Second Geological Survey of Pennsylvania, Report of Progress (2 vols.). 694 pp., pls. 86,87. Vol. I:1. Cellular cryptogamous plants, fungi, thalassophytes. 2. Vascular cryptogamous plants, Calamariae, Filicaceae (ferns). Vol. II: 1. Lycopodiaceae. 2. Sigillariae. 3. Gymnosperms.

LESQUEREUX, L. 1884. Description of the Coal Flora of the Carboniferous Formation in Pennsylvania and Throughout the United States. Board of Commissioners, *for* Second Geological Survey, Harrisburg. Second Geological Survey of Pennsylvania, Report of Progress. Pp. P695-P977, pls. 88-11.

LESQUEREUX, L. 1889. Fossil plant collection. Pp. 99-122 *in* Geological Survey of Pennsylvania, Catalogue of the Geological Museum, Part 3, Board of Commissioners, *for* the Geological Survey, Harrisburg.

MERRILL, G. P. 1907. Catalogue of the Type and Figured Specimens of Fossils, Minerals, and Ores. Government Printing Office, Washington. Bulletin of the United States National Museum, Bulletin 52, part 2: Fossil Vertebrates. 2. Fossil Plants. 3. Minerals, Rocks, and Ores. 370 pp.

SPAMER, E. E. 1988. Catalogue of type specimens of fossil plants in the Academy of Natural Sciences. Proceedings of the Academy of Natural Sciences of Philadelphia 140: 1-17.

SPAMER, E. E., LENDEMER, J. C. 2000. Type specimens of fossil plants in the Paleobotany Collection, of the Academy of Natural Sciences of Philadelphia — revised catalogue. Proceedings of the Academy of Natural Sciences of Philadelphia 150: 315-328.

STOCKMANS, F. 1933. Les Neuropteridees des Bassins houillers Belges (1e pt.), Memoirs of the Royal Museum of Natural History of Belgium 57: 1-61.

WATT, A. D. 1974. Catalog of Specimens Illustrated in the Lesquereux Coal Flora. Paleobotanical Section of the Botanical Society of America. University of Indiana, Bloomington, Indiana. 42 pp.

WHITE, D. 1899. Fossil flora of the Lower Coal Measures of Missouri. United States Geological Survey Monograph, No. 37.

APPENDIX A. List of taxa for which no types have been located. The taxa are listed alphabetically by genus in their original combinations as given by Lesquereaux.

| Taxon | Year Described |
|---|---|
| *Calamostachys praelongus* | 1880 |
| *Carpolithes minimus* | 1884 |
| *Conostrichus prolifer* | 1880 |
| *Cordaianthus scabar* | 1884 |
| *Cordaicarpus cinctus* | 1884 |
| *Cordaicarpus stabilis* | 1884 |
| *Dendrophycus desorii* | 1884 |
| *Halonia secreta* | 1880 |
| *Lepidocystis quadrangularis* | 1880 |
| *Lepidocystis obtusus* | 1880 |
| *Lepidodendron lanceolatum* | 1880 |
| *Lepidophyllum cultriforme* | 1884 |
| *Lepidostrobus aldrichii* | 1880 |
| *Lepidostrobus lacoei* | 1880 |
| *Lepidostrobus latus* | 1884 |
| *Lepidostrobus mansfieldi* | 1880 |
| *Lepidostrobus quadratus* | 1880 |
| *Lycopodites flexifolius* | 1884 |
| *Lycopodites ortoni* | 1880 |
| *Lycopodites strictus* | 1880 |
| *Megalopteris abbreviata* | 1880 |
| *Megalopteris rectinervis* | 1884 |
| *Megaphitum grand'euryi* | 1880 |
| *Neuropteris blissii* | 1884 |
| *Neuropteris carrii* | 1884 |
| *Neuropteris obscura* | 1880 |
| *Odontopteris affinis* | 1884 |
| *Odontopteris dilatata* | 1884 |
| *Pecopteris carrii* | 1884 |
| *Pecopteris obsoleta* | 1884 |
| *Pecopteris venulosa* | 1880 |
| *Pseudopecopteris denudata* | 1880 |
| *Rhabdocarpus emarginatus* | 1884 |
| *Rhabdocarpus howardi* | 1880 |
| *Sigillaria lorenzii* | 1880 |
| *Sphenopteris microcarpa* | 1880 |
| *Sphenopteris pseudo-murrayana* | 1880 |
| *Stemmatopteris schimperi* | 1880 |
| *Stigmaria amoena* | 1880 |
| *Trigonocarpus multistriatus* | 1884 |
| *Trigonocarpus saffordi* | 1880 |

APPENDIX B. List of taxa erected in the *Coal Flora* arranged alphabetically by genus in their original combinations as given by Lesquereaux. Species for which no type specimens have been located are listed separately in Appendix A.

*Althopteris amibgua*
*Alethopteris evansi*
*Alethopteris gibsoni*
*Alethopteris robusta*
*Annularia emersoni*
*Archaeopteris denticulata*
*Archaeopteris macilenta*
*Archaeopteris sphenophyllifolia*
*Asterophycus simplex*
*Asterophyllites fasciculatus*
*Calamites gracilis*
*Calamostachys brevifolia*
*Calamostachys lanceolata*
*Callipteridium aldrichi*
*Callipteridium ineaquale*
*Callipteridium mansfieldi*

*Callipteridium membranaceum*
*Callipteridium neuropteroides*
*Callipteridium pardei*
*Callipteridium rigidum*
*Cardiocarpus circularis*
*Cardiocarpus conglobatus*
*Cardiocarpus crassus*
*Cardiocarpus dilatatus*
*Cardiocarpus diminutivus*
*Cardiocarpus diplotesta*
*Cardiocarpus divergens*
*Cardiocarpus fasciculatus*
*Cardiocarpus harveyi*
*Cardiocarpus late-alatus*
*Cardiocarpus latior*
*Cardiocarpus longicollis*
*Cardiocarpus ovalis*
*Cardiocarpus pachytesta*
*Cardiocarpus patens*
*Cardiocarpus pusillus*
*Cardiocarpus simplex*
*Cardiocarpus specious*
*Cardiocarpus zonulatus*
*Carpolithes butlerianum*
*Carpolithes conicus*
*Carpolithes perpusillus*
*Carpolithes transsectus*
*Caulopteris giffordi*
*Caulopteris lacoei*
*Caultoperis mansfieldi*
*Conostrichus broadheadi*
*Cordaicarpus apiculatus*
*Cordaicarpus lineatus*
*Cordaicarpus ovalis*
*Cordaianthus dichotomus*
*Cordaianthus ebracteatus*
*Cordaianthus flexuosus*
*Cordaianthus ovatus*
*Cordaianthus rugosus*
*Cordaianthus spicatus*
*Cordaites lacoei*
*Cordaites radiatus*
*Danaeites emersoni*
*Dechenia striata*
*Dicranophyllum dichotomum*
*Dictyophytum ramosum*
*Eremopteris cheathami*
*Eremopteris microphylla*
*Eremopteris missouriensis*
*Equisetites gracilis*
*Halonia mansfieldi*
*Idiophyllum rotundifolium*
*Knorria compacta*
*Lepidocystis angularis*
*Lepidocystis lineatus*
*Lepidocystis pectinatus*
*Lepidodendron andrewsi*
*Lepidodendron brittsii*
*Lepidodendron cuspidatum*
*Lepidodendron cyclostigma*
*Lepidodendron latifolium*
*Lepidodendron rigidum*
*Lepidodendron scutatum*
*Lepidodendron squamiferum*
*Lepidophloios dilatatus*
*Lepidophloios icthyoderma*
*Lepidophloios sigillarioides*
*Lepidophyllum campbellianum*
*Lepidophyllum coriaceum*
*Lepidophyllum elegans*
*Lepidophyllum fallax*
*Lepidophyllum gracile*
*Lepidophyllum linearifolium*
*Lepidophyllum mansfieldi*
*Lepidophyllum minutum*
*Lepidophyllum morrisianum*
*Lepidophyllum stantoni*
*Lepidophyllum timidum*
*Lepidostrobus butleri*
*Lepidostrobus incertus*
*Lepidostrobus macrocystis*
*Lepidostrobus praelongus*
*Lepidostrobus salisburyi*
*Lepidostrobus spectabilis*
*Lesleya grandis*
*Lycopodites arborescens*
*Lycopodites lacoei*
*Lycopodites pendulus*
*Lycopodites simplex*
*Macrostachya communis*
*Macrostachya minor*
*Megalopteris dentata*
*Megalopteris faciculata*
*Megalopteris? marginata*
*Megalopteris serrata*
*Megalopteris southwelli*
*Neuropteris agassizi*
*Neuropteris anomala*
*Neuropteris aspera*
*Neuropteris biformis*
*Neuropteris callosa*
*Neuropteris decipiens*
*Neuropteris elrodi*
*Neuropteris griffithii*

*Neuropteris missouriensis*
*Neuropteris oblongifolia*
*Neuropteris smithsii*
*Neuropteris subfalcata*
*Odontopteris abbreviata*
*Odontopteris cornuta*
*Odontopteris monstruosa*
*Odontopteris patens*
*Odontopteris sphenopterioides*
*Odontopteris subcrenulata*
*Pecopteris clarkii*
*Pecopteris clintoni*
*Pecopteris georgiana*
*Pecopteris ornata*
*Pecopteris quadratifolia*
*Pecopteris robusta*
*Pecopteris serpillifolia*
*Pecopteris vestita*
*Pseudopecopteris dimorpha*
*Pseudopecopteris hispida*
*Pseudopecopteris speciosa*
*Pseudopecopteris subcrenulata*
*Rachiopteris squamosa*
*Rhabdocarpum mansfieldi*
*Rhabdocarpus abnormalis*
*Rhabdocarpus apiculatus*
*Rhabdocarpus cornutus*
*Rhabdocarpus inflatus*
*Rhabdocarpus insignis*
*Rhabdocarpus late-costatus*
*Rhabdocarpus mamillatus*
*Rhabdocarpus pachytesta*
*Rhabdocarpus sub-globosus*
*Rhabdocarpus tenax*
*Rhacophyllum corallinum*
*Rhacophyllum cornutum*
*Rhacophyllum expansum*
*Rhacophyllum fucoideum*
*Rhacophyllum hamulosum*
*Rhacophyllum membranaceum*
*Rhacophyllum spinosum*
*Rhacophyllum trichoideum*
*Rhacophyllum truncatum*
*Sigillaria grand'euyri*
*Sigillaria lacoei*
*Sigillaria leptoderma*
*Sigillaria leveretti*
*Sigillaria marginata*
*Sigillaria ovalis*
*Sigillaria pittstoniana*
*Sigillaria williamsi*
*Sorocladus ophioglossoides*
*Sphenopteris brittsii*
*Sphenopteris communis*
*Sphenopteris goniopteroides*
*Sphenopteris harveyi*
*Sphenopteris inaequilateralis*
*Sphenopteris royi*
*Sphenopteris solida*
*Sphenopteris tracyana*
*Spirangium intermedium*
*Spirangium multiplicatum*
*Sporocystis planus*
*Stemmatopteris anceps*
*Stemmatopteris angustata*
*Stemmatopteris cyclostigma*
*Stemmatopteris emarginata*
*Stemmatopteris hirsuta*
*Stemmatopteris microstigma*
*Stemmatopteris mimica*
*Stemmatopteris polita*
*Stemmatopteris squamosa*
*Taeniophyllum brevifolium*
*Taeniopteris smithsii*
*Taeniopteris truncata*
*Trigonocarpus adamsii*
*Trigonocarpus ampullaeformis*
*Trigonocarpus giffordi*
*Trigonocarpus grandis*
*Trigonocarpus kansaseanus*
*Trigonocarpus perpusillus*
*Trigonocarpus starkianus*
*Trigonocarpus subcylindricus*
*Trochophyllum clavatum*
*Volkmannia crassa*
*Volkamnnia fertilis*
*Whittleseya integrifolia*
*Whittleseya microphylla*

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# The Flora of Coastal Plain Pond Herbaceous Communities on the Delmarva Peninsula

William A. McAvoy and Peter Bowman
*Delaware Natural Heritage Program, Delaware Dept. of Natural Resources, Division of Fish & Wildlife, 4876 Hay Point Landing Rd, Smyrna DE 19977*
*wmcavoy@state.de.us pbowman@state.de.us*

ABSTRACT. Coastal plain ponds on the Delmarva Peninsula are ecologically unique wetlands that support a diverse assemblage of plant species and are a prominent part of the peninsula's natural heritage. As such, conservation of these wetlands is critical in helping to maintain biodiversity on Delmarva. Very little has been published regarding the vegetation associated with Delmarva coastal plain ponds, both in terms of the natural community types and the individual plant species that are closely associated with them. This paper provides a general description of the natural community types, or vegetation zones, found in Delmarva coastal plain ponds and focuses on the flora of the most diverse vegetation zone, the herbaceous community. Particular attention is given to the rare and uncommon flora of these wetlands. The summary of the flora of herbaceous communities in Delmarva coastal plain ponds provides strong evidence regarding their importance for biodiversity conservation on the peninsula.

## Introduction

Akin to the well known Carolina Bays of the southeastern U.S., coastal plain ponds on the Delmarva Peninsula (also known as Delmarva Bays or "whale wallows") are a unique type of shallow, seasonally flooded, freshwater depressional wetland. Generally elliptical in shape and often with a pronounced sandy rim along the southeast side, these wetlands are typically inundated in the winter and spring and draw down in late summer or early fall (Phillips and Shedlock 1993). They are most commonly found as open, sunny depressions within areas of forested uplands. The majority of these ponds are small (most are less than one acre in size), but they are numerous—it is estimated that there are between 1,500 and 2,500 of these ponds on the Delmarva Peninsula (Stolt and Rabenhorst 1987b; McAvoy and Clancy 1994; Zankel and Olivero 1999).

Coastal plain ponds are recognized as a highly significant part of the Delmarva Peninsula's natural heritage (Sipple and Klockner 1984; Tyndall et al. 1990; Sipple 1999). Their uncommon ecological context and features provide irreplaceable habitat for an abundance of rare and uncommon species and unique natural communities. On Delmarva, coastal plain ponds are known to harbor 45 rare and uncommon plant species, including eight globally rare species and one federally listed species. Coastal plain ponds are also among the most threatened natural systems on the peninsula, with hundreds of ponds having been degraded or destroyed by anthropogenic activities (e.g., agricultural ditching and clear-cut timber harvesting methods [McAvoy and Clancy 1994]). Despite the estimate of thousands of ponds

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occurring on Delmarva, it is often difficult to find ponds of good to high quality (i.e., with intact and functioning water regimes, open canopy, high species diversity, and rare and uncommon species).

Coastal plain ponds on Delmarva typically consist of concentric zones of herbaceous, shrub, and forest natural community types. The most significant and floristically diverse zone is the herbaceous community. It is within this community that a distinct assemblage of plant species is found, and where rare and uncommon species are encountered. The focus of this paper is on the flora of the herbaceous communities of coastal plain ponds on the Delmarva Peninsula.

## Distribution of Coastal Plain Ponds

Coastal plain ponds can be found from Florida to Massachusetts. They are most conspicuous in North and South Carolina (the "true" Carolina Bays), where they are typically at their largest and most uniform in shape and orientation (Savage 1982), although smaller, irregular ponds occur there as well (Sipple 1999). From Virginia northward, they are typically smaller (usually less than 1 acre), and more variable in shape (Savage 1982). Although most numerous in the Carolinas, they are still quite abundant on the Delmarva Peninsula. Rangewide, it has been estimated that there are as many as 500,000 coastal plain ponds between Florida and Massachusetts (Savage 1982).

On the Delmarva Peninsula, the greatest concentrations of coastal plain ponds can be found in southwestern New Castle and northwestern Kent Counties, Delaware, the western portions of Queen Annes and Kent Counties, Maryland, and Caroline County, Maryland (Stolt and Rabenhorst 1987b). Outside this region, coastal plain ponds on Delmarva are scattered and infrequent. They are also locally abundant in portions of Sussex County, Delaware and Dorchester County, Maryland.

The Delmarva Peninsula (Figure 1) is an area lying entirely within the Atlantic Coastal Plain physiographic province of the eastern United States. The Peninsula lies south of the Fall Line (a term applied to the boundary between the Appalachian Piedmont province and the Atlantic Coastal Plain) of New Castle County, Delaware and Cecil County, Maryland, and is bordered on the east by the Delaware River, Delaware Bay and the Atlantic Ocean, and on the west by the Elk River and Chesapeake Bay. It includes the Coastal Plain province of the state of Delaware (three counties), the Eastern Shore of Maryland (nine counties), and the Eastern Shore of Virginia (two counties).

## Origin of Coastal Plain Ponds

Despite decades of research and debate, the geologic origins of coastal plain ponds are still unresolved. The debate actually began in 1933 (Savage 1982), when Melton and Schriever proposed that the presence of Carolina Bays were actually the result of meteorite strikes. They argued that the incredible uniformity in shape and orientation, along with the presence of a raised sandy rim around each bay, indicated a single widespread phenomenon, with the impacts of meteorites being the most plausible explanation. Over the years, this theory has been highly controversial, with many strong arguments both for and against, and it still has many adherents to this day (Savage [1982] provides an excellent overview of the development of the theories on the origin of Carolina Bays).

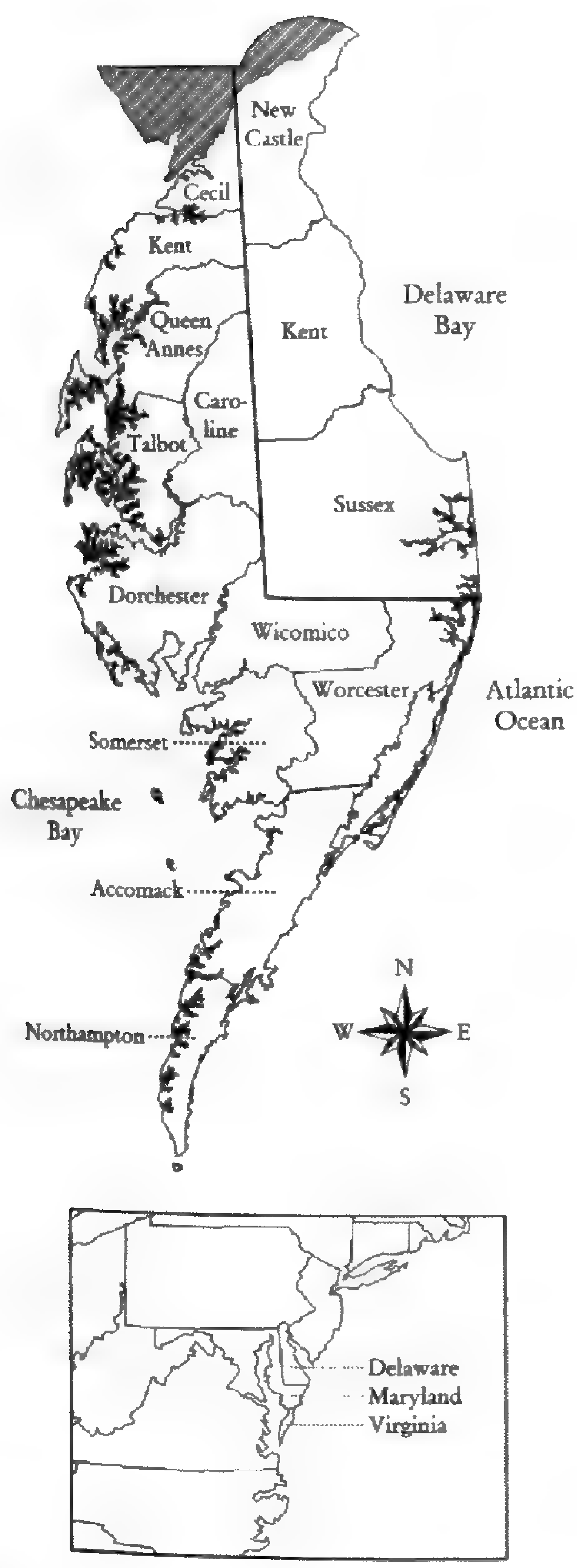


Figure 1. Delmarva Peninsula. Shaded areas of Cecil County, Maryland, and New Castle County, Delaware, are not part of the peninsula.

Whether or not the meteorite theory is true in the Carolinas, it is unlikely to be so on the Delmarva Peninsula (Stolt and Rabenhorst 1987b). The pond features that strengthen the meteorite theory—uniformity of shape and orientation, raised sandy rims, overlapping rims—are much less prevalent in coastal plain ponds on Delmarva. Currently, the most plausible theory is that Delmarva coastal plain ponds began forming between 15,000 and 20,000 years ago as depressions in coastal areas in a climate that was much colder and somewhat drier (Stolt and Rabenhorst 1987b). Stolt and Rabenhorst's theory suggests that strong winds created these depressions in unvegetated sandy dune areas and deposited the sand as the elevated rim found around many of the wetlands today.

## Geomorphology, Hydrology and Soils of Delmarva Coastal Plain Ponds

Stolt and Rabenhorst (1987a) identified two basic types of coastal plain ponds on the Delmarva Peninsula: the basin-fill and the sandy bottom. Of the two types, the basin-fill ponds are generally deeper, with steeper slopes extending down to distinct low areas. These low areas are usually filled with loess deposits—silty loam material that was originally deposited by the wind when the ponds were forming. These basin-fill deposits are typically 1 to 3 m deep, but may be as deep as 5 m. The second pond type, the sandy bottom, usually has some basin-fill sediments as well, but in much smaller amounts. The sandy bottom ponds typically have a relatively flat bottom, with a thin layer of mucky loam over deep sands.

The two pond types also appear to differ in distribution. The steep-sided, basin-fill type is found in the northern part of the peninsula, especially in the southwestern region of New Castle County, Delaware and western Kent County, Maryland (pers. obs. by the first author; Frank Hirst and Ron Wilson, pers. comm.). As one moves south into Queen Annes and Caroline Counties, the sandy, flat-bottom ponds start appearing, and are the prevalent pond type in southern Delmarva (pers. obs. by the first author; Frank Hirst and Ron Wilson, pers. comm.).

In a study of hydrology in coastal plain ponds in Delaware, Phillips and Shedlock (1993) state that Delmarva coastal plain ponds function as seasonally inundated wetlands. Typically, they are full in the winter, often to a depth of more than 1 m. In the summer, as temperature and evapotranspiration increase, the water level drops. The amount and the timing of drawdown depend on annual weather patterns, with the substrate being completely exposed in hotter, drier years. In wetter, cooler years, many ponds remain inundated (though not full) throughout the summer.

Studies of water chemistry in Delmarva coastal plain ponds have typically found the waters to be very soft and acidic (Stolt and Rabenhorst 1987a; Newman and Schalles 1990). Rasmussen (1958) reported near neutral (6.2 to 7.1) pH values for a site in Sussex County, Delaware; Phillips and Shedlock (1993) found the pH to be below 5.0 at sites in southwestern New Castle County, Delaware.

## Delmarva Coastal Plain Pond Natural Communities

Historically, the vegetation dynamics of Delmarva coastal plain ponds have been poorly documented, although a few studies have been conducted in recent years (Tyndall et al 1990; Berdine and Gould 1999; Tyndall 2000). The natural vegetation communities of Delmarva coastal plain ponds cover a wide range of variation, from closed-canopy forests to dense shrublands to communities dominated by herbaceous plants (Berdine and Gould 1999). Most commonly, these different community types occur as a complex of concentric vegetation zones within an individual pond (Tyndall et al 1990; Berdine and Gould 1999; Tyndall 2000). The center of the pond is usually open and dominated by herbaceous species. Moving away from the center and toward the upland perimeter of the pond, there is typically a transition to a shrub-dominated zone and finally to a forested community. Each of these zones is defined by the Delaware and Maryland Natural Heritage Programs as an individual community type (i.e., comprised of a characteristic suite of dominant plant species occurring in a consistent, repeating pattern on the landscape). Although zones are defined as individual community types, they occur as a complex, which exhibit repeating patterns from pond to pond. However, it is possible to find Delmarva coastal plain ponds that have succeeded to purely shrub or forest communities, although they are less common than the pattern described above (pers. obs. by the first author).

### *FOREST COMMUNITIES*

Forested communities can occupy the entire depression, but more frequently are found at the perimeters of pond openings. Whether they dominate the depression or are at the periphery, these communities typically have a rather dense shrub layer of *Clethra alnifolia, Vaccinium corymbosum, Rhododendron viscosum* and *Leucothoe racemosa*, and are usually very low in herbaceous species diversity. The canopy is typically composed of *Acer rubrum, Liquidambar styraciflua, Nyssa sylvatica, Pinus taeda* (in southern Delmarva), *Quercus palustris,* and *Quercus phellos* (Berdine and Gould 1999; Bowman 2000).

### *SHRUB COMMUNITIES*

There are several shrub communities that occupy Delmarva coastal plain ponds, but they all feature the same shrub species: buttonbush (*Cephalanthus occidentalis*). This extremely wide-ranging species can be found in a variety of wetland habitat types throughout the peninsula, but is characteristic for Delmarva coastal plain ponds (pers. obs. by the first author). In many cases, buttonbush is the sole dominant in the pond, and essentially forms a monoculture with few other species present (Bowman 2000).

### *HERBACEOUS COMMUNITIES*

Delmarva coastal plain pond herbaceous communities (DCPPHC) are unique wetland community types on the peninsula. Classifying these communities is often a challenge, as species composition and abundance can vary significantly from year to year in individual ponds (pers. obs. by the first author; Ron Wilson, pers. comm.). These fluctuations in species composition and abundance are almost certainly attributable to variation in precipitation and temperature. However, no studies to date have looked at the correlation between species composition and weather data.

Despite these challenges, numerous attempts have been made to describe DCPPHCs, with various studies identifying five to ten different types (Tyndall et al. 1990; McAvoy and Clancy 1994; Berdine and Gould 1999). While it is beyond the scope of this paper to describe these various communities, it is worth noting that these studies have identified differences between communities occupying basin-fill ponds and sandy-bottom ponds. There seems to be a greater variety of sandy-bottom pond communities (Bowman 2000), and these communities often have species with a southern affinity as dominants or co-dominants (Table 1). These species are much less common in the basin-fill type ponds (pers. obs. by the first author; Frank Hirst and Ron Wilson, pers. comm.).

## THE VASCULAR FLORA OF DELMARVA COASTAL PLAIN POND HERBACEOUS COMMUNITIES

The vascular flora of DCPPHCs (Table 1) is based primarily on observations made through the years by the first author while visiting an abundance of coastal plain ponds throughout the peninsula. A site visit usually consisted of traversing through the DCPPHC while recording each species observed. Certain sites that were high in species diversity or contained rare and uncommon taxa were visited annually to record observations on species assemblages and the presence/absence of rare and uncommon taxa. Voucher specimens were frequently collected and deposited in the herbarium of the Delaware Natural Heritage Program. In the future, these specimens will be transferred to the Claude E. Phillips Herbarium, Delaware State University (DOV; herbarium acronyms follow Holmgren et al. 1990). The vascular flora of DCPPHCs is also based on consultations with knowledgeable individuals (primarily Frank Hirst and Ron Wilson), natural community data from the Delaware and Maryland Natural Heritage Programs (McAvoy and Clancy 1994; Berdine and Gould 1999; Bowman 2000), herbarium specimens (primarily PH and DOV), and the literature (Tatnall 1946; Sipple and Klockner 1984; Tyndall et al. 1990; Tyndall 2000).

The flora of DCPPHCs includes 78 native species and varieties of vascular plants, represented by 22 families and 41 genera (Table 1). The largest families are Cyperaceae with 29 species and Poaceae with 15 species. The largest genera represented are *Carex* (9 species) and *Rhynchospora* (8 species). Graminoids (grasses, sedges, and rushes) comprise the majority of herbaceous plants with 47 species, or 62% of the typical flora of DCPPHCs. Eighty-five percent of the typical flora of DCPPHCs are perennials (66 species) and 16% (12 species) are annuals.

Twelve species appear to be regionally restricted to DCPPHCs (Table 1), and have not been collected from any other habitat type on the peninsula (Tatnall 1946; rare species databases of the Delaware and Maryland Natural Heritage Programs; pers. obs. by the first author; Frank Hirst and Ron Wilson, pers. comm.).

The DCPPHC flora has strong affinities to the southeastern U.S., as 43 species (55%) have a more southern distribution, (i.e., are at or near the northern limits of their natural geographic distribution [Table 1]). In contrast, only ten species of the 78 (13%) have a more northern distribution (i.e., are at or near the southern limits of their natural geographic distribution [Table 1]). Species range-wide distribution data are based on Gleason and Cronquist (1991).

There appear to be differences in species composition between the sandy, flat-bottom type and the steep-sided, basin-fill type of coastal plain pond on the Delmarva Peninsula. Forty species occur primarily within the DCPPHC of the sandy, flat-bottom type and are only rarely found in the steep-sided, basin-fill type (Table 1; pers. obs. by the first author; Frank Hirst and Ron Wilson, pers. comm.). Of these, 33 species have southern affinities and only 3 species have northern affinities. In contrast, there are 16 species that occur primarily in the steep-sided, basin-fill type and are only rarely found in the sandy, flat-bottom type (Table 1; pers. obs. by the first author; Frank Hirst and Ron Wilson, pers. comm.). Of these 16, five have northern affinities and only three species have southern affinities. Twenty-two species are common to both pond types.

## Rare and Uncommon Plants of Delmarva Coastal Plain Pond Herbaceous Communities

Delmarva coastal plain pond herbaceous communities contain a high number of rare and uncommon plant taxa. The data presented below provide strong evidence that conservation of this unique wetland type is critical in helping to maintain biodiversity on the Delmarva Peninsula.

Based on rare species data from the Delaware and Maryland Natural Heritage Programs, to date, 45 species known to be associated with DCPPHCs are considered to be rare and uncommon (Table 1; rare and uncommon species are known from only 1 to 100 populations and are based on standardized criteria developed by The Nature Conservancy). This represents 58% of the flora typical of this community type. The 45 rare and uncommon species include 8 that are classified as globally rare by The Nature Conservancy (Table 1). In addition, one species is listed by the U.S. Fish and Wildlife Service as endangered (*Oxypolis canbyi*). All 12 of the species that appear to be restricted to DCPPHCs (Table 1) are considered to be rare and uncommon. Of these, 6 are known from only a single occurrence on the peninsula (Table 1). Of the 40 species that primarily occur in the sandy, flat-bottom pond type, 32 species are rare and uncommon. Of the 16 species that primarily occur in the steep-sided, basin-fill pond type, 11 species are rare and uncommon. The families Cyperaceae (18 species), and Poaceae (9 species) represent the majority of the rare and uncommon flora. The genera *Carex* (7 species) and *Rhynchospora* (6 species) contain the largest number of rare and uncommon species.

In addition, at least four species now thought to be extirpated on the Delmarva Peninsula may have occurred in coastal plain ponds historically: *Juncus elliotii* Chapman, *Lobelia boykinii* Torrey & Gray ex A. DC., *Polygala cymosa* Walt., and *Polygala ramosa* Ell. These species are all known from a single, or very few, collections from the Ellendale area of Sussex County, Delaware. Although extant coastal plain ponds still occur near Ellendale, extensive ditching and land conversion over time has degraded any remaining natural habitat. Habitat descriptions on historical specimen labels usually refer to "meadows" and "ditches," which do not specifically describe coastal plain pond habitat. However, these species are often found in coastal plain ponds in other regions within their distribution

TABLE 1. Flora of Delmarva Coastal Plain Pond Herbaceous Communities.

The list is arranged alphabetically by family. With some exceptions, nomenclature follows Kartesz (1994). Synonyms are listed in brackets where necessary for clarification. Taxa considered to be rare and uncommon on the Delmarva Peninsula by the Delaware and Maryland Natural Heritage Programs are highlighted in bold. The following indicators follow the scientific name: G = considered to be globally rare by The Nature Conservancy, a private international conservation organization (globally rare species are known from only 1 to 100 populations worldwide); 1 = known from only a single occurrence or population on Delmarva; R = restricted to DCPPHCs on Delmarva; S-B = occurs primarily in sandy, flat-bottom type ponds on Delmarva (when no indicator is given, the species is common to both pond types); B-F = occurs primarily in steep-sided, basin-fill type ponds on Delmarva; S = southern affinities; N = northern affinities.

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ALISMATACEAE
**_Sagittaria graminea_ Michx. var. _graminea_ (S-B)**
APIACEAE
**_Oxypolis canbyi_ (Coult. & Rose) Fern. (G, 1, R, S-B, S)**
ASTERACEAE
*Bidens frondosa* L.
**_Boltonia asteroides_ (L.) L'Her. (S-B, S)**
**_Coreopsis rosea_ Nutt. (G, R, S-B, N)**
**_Sclerolepsis uniflora_ (Walt.) B.S.P. (S-B, S)**
BLECHNACEAE
*Woodwardia virginica* (L.) Sm.
CAMPANULACEAE
**_Lobelia canbyi_ Gray (S-B, S)**
CLUSIACEAE
**_Hypericum adpressum_ Raf. ex W. Bart. (G, S-B, S)**
**_Hypericum denticulatum_ Walt. (S-B, S)**
*Hypericum mutilum* L.
CYPERACEAE
**_Carex barrattii_ Schwein. & Torr. (B-F)**
**_Carex bullata_ Schkuhr ex Willd. (B-F)**
**_Carex gigantea_ Rudge (B-F, S)**
**_Carex joorii_ Bailey (S-B, S)**
**_Carex lupuliformis_ Sartwell ex Dewey (B-F)**
*Carex lupulina* Muhl. ex Willd.
**_Carex pellita_ Muhl. ex Willd. (B-F, N)** [*Carex lanuginosa* Michx. misapplied]
*Carex striata* Michx. var. *brevis* Bailey
**_Carex vesicaria_ L. (B-F, N)**
*Cladium mariscoides* (Muhl.) Torr. (S-B)
*Cyperus erythrorhizos* Muhl. (N)
*Dulichium arundinaceum* (L.) Britt.
**_Eleocharis melanocarpa_ Torr. (S-B, S)**
*Eleocharis microcarpa* Torr. (S)
*Eleocharis quadrangulata* (Michx.) Roemer & J.A. Schultes (S-B, S)
**_Eleocharis robbinsii_ Oakes (S-B)**
**_Eleocharis tricostata_ Torr. (S-B, S)**
*Fimbristylis autumnalis* (L.) Roemer & J.A. Schultes
**_Fimbristylis perpusilla_ Harper ex Small & Britt. (G, R, B-F, S)**

Table 1 (*cont'd*)

*Rhynchospora chalarocephala* Fern. & Gale (S-B, S)
***Rhynchospora corniculata*** **(Lam.) Gray (S)**
***Rhynchospora filifolia*** **Gray (1, R, S-B, S)**
***Rhynchospora harperi*** **Small (G, S-B, S)**
***Rhynchospora inundata*** **(Oakes) Fern. (S-B, N)**
*Rhynchospora macrostachya* Torr. ex Gray var. *macrostachya* (S)
***Rhynchospora nitens*** **(Vahl) Gray (S-B, S)** [*Psilocarya nitens* (Vahl) Wood]
***Rhynchospora scirpoides*** **(Torr.) Gray (S-B, N)** [*Psilocarya scirpoides* Torr.]
*Scirpus cyperinus* (L.) Kunth
***Scleria reticularis*** **Michx. (S-B, S)**
GENTIANACEAE
***Sabatia difformis*** **(L.) Druce (S-B, S)**
HAEMODORACEAE
***Lachnanthes caroliana*** **(Lam.) Dandy (S-B, S)**
HALORAGACEAE
*Proserpinaca pectinata* Lam.
JUNCACEAE
*Juncus canadensis* J. Gay ex Laharpe (N)
*Juncus debilis* Gray (S)
*Juncus repens* Michx. (S)
LAURACEAE
***Litsea aestivalis*** **(L.) Fernald (G, 1, R, S-B, S)**
LENTIBULARIACEAE
***Utricularia fibrosa*** **Britt. (S-B, S)**
*Utricularia geminiscapa* Benj. (B-F, N)
*Utricularia gibba* L. (B-F)
***Utricularia inflata*** **Walt. (S-B, S)**
***Utricularia purpurea*** **Walt. (S-B)**
*Utricularia radiata* Small (S-B, S)
MELASTOMATACEAE
***Rhexia aristosa*** **Britt. (S-B, S)**
*Rhexia virginica* L.
NYMPHAEACEAE
*Nymphaea odorata* Ait. ssp. *odorata*
ONAGRACEAE
*Ludwigia linearis* Walt. (S-B, S)
*Ludwigia sphaerocarpa* Ell.
POACEAE
***Coelorachis rugosa*** **(Nutt.) Nash (R, S-B, S)** [*Manisuris rugosa* (Nutt.) Kuntle]
***Dichanthelium hirstii*** **(Swallen) Kartesz, comb. nov. (G, 1, R, S-B, S)** [*Panicum hirstii* Swallen]
*Dichanthelium spretum* (J.A. Schultes) Freckmann (S-B) [*Panicum spretum* J.A. Schultes]
***Dichanthelium wrightianum*** **(Scribn.) Freckmann (S-B, S)** [*Panicum wrightianum* Scribn.]
***Eragrostis hypnoides*** **(Lam.) B.S.P. (R, B-F)**
*Glyceria acutiflora* Torr. (R, B-F, N)
*Glyceria septentrionalis* A.S. Hitchc. (B-F)
***Leersia hexandra*** **Sw. (1, R, S-B, S)**
***Muhlenbergia torreyana*** **(J.A. Schultes) A.S. Hitchc. (G, 1, R, S-B, S)**
*Panicum dichotomiflorum* Michx. (B-F)
***Panicum hemitomon*** **J.A. Schultes (S-B, S)**

Table 1 (*cont'd*)

*Panicum rigidulum* Bosc ex Nees var. *pubescens* (Vasey) Lelong (S-B, S) [*Panicum longifolium* Torr.]
*Panicum verrucosum* Muhl. (S)
***Paspalum dissectum* (L.) L. (S)**
*Saccharum giganteum* (Walt.) Pers. (S-B, S) [*Erianthus giganteus* (Walt.) P. Beauv.]
POLYGONACEAE
*Polygonum amphibium* L. var. *emersum* Michx. (B-F) [*Polygonum coccineum* Muhl. ex Willd.]
PRIMULACEAE
***Hottonia inflata* Ell. (B-F, S)**
RANUNCULACEAE
***Ranunculus flabellaris* Raf. (R, B-F, N)**
RUBIACEAE
*Oldenlandia uniflora* L. ( S)
XYRIDACEAE
***Xyris smalliana* Nash (S-B, S)**

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Table 2. Additional rare and uncommon plant species documented from DCPPHCs that are not typical for the community type on Delmarva.

*Amphicarpum purshii* Kunth
*Asclepias lanceolata* Walt.
*Carex typhina* Michx.
*Centella erecta* (L. f.) Fern.
*Eriocaulon compressum* Lam.
*Euthamia tenuifolia* (Pursh) Nutt. var. *microcephala* Greene
*Fuirena squarrosa* Michx.
*Iris prismatica* Pursh ex Ker-Gawl.
*Juncus pelocarpus* E. Mey.
*Nymphoides cordata* (Ell.) Fern.
*Polygala cruciata* L. var. *aquilonia* Fern. & Schub.
*Rhynchospora cephalantha* Gray var. *cephalantha*
*Rhynchospora cephalantha* Gray var. *microcephala* (Britt.) Kukenth.
*Sagittaria engelmanniana* J.G. Sm.
*Trachelospermum difforme* (Walt.) Gray

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(Godfrey and Wooten 1981; Weakley 1999). Therefore, it is highly likely that they did occur in coastal plain ponds on Delmarva prior to human disturbance. Another species, also thought to be extirpated on Delmarva, *Echinodorus parvulus* Engelm., may also have been collected from a coastal plain pond. The habitat description given on the specimen label is, "border of pond, Canterbury" (*W. Canby*, 1874, Kent County, Delaware, PH). At present, a small complex of degraded coastal plain ponds still exists in the Canterbury area, but field surveys by the first author have failed to rediscover *E. parvulus* at this site. Lacking clear documentation that the these five species actually occurred in coastal plain ponds on Delmarva, and with no evidence that they still occur anywhere on Delmarva, they were not included on the overall species list (Table 1).

An additional 15 species of rare and uncommon plants have been documented from DCPPHCs (Table 2), but their occurrence in this community type is anomalous, for they are usually found in other wetland types on the peninsula (Tatnall 1946; pers. obs. by the first author; Frank Hirst and Ron Wilson, pers. comm.).

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## Literature Cited

Berdine, M. A., and A. M. A. Gould. 1999. Identification and Protection of Reference Wetland Natural Communities in Maryland: Delmarva Bay Wetlands. Maryland Department of Natural Resources, Annapolis. 87 pp.

Bowman, P. 2000. The Natural Communities of Delaware: DRAFT. Unpublished report by the Delaware Natural Heritage Program, Dover. 70 pp.

Gleason, H. A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada, 2nd ed. The New York Botanical Garden, Bronx, NY.

Godfrey, R. K., and J. W. Wooten. 1981. Aquatic and Wetland Plants of the Southeastern United States, Dicotyledons and Monocotyledons. Universtiy of Georgia Press, Athens, GA.

Holmgren, P. K., N. H. Holmgren and L. C. Barnett. 1990. Index Herbariorum Part I: the Herbaria of the World, 8th ed. New York Botanical Garden, Bronx, NY.

Kartesz, J. 1994. A Synonymized Checklist of the Vascular Flora of the United States, Canada and Greenland, 2nd ed. Vol. I. Timber Press, Portland, OR. 622 pp.

McAvoy, W. A., and K. E. Clancy. 1994. Community classification and mapping criteria for category I interdunal swales and coastal plain pond wetlands in Delaware. Unpublished report by the Delaware Natural Heritage Program, Dover.

Newman, M. C., and J. F. Schalles. 1990. The water chemistry of Carolina bays: a regional survey. Archiv für Hydrobiologie 118: 146-168.

Phillips, P. J., and R. J. Shedlock. 1993. Hydrology and chemistry of groundwater and seasonal ponds in the Atlantic Coastal Plain in Delaware, USA. Journal of Hydrology 141: 157-178.

Rasmussen, W. C. 1958. Geology and hydrology of the "bays" and basins of Delaware. Doctoral Dissertation, Bryn Mawr College, Bryn Mawr, Pennsylvania. 206 pp.

Savage, H. 1982. The Mysterious Carolina Bays. University of South Carolina Press, Columbia. 121 pp.

Sipple, W. S. 1999. Days Afield: Exploring Wetlands in the Chesapeake Bay Region. Gateway Press, Inc., Baltimore.

Sipple, W. S., and W. A. Klockner. 1984. Uncommon wetlands in the coastal plain of Maryland. Pp. 111-138 *in* Norden, A. W., D. C. Forester, and G. H. Fenwick (eds). Threatened and Endangered Plants and Animals of Maryland. Maryland Natural Heritage Program, Department of Natural Resources, Annapolis.

Stolt, M. H., and M. C. Rabenhorst. 1987a. Carolina bays on the Eastern Shore of Maryland: I. Soil characterization and classification. Soil Science Society of America Journal 51: 394-398.

Stolt, M. H., and M. C. Rabenhorst. 1987b. Carolina bays on the Eastern Shore of Maryland: II. Distribution and origin. Soil Science Society of America Journal 51: 399-405.

Tatnall, R. 1946. Flora of Delaware and the Eastern Shore. The Society of Natural History of

Delaware, Wilmington.

TYNDALL, R. W. 2000. Vegetation change in a Carolina bay on the Delmarva Peninsula of Maryland during an eleven-year period (1987-1997). Castanea 65: 155-164.

TYNDALL, R. W., K. A. MCCARTHY, J. C. LUDWIG, AND A. ROME. 1990. Vegetation of six Carolina bays in Maryland. Castanea 55: 1-21.

WEAKLEY, A. S. 1999. Flora of the Carolinas and Virginia, working draft of 19 January 1999. The Nature Conservancy, Southeast Regional Office, Southern Conservation Science Department, Chapel Hill, NC. 833 pp.

ZANKEL, M., AND A. OLIVERO. 1999. Mapping and assessing the conservation status of Delmarva bay wetlands in Delaware. Unpublished report by the Eastern Conservation Office of The Nature Conservancy, Boston. 28 pp.

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# *Carex* (Cyperaceae) in the Potomac River Gorge of Maryland, Virginia, and the District of Columbia

CHRISTOPHER LEA
*National Park Service, 7206 National Seashore Lane, Berlin, MD 21811*
*chris_lea@nps.gov*

CHRISTOPHER T. FRYE
*Maryland Department of Natural Resources, Wildlife and Heritage Service, Tawes State Office Building, E-1, 580 Taylor Avenue, Annapolis, MD 21401*

A field survey and herbarium search for taxa of the genus *Carex* (Cyperaceae) were conducted for the Potomac River Gorge from 1995 through 2000. In the 120 years prior to this study (1875-1994), 77 taxa had been documented from the gorge. Eighty-two taxa were found during the current fieldwork; 13 of these are new to this historically well-collected area. The total *Carex* flora for the gorge now consists of 90 taxa representing 81 species. *Carex corrugata* and *Carex laxiculmis* var. *copulata* are reported for the first time from Maryland, and 6 taxa are newly reported from the District of Columbia. Additional new records for Montgomery County, Maryland and Fairfax and Arlington Counties, Virginia are noted. Phytogeographical and ecological affinities of taxa groups are discussed. An annotated checklist of taxa, with notes on local and regional distribution, habitat, and taxonomic issues, is presented.

## INTRODUCTION

The Fall Line gorge of the Potomac River is an area of geological, scenic, and biological interest. This steep-sided, high-gradient reach begins at the intersection of the Coastal Plain and Piedmont physiographic provinces in Washington, D.C. and Arlington County, Virginia. It extends upstream some 24 km as the boundary between Montgomery County, Maryland and Fairfax County, Virginia to Great Falls, a series of spectacular cataracts.

The Potomac Gorge is also ecologically and floristically diverse, as authors of the late nineteenth and early twentieth century noted (Ward, 1881; Hitchcock and Standley, 1919). McAtee (1918) described the unusual mix of Piedmont and Coastal Plain floristic elements here. The long association of the Washington Biologists' Field Club with Plummers Island ensured that some level of botanical exploration continued throughout the middle part of the twentieth century, although herbaria records indicate that this was reduced after 1930. Creation of Natural Heritage Programs in Maryland (1979), Virginia (1986), and the District of Columbia (1994) brought new recognition of the gorge as a significant site for biodiversity and for conservation of state and regionally rare vascular plants (Rawinski, 1989). Bartgis et al. (1993) noted records of 110 state rare species from the Maryland side of the gorge.

Although the botanical elements of this diverse area were relatively well represented in early floras of the Washington, D.C. area (Ward, 1881; Hitchcock and Standley, 1919) pub-

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lished accounts or even formal listings of vascular plants of the gorge itself have been surprisingly few. Terrell (1970) gave an account of spring-blooming flora of the Maryland-District of Columbia side of the gorge, while Grimshaw and Bradley (1973) documented the vascular flora of Great Falls Park on the Virginia side. In the 1980s and 1990s, Natural Heritage Program surveys documented a number of rare plant occurrences, but generally in internal or interagency reports.

The genus *Carex* (Cyperaceae) is by far the most species-rich vascular plant genus in most areas of temperate eastern North America (e.g., Harvill, 1973; Reznicek and Ball, 1974; Wheeler and Ownbey, 1984; Reznicek, 1989). Brown and Brown (1984) reported 145 species (154 total taxa) for Maryland. For Virginia, Harvill et al. (1992) list 137 species, a total that is conservative in comparison because of the relatively broad concepts of a number of species employed by the authors. Despite the considerable representation of the genus in the floras of many areas, the ecologies, distributions, abundances, and, in some cases, systematics of the various taxa are often poorly known. The large number of taxa and overall complexity of the genus, the poorly understood systematics of some groups, the somewhat inconspicuous aspect of the plants themselves, and the relatively short seasonal period during which reliable identifications can be made are all problems that mandate a level of taxonomic study and effort often impractical for many general field surveys of vascular flora. Despite these problems, carices are of floristic and conservation interest and are often well represented in lists of rare, threatened, and endangered species (Reznicek, 1989). Seventy-seven species of *Carex* have been listed as being of some level of conservation concern in Maryland (Maryland Natural Heritage Program, 1994), although ongoing research (Frye and Lea, 2001) suggests that a number of these are not rare in the state.

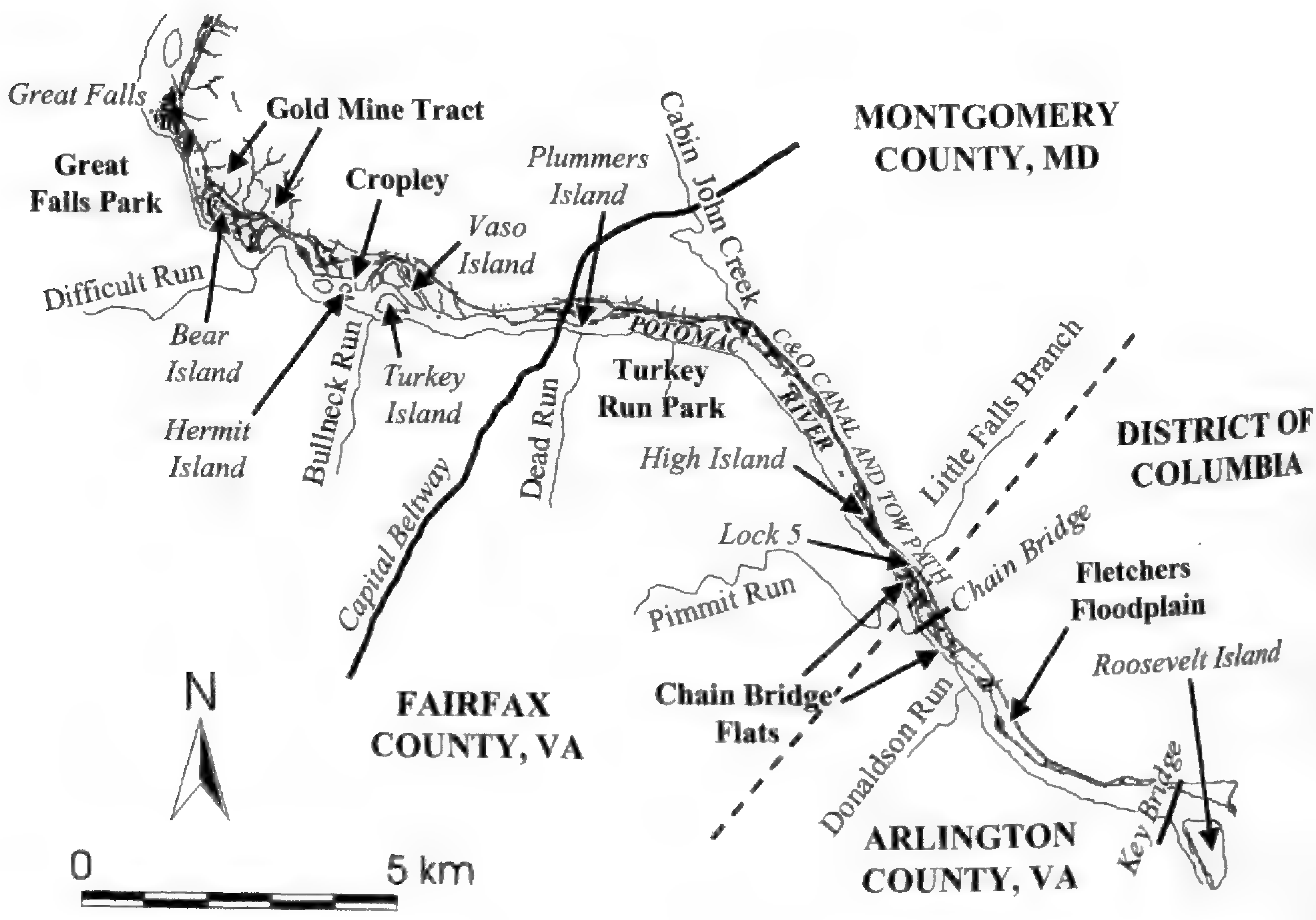


Figure 1. Potomac River Gorge, showing place names appearing in text.

Documentations of *Carex* in the Potomac Gorge prior to 1995 suggest that there were knowledge gaps about the floristics of the genus that were similar to those described for areas of New England by Reznicek (1989). Terrell (1970) found 15 species in the lower Chesapeake and Ohio (C&O) Canal National Historical Park, 11 of which occurred in the Potomac Gorge, while Grimshaw and Bradley (1973) compiled 10 species for Great Falls Park, on the Virginia side of the gorge. In contrast, Hitchcock and Standley (1919) previously had listed 95 species of *Carex* for the vicinity of Washington, D.C., an area that included the valley of the Potomac below Great Falls. It was evident that organized floristic and ecological information on *Carex* in the gorge was substantially incomplete.

## Description of the Potomac River Gorge

The area of this study encompasses lands along the 24-km reach of the Potomac River from Theodore Roosevelt Island, which lies at the head of the estuarine section of the Potomac on the Fall Line, upstream to Great Falls (Figure 1). The study area extends generally 1 km from the river on both sides to the rim of the gorge, approximately to an elevation of 100 m above sea level, and to equivalent elevations in tributary stream valleys. Most fieldwork was conducted on lands managed by the National Park Service (C&O Canal National Historical Park on the Maryland-District of Columbia side and Great Falls Park, Turkey Run Park, the George Washington Memorial Parkway, and Theodore Roosevelt Island on the Virginia side). Small amounts of fieldwork occurred in county parks and on other private lands.

The gorge is a Fall Line feature formed by accelerated rates of erosion of the river's bed as it responded to fluctuations in sea level during the Pleistocene. The resistant nature of the underlying crystalline metamorphic rock in this section of the Piedmont has produced bedrock-controlled features such as falls, rapids, exposed rock outcrops, and steep topography. Modern (Holocene) floodplains and other depositional features are less extensive than on the lower gradient reaches of the Potomac upstream and downstream from the gorge. Terraces (former floodplains that are rarely to never flooded) of various elevations and of Pleistocene age or older are prominent. More complete descriptions of the geology and geomorphology of the gorge are given by Reed at al. (1970) and Tormey (1980).

Recent research (Lea, 2000) has classified and described the diverse, often unusual vascular plant communities of the gorge and described the strong influence of fluvial processes on soils and vegetation. Occasionally, the influence of the underlying bedrock is expressed in a site's flora, such as in the presence of bosophiles on soils over amphibolite, a mafic rock. Although much of the riparian zone in the gorge supports forests similar to those of other large river floodplains in the mid-Atlantic region, higher gradient sections have unusual, scour-influenced plant communities that include riverside prairies, open, grassy woodlands, and xeric, rocky forests. These are concentrated in the 4-km reach immediately downstream from Great Falls (the Mather Gorge) and the 4 km centered on Chain Bridge (Chain Bridge Flats). The C&O Canal, restored as a shallow waterway parallel to the Potomac River throughout the Maryland–District of Columbia side of the study area, provides wet, open habitat similar to pond edges, while its associated towpath, with its mowed edges, provides a weedy, open corridor, as may occur along roadsides.

## Methods

The objectives of the study were to record as many *Carex* taxa as possible in the Potomac Gorge, to describe the distribution, habitat, and relative abundance of each, and to provide information for more extensive research on *Carex* in Maryland and the District of Columbia (Frye and Lea, 2001). To locate and examine vouchers for the gorge and to plan fieldwork, the authors searched the collections of GMUF, MARY, NA, PH, and US (acronyms follow Holmgren et al., 1990) and (with acronyms as assigned here and in lower case letters) those of the Maryland Department of Natural Resources in Annapolis, Maryland (Tawes), the Cylburn Arboretum in Baltimore, Maryland (Cylb), the National Park Service at Great Falls Park, Great Falls, Virginia (Grfa), and the U.S. Geological Survey Water Resource Division in Reston, Virginia (Usgs). The first author observed and collected some *Carex* between 1994 and 1999, pursuant to other research (Lea, 2000). Field surveys, primarily by the first author, were conducted on foot, throughout the study area, with emphasis of the Maryland-District of Columbia side of the gorge. A canoe was occasionally employed to reach river islands. Fieldwork was conducted between April 8 and July 20 each year and totaled 12 days in 1999, 14 days in 2000, and a somewhat fewer number of days each year from 1995 to 1998.

Individual *Carex* plants were identified in the field, and notes were made of the location, habitat, and relative abundance of each taxon. Specimens were collected as needed to facilitate identification or as vouchers if a taxon were not previously recorded from the study area or the applicable political jurisdiction. A 30-power dissecting microscope with an ocular micrometer often assisted laboratory examination, and voucher specimens from collections were used for comparison. Both authors examined all voucher specimens collected during fieldwork, and specialists, particularly A. A. Reznicek (MICH), provided assistance with some determinations.

## Results and Discussion

### Summary of Floristic Findings, Including Significant Taxa

Ninety taxa representing 81 species were confirmed from both field and collections research. Of these, 13 taxa are newly reported for the Potomac Gorge (Table 1). Nine taxa that had been historically collected there (*Carex annectens* var. *xanthocarpa*, *C. davisii*, *C. decomposita*, *C. glaucodea*, *C. hystericina*, *Carex muhlenbergii* var. *muhlenbergii*, *C. pallescens*, *C. pellita*, and *C. seorsa*) were not found by the current fieldwork. New records were determined for Montgomery County and for the District of Columbia based on existing herbarium vouchers. New records for Fairfax and Arlington Counties were based largely on Harvill et al. (1992). New jurisdictional records are summarized in Table 1. *Carex corrugata* and *Carex laxiculmis* var. *copulata* are newly reported for Maryland.

Nine species previously documented from the gorge were considered historical (presumed extirpated) from Maryland at the beginning of this study (Maryland Natural Heritage Program, 1994). Of these, five (*C. aggregata*, *C. careyana*, *C. conjuncta*, *C. leavenworthii*, and *C. striatula*) were relocated in the gorge by this study (and in other Maryland locations during the same period), and two (*C. davisii* and *C. decomposita*) were not (*C. davisii* has been rediscovered elsewhere in Maryland). We found that previous reports of the remaining two historical taxa (*C. tenera* and *C. tetanica*) had been based on misidentified material, although *C. tenera* was subsequently found in the gorge, for the first time, during this study. Additionally, a tenth species considered historical for the state, *C. woodii*, was also found

Table 1. Additions to *Carex* flora of three counties, District of Columbia, and Potomac Gorge, this study.

| Jurisdiction (and no. of new taxonomic records) | | New Taxonomic Records | |
|---|---|---|---|
| District of Columbia | 6 | *Carex caroliniana*<br>*Carex cristatella*<br>*Carex granularis* var. *haleana* | *Carex grayi*<br>*Carex stipata* var. *maxima*<br>*Carex typhina* |
| Montgomery County | 8 | *Carex brevior*<br>*Carex corruguata**<br>*Carex digitalis* var. *macropoda*<br>*Carex emoryi* | *Carex laxiculmis* var. *copulata**<br>*Carex lupuliformis*<br>*Carex tonsa* var. *rugosperma*<br>*Carex stipata* var. *maxima* |
| Fairfax County | 3 | *Carex conjuncta*<br>*Carex emoryi* | *Carex oligocarpa* |
| Arlington County | 3 | *Carex emoryi*<br>*Carex grayi* | *Carex nigromarginata* |
| Potomac Gorge | 13 | *Carex albicans* var. *emmonsii*<br>*Carex brevior*<br>*Carex corrugata**<br>*Carex debilis* (var. *debilis*)<br>*Carex debilis* var. *macrocarpa*<br>*Carex laxiculmis* var. *copulata**<br>*Carex lupuliformis* | *Carex stipata* var. *maxima*<br>*Carex stricta*<br>*Carex tenera*<br>*Carex tonsa* var. *rugosperma*<br>*Carex typhina*<br>*Carex woodii* |

*Addition to Maryland flora

for the first time in the gorge during this study (and has been relocated elsewhere in Maryland).

## Phytogeographical Aspects

Based on other research on *Carex* in Maryland and the District of Columbia (Frye and Lea, 2001), we note several phytogeographical patterns of the Potomac Gorge *Carex* flora. Definitions of physiographic provinces follow Schmidt (1993).

All taxa found by this study are native to eastern North America and, probably, to Maryland. Patterns of collections suggest that *Carex aggregata* may have entered, or expanded its range in, our area due to human activities.

Of the 90 taxa found, 37 (41%) are widely distributed in Maryland. These include both taxa found in most or all major regions of the state (e.g., *Carex cephalophora*, *C. lurida*, *C. tribuloides*, *C. vulpinoidea*) and those widespread in the Piedmont and Coastal Plain, but largely absent from the Appalachian Mountains (e.g., *Carex umbellata*).

Forty-two taxa (47%) show a preference for, or a restriction to, the Piedmont or Appalachian Mountains. These include taxa that also occur on the Coastal Plain west of the Chesapeake Bay (e.g., *Carex grayi*, *C. prasina*, *C. squarrosa*, *C. willdenowii*), taxa that are widespread west of the Fall Line, but more strictly limited to that area (e.g., *Carex conjuncta*, *C. gracillima*, *C. normalis*), taxa known exclusively from the Piedmont or nearly so (e.g., *Carex bushii*, *C. hystericina*, *C. planispicata*), taxa that are more characteristically Appalachian (e.g., *Carex leptalea* ssp. *leptalea*, *C. tonsa* var. *rugosperma*, *C. torta*, *C. woodii*), and several primarily restricted to the valleys of the Potomac and Susquehanna Rivers (e.g., *C. cristatella*, *C. davisii*, *C. emoryi*, *C. jamesii*, *C. shortiana*).

Eleven taxa (12%) are characteristic of the Coastal Plain, with most of these reaching their western limit along the Fall Line areas of Piedmont rivers. Most seem to be more abruptly restricted by the Fall Line than do many of their Piedmont counterparts. These taxa include *Carex albolutescens*, *C. complanata*, *C. crinita* var. *brevicrinis*, *C. seorsa*, and *C. styloflexa*.

## Habitat Descriptions

We describe seven typical habitats in the gorge and their *Carex* flora. Nomenclature of taxa in genera other than *Carex* follows Gleason and Cronquist (1991). More detailed descriptions of vascular plant communities in for the gorge are given by Lea (2000).

Dry-mesic upland forests: Never-flooded upland forests, generally dominated by oaks (including *Quercus rubra*, *Q. alba*, and *Q. velutina*) and other tree species of well-drained, mildly acidic soils (*Fagus grandifolia*, *Acer rubrum*, *Nyssa sylvatica*, *Liriodendron tulipifera*, *Cornus florida*). Typical *Carex* of this habitat include *C. albicans* var. *albicans*, *C. cephalophora*, *C. digitalis* var. *digitalis*, *C. laxiculmis* var. *laxiculmis*, *C. rosea*, and *C. virescens*.

Xeric forests and woodlands: Never-flooded upland forests on shallow, apparently acidic soils and dominated by *Quercus prinus*. Also, flood-scoured, rocky woodlands, dominated by *Pinus virginiana* and oaks (*Quercus rubra*, *Q. prinus*, and *Q. stellata*), and scoured riverside "prairies," dominated by bunchgrasses such as *Andropogon gerardii*, *Schizachyrium scoparium*, *Panicum virgatum* and by shrubby dry-land tree species. Both of the latter situations occur on bedrock (strath) terraces and are maintained by infrequent floods with high current velocities. For all xeric forests and woodlands, the *Carex* flora is relatively depauperate, but distinctive, and includes *C. albicans* var. *emmonsii*, *C. nigromarginata*, *C. tonsa* var. *tonsa*, and *C. umbellata*.

Bedrock terrace forests: Dry, rich forests over shallow soils of bedrock terraces influenced by rare, scouring floods. These occur primarily in the vicinity of Bear Island. Dominant tree species include several oaks (*Quercus rubra*, *Q. prinus*, and *Q. alba*), *Carya glabra*, *Fraxinus americana*, *Juniperus virginiana*, and *Ostrya virginiana*. The *Carex* flora is diverse and includes *C. albicans* var. *albicans*, *C. cephalophora*, *C. hirsutella*, *C. laxiculmis* var. *laxiculmis*, *C. nigromarginata*, *C. pensylvanica*, *C. planispicata*, *C. retroflexa*, *C. swanii*, *C. willdenowii*, and *C. woodii*.

Floodplain and alluvial terrace forests: Regularly flooded alluvial forests on true floodplains in lower gradient reaches of the gorge, dominated by flood-tolerant tree species, including *Platanus occidentalis*, *Acer saccharinum*, *Acer negundo*, *Fraxinus pennsylvanica*, and *Ulmus americana*. Also, mesophytic forests with *Fraxinus americana*, *Liriodendron tulipifera*, *Acer saccharum*, *Celtis occidentalis*, *Tilia americana*, *Juglans nigra*, *Carya cordiformis*, and *Ulmus* spp. on more elevated, less frequently flooded terraces with sandy, well-drained soils. The *Carex* flora includes *C. amphibola*, *C. blanda*, *C. grayi*, *C. grisea*, *C. jamesii*, and *C. radiata*, with *C. careyana*, *C. oligocarpa*, and *C. sparganioides* present only in the mesophytic forests.

Scoured woodlands: Rocky riparian woodlands scoured by frequent floods and growing on the active channel shelf, a gently sloping riparian feature that is developed at a level below that of floodplain (Osterkamp and Hupp, 1984) and is unusually extensive at the Chain Bridge Flats. These woodlands are dominated by stunted flood-tolerant trees (*Quercus* *bicolor*, *Fraxinus pennsylvanica*, *Acer negundo*, *Platanus occidentalis*, *Diospyros virginiana*, *Ulmus americana*, *Juglans nigra*, and *Betula nigra*) and meadow-forming grasses (*Chasmanthium latifolium*, *Elymus* spp., *Panicum clandestinum*). Members of *Carex* are well represented in this habitat, being generally concentrated in moist, scoured depressions, with 23 species counted in one 10-$m^2$ swale. Typical taxa include *C. amphibola*, *C. blanda*, *C. conjuncta*, *C. crinita*, *C. frankii*, *C. granularis*, *C. grisea*, *C. leavenworthii*, *C. lupulina*, *C. lurida*, *C. normalis*, *C. radiata*, *C. scoparia*, *C. shortiana*, *C. squarrosa*, *C. stipata* var. *stipata*, *C. tribuloides*, and *C. vulpinoidea*.

Forested vernal pools: Poorly drained depressions, primarily in the upper section of the gorge on bedrock terraces, holding water in winter and early spring, drying by summer, and occupied by hydric vegetation, including *Acer rubrum* and *Nyssa sylvatica*. The *Carex* flora is fairly distinctive, with a number of taxa of primarily Coastal Plain affinity, including *C. albolutescens*, *C. annectens* var. *annectens*, *C. caroliniana*, *C. debilis* var. *debilis*, *C. intumescens*, and *C. typhina*.

Seepages and spring runs: Moist to mucky soils along drainages in upland forests. The *Carex* flora includes *C. laevivaginata*, *C. prasina*, *C. radiata*, and *C. styloflexa*.

With over one-half of Maryland's and Virginia's total *Carex* flora represented, the Potomac Gorge is clearly a significant and diverse site for this group, as it has been so recognized for vascular plants in general. Within this restricted area, the floristic and habitat diversity allows the opportunity to gain insight into the ecological and taxonomic patterns of a large portion of each state's complement of this large and relatively understudied genus.

## Annotated List of Taxa

Our treatment of taxa generally follows Rhoads and Block (2000). Treatment of taxa not listed for Pennsylvania by those authors follows Fernald (1950), with the following exceptions: the *Carex albicans* complex (*C. artitecta* Mackenzie, *C. emmonsii* Dewey *in* Torrey, and *C. physorhyncha* Liebman of Fernald, 1950) follows Rettig (1990), and *C. tribuloides* var. *sangemonensis* follows Mackenzie (1931).

Our assessment of the relative abundance of a taxon is:

*Common*: easily found in appropriate habitat and usually will be noted by general botanical surveys.
*Frequent*: more than 10 occurrences seen; if fewer than 10, occurrences have large numbers of plants.
*Infrequent*: 4 to 10 occurrences seen; habitat often specialized or limited.
*Rare*: 1 to 3 occurrences seen, usually with small numbers of individuals.
*Historical*: At least one collection from earlier than 1995 seen, but not found in the current fieldwork.

A habitat description (as described above or in a more generalized manner) for each taxon is provided. A discussion of distribution (if restricted within the gorge), regional conservation status, and taxonomic concerns follows, as applicable. The local seasonal period for finding phenologies optimal for identification (i.e., when infructescences of most plants are mature, but not senescing) is listed; in some cases, these periods may be conservatively narrow because of the small number of specimens available for evaluation. A list of voucher specimen collection numbers and repositories, comprehensive for the fieldwork of this study and also including some representative pre-1995 collections (for infrequent, rare, and historical taxa) appears at the end of each taxon entry. All collection numbers without an associated collector name are those of the first author and represent material from the current fieldwork. Repositories are designated as in the Methods section and also include the Frostburg State University herbarium, Frostburg, Maryland (Frost), the Anne Arundel Community College herbarium, Arnold, Maryland (Aacc), and the Delaware Natural Heritage Program herbarium in Smyrna, Delaware (Dnhp). Vouchers at US will be found in the Washington, D.C. and vicinity collection (including the Plummers Island collection).

*Carex aggregata* MacKenzie

Frequent. In open areas in dry woods and less commonly on floodplains. Also in disturbed soil, such as along C&O Canal towpath. It has been listed as historical for Maryland (Maryland Natural Heritage Program, 1994). It has been found recently to be a relatively common species in the state and has been often misidentified or overlooked. Mid-May to mid-June. *484*, *1479* (US); *1488* (MARY); *1561* (GMUF, Grfa); *870*, *1020*, *s.n.* (Tawes); *s.n.* (Aacc).

*Carex albicans* Willdenow *ex* Sprengel var. *albicans*

Common. In dry to dry-mesic upland forests and rich bedrock terrace forests. One of our most abundant taxa. Also treated as *C. artitecta* Mackenzie, it occurs in more rich or mesic (but still dry) forests than var. *emmonsii*. Evidently included under *C. emmonsii* Dewey by Hitchcock and Standley (1919). Mid-April to mid-May. *429*, *1340* (US); *1448* (MARY); *779*, *790* (Tawes); *952*, *1345* (Frost); *773* (Aacc).

*Carex albicans* Willdenow *ex* Sprengel var. *emmonsii* (Dewey) Rettig

Infrequent. In dry, acidic forests, usually under *Quercus prinus*. Vaso and Hermit Islands, Donaldson Run ravine, Great Falls Park (Virginia). Often treated as *Carex emmonsii* Dewey *in* Torrey. This is the first report of the taxon for the Potomac Gorge. Mid-April to mid-May. *436* (US); *442* (MARY); *950* (Tawes); *1333* (Grfa).

*Carex albolutescens* Schweinitz

Frequent. Edges of forested vernal pools, where it is one of the characteristic taxa. Hitchcock and Standley (1919) have misapplied the name *C. straminea* to this species, while *C. albolutescens* of Hitchcock and Standley (1919) evidently represents *C. longii* Mackenzie, a Coastal Plain species. Mid-May to late June. *1261*, *1485*, *1924* (US); *1925* (MARY); *1240*, *1246* (Tawes); *1709* (Grfa).

*Carex albursina* Sheldon

Rare. In mesophytic alluvial terrace forests. Found in small numbers at Bear, Vaso, and High Islands; more numerous at Turkey Run Park. *C. albursina* is a calciphilic species that is rare in the Piedmont, where it is apparently restricted to the Potomac and Susquehanna valleys. Early May to late May. *1455* (US); *452* (MARY); *880* (Tawes).

*Carex amphibola* Steudel

Common. In floodplain and rich dry-mesic upland forests. This taxon was treated as *Carex amphibola* Steudel var. *rigida* (Bailey) Fernald by Fernald (1950), but is now considered the type of *C. amphibola* (Naczi, 1999). Early May to mid-June. *1028*, *1048*, *1116*, *1263*, *1482* (US); *1204* (MARY); *1178* (Tawes); *1087*, *1491* (Frost); *1012* (Aacc).

*Carex annectens* (Bicknell) Bicknell var. *annectens*

Frequent. Primarily along edges of forested vernal pools, where it is a characteristic taxon. Also in other open or disturbed wet areas, in apparently more acidic situations than *C. vulpinoidea*. Mid-May to mid-June. *453, 1695, 1704* (US); *1694, 1931* (MARY); *883, 1251* (Tawes); *2090* (Grfa).

*Carex annectens* (Bicknell) Bicknell var. *xanthocarpa* (Bicknell) Wiegand

Historical. Single collection in 1932 (det. by F. J. Hermann) from Plummers Island, with habitat given as "barrens" (most likely, flood-scoured bedrock). Sometimes treated as *Carex brachyglossa* Mackenzie, it is said to occur in more basic soils than the typical variety (Weakley, 1999). Late May. *Killip 32611* (US).

*Carex atlantica* Bailey. ssp. *atlantica*

Rare. Along spring run. A single station found in the Gold Mine Tract, found. There are two historical collections (from the same date) from 1899, both possibly from the present station, and a third from 1915 from the edge of a pool on the mainland opposite Plummers Island. Early May to early June. *1599, Morris s.n., Pollard s.n., Standley 11663* (US); *1597* (MARY).

*Carex blanda* Dewey

Common. In a variety of forests and open, often disturbed, habitats, but most common on floodplains. One of our most frequently encountered *Carex* species. Late April to early June. *894, 1037, 1947* (US); *757* (MARY); *460, 466, 857, 998* (Tawes); *875* (Frost); *886* (Aacc); *1469* (Grfa).

*Carex brevior* (Dewey) Mackenzie *ex* Lunnell

Rare. Seen at a single location in bedrock terrace forest, Bear Island. This is the first report of *C. brevior* for the Potomac Gorge and for Montgomery County. Mid-May. *1590* (Tawes).

*Carex bushii* Mackenzie

Rare. Found at a single station on Olmsted Island (Maryland side of Great Falls), in dry riverside "prairie." Also known historically from the "District line, Dalecarlia" (vicinity of Little Falls Branch) in 1897 and from "open flat ground, Ft. Ethan Allen" (near rim of gorge near Fairfax-Arlington County line) in 1929. Late May to early June. *Steele s.n.* (US); *1932* (MARY); *Hasselbring s.n.* (NA).

*Carex careyana* Torrey *ex* Dewey

Infrequent. In rich mesophytic forests on alluvial terraces. Considered historical for Maryland (Maryland Natural Heritage Program, 1994), it was rediscovered in the state during this survey. About 12 stations in the gorge, mostly upstream from the Capital Beltway, are now known, though it is not numerous at any site. This distinctive sedge can be identified in winter by its wide, purple-based leaves. Late April to mid-May. *G. Fleming 8885* (GMUF); *797* (Tawes); *1330* (Grfa); *Sigafoos 612* (Usgs).

*Carex caroliniana* Schweinitz

Infrequent. Edges of forested vernal pools, Bear Island and Great Falls Park (Virginia) and in floodplain forest dominated by *Quercus phellos* at Fletchers Floodplain. This is the first

District of Columbia record for *C. caroliniana*. Mid-May to early June. *1588, 1692* (US); *1581, 1691* (MARY); *1693* (Tawes); *1711* (Grfa); *Baltars 3909* (Cylb).

*Carex cephalophora* Muhlenberg *ex* Willdenow

Common in dry-mesic upland forests and in rich bedrock terrace forests, less so in floodplain forests. Mid-May to late June. *1066, 1162, 1232, 1483, 1593, 1700* (US); *1161, 1698, 1919* (MARY); *1031, 1202* (Tawes); *1160, 1218, 1699, 1701, 1919* (Frost); *1030, 1252* (Aacc); *1715* (Grfa).

*Carex communis* Bailey var. *communis*

Infrequent. In dry-mesic forest, usually on steep slopes with bare soil or exposed rock. Turkey Run Park, High Island, and in ravines of Donaldson Run, Bullneck Run, and Cabin John Creek. Late April to mid-May. *968, 1445, 1454* (US); *992* (MICH, Tawes).

*Carex comosa* F. Boott

Infrequent. In wet open areas, including edges of C&O Canal and in an open fresh tidal swamp. Seen along canal at Bear Island and Cropley and at Roosevelt Island. Early June to early July. *1224, 1254* (US); *1223* (MARY); *1093* (MICH); *1091* (Tawes); *536* (Frost).

*Carex complanata* Torrey & Hooker

Infrequent. In bedrock terrace forests and along edges of vernal pools, Bear Island, Olmsted Island (Maryland side of Great Falls), and Great Falls Park (Virginia) and in floodplain forest dominated by *Quercus phellos* at Fletchers Floodplain. Difficult to distinguish from similar taxa (*C. bushii, C. caroliniana, C. hirsutella*), and specimens from this group are frequently misidentified in collections. Mid-May to early June. *869, 872* (US); *1585* (MARY); *1710* (Grfa).

*Carex conjuncta* F. Boott

Frequent. In moist swales in channel shelf woodlands, less frequently in shaded floodplain forests. Formerly regarded as historical in Maryland (Maryland Natural Heritage Program, 1994). Now known to be fairly widely distributed in the Piedmont and Ridge and Valley provinces in the state. Chain Bridge Flats may be an important population center for this species, which is evidently uncommon in the region. This is the first report of *C. conjuncta* for Fairfax County. Mid-May to late June. *1098* (US); *1089* (MICH); *1702* (GMUF); *735, 1094, 1159* (Tawes); *533* (Frost); *2091* (Grfa).

*Carex corrugata* Fernald

Rare. Found only in mesophytic alluvial terrace forest along Maryland side of Potomac, just above the Capital Beltway. A second specimen was collected as *C. grisea* from "rich open ground" at Cropley in 1929. Very similar to *C. amphibola* (from which it is distinguished by the truncate apex of its achene) and to *C. grisea* (from which it is distinguished by its longer stipe). These and specimens we have collected in other areas of Maryland represent the first reports of *C. corrugata* from the state (Frye and Lea, 2001). Mid-May. *Blake 10839* (US); *877* (Tawes).

*Carex crinita* Lamarck var. *brevicrinis* Fernald

Frequent. In moist swales in floodplain forests, in forested swamps, and along edges of ponds and the C&O Canal. Mostly restricted to the Coastal Plain in Maryland, where it is the more frequently encountered variety of *C. crinita*. Mid-May to mid-June. *1574* (US); *1573* (MARY); *550, 1198* (Tawes); *2083* (Grfa).

*Carex crinita* Lamarck var. *crinita*

Common. In similar habitat as var. *brevicrinis*. The dominant variety of *C. crinita* in the Piedmont and the Appalachian Mountains of Maryland. Mid-May to mid-June. *1477, 1572* (US); *1081, 1478* (MARY); *1568* (GMUF); *1567* (Grfa).

*Carex cristatella* Britton

Rare. In moist swales in open channel-shelf woodlands at Chain Bridge Flats, in open fresh tidal swamp at Roosevelt Island, and in marsh at edge of canal near Cropley. Historically found along Difficult Run and at Plummers Island. This is the first report of this species for the District of Columbia. Late May to early July. *1072, 2094* (US); *1197, 1212* (MARY); *1214* (MICH); *1220* (Tawes); *2095* (Frost).

*Carex davisii* Schweinitz & Torrey

Historical. Known from a single collection in 1905 from "among rocks at Great Falls of the Potomac, Maryland." This species was known from only one other collection in Maryland and was considered historical for the state (Maryland Natural Heritage Program, 1994) until 2000, when it was found in two locations, one along the Potomac about 40 km upstream from the Potomac Gorge. It has not been recorded from Virginia. It is rare in the mid-Atlantic states, where it occurs in rich alluvial woods and meadows. Late May to early June. *Holm s.n.* (US).

*Carex debilis* Michaux var. *debilis*

Infrequent. Edges of forested vernal pools and along spring runs. Bear and Vaso Islands, Great Falls Park (Virginia), and near Plummers Island. This is the first record for *C. debilis* in the Potomac Gorge. *451, 1466, 1484* (US); *1580* (MARY); *888* (Tawes); *1466* (Grfa).

*Carex decomposita* Muhlenberg

Historical. Apparently occurred along edges of forested vernal pools or other wetlands. There are several collections at US and NA (dating from 1878 to 1920), from the Widewater area (section of C&O Canal along Bear Island). These are the only Maryland records for *C. decomposita*. Specific search efforts were made for this species in the locations and general habitat described in historical collections. Since this large, distinctive sedge has also not been seen in recent rare plant surveys in the area, it may well be locally extirpated. *C. decomposita* is considered historical for Maryland (Frye and Lea, 2001) and rare in Virginia (Killeffer, 1999). Late May to early July. *Holm s.n., Killip 7108, Maxon 6334, Pollard s.n.* (US); *Chase 7552* (NA).

*Carex digitalis* Willdenow var. *digitalis*

Common in dry-mesic to mesic upland forests, less so in rich bedrock terrace forests. A characteristic upland forest taxon in this area. Early May to mid-June. *1032, 1118, 1441* (US); *867, 1165* (Tawes).

*Carex digitalis* Willdenow var. *macropoda* Fernald

Rare. In rich, dry forests. Found on Bear and Vaso Islands, and in ravine of Cabin John Creek. The dominant form of *C. digitalis* on the Coastal Plain to the south of Maryland, it reaches its apparent northern limit in Maryland, where, contrary to Brown and Brown (1984), it is much less common than var. *digitalis*. Distinguished from var. *digitalis* primarily by its long-peduncled spikes; we have not noted the coralline-knotty rhizomes described by Fernald (1950). In Maryland and in the gorge, apparently prefers more basic soils than typical *C. digitalis*. This is the first report of the taxon from Montgomery County and from the Potomac Gorge. Early May to mid-June. *439, 1065* (Tawes).

*Carex emoryi* Dewey

Frequent. On rocky, scoured river bars and frequently flooded channel-shelf woodlands, where it can form extensive stoloniferous colonies, as at Chain Bridge Flats and High Island. Also in an open fresh tidal swamp at Roosevelt Island. Often, relatively few plants in a colony will flower. We report here the first records for *C. emoryi* for Montgomery, Fairfax, and Arlington Counties. Mid-May to late May. *474, 1557* (US); *1586* (MARY); *1053, 1168* (MICH); *1109, 1558* (GMUF); *1059, 1083, 1109, 1167* (Tawes); *1136, 1686* (Frost); *1052* (Aacc).

*Carex festucacea* Schkuhr *ex* Willdenow

Rare. In floodplain forest, Fletchers Floodplain and in rich bedrock terrace forests near Cropley; historically recorded from Great Falls, Maryland. There had been only one previous collection of *C. festucacea* from the gorge (in 1907, originally misidentified as *C. tenera*). Mid-May to mid-June. *1596, 1696, Shreve 1464* (US); *1920* (MARY).

*Carex frankii* Kunth

Common. In moist, open areas, including scoured channel shelf woodlands, open floodplain forests, wet meadows, bedrock pools along the river, ditches, and other disturbed wetlands. Early June to late July. *482, 1101, 1943* (US); *967, 1199* (Tawes).

*Carex glaucodea* Tuckerman

Historical. Known from a single collection, in 1893 near the Aqueduct Bridge, Virginia (near present-day Key Bridge in Arlington County) in "shaded places in woods." This species, sometimes treated as *Carex flaccosperma* Dewey var. *glaucodea* (Tuckerman) Kükenthal, is found in dry calcareous or mafic upland soils in Maryland. In the gorge, it may occur over amphibolite. Late May to early June. *Holm s.n.* (US).

*Carex gracilescens* Steudel

Rare. In early successional upland forest dominated by *Liriodendron tulipifera*. Seen only in Difficult Run stream valley. Historically collected from Bear Island and Little Falls Branch. This species is locally common along smaller stream valleys in the Maryland Piedmont and may be more frequent along tributary streams than along the Potomac. Hitchcock and Standley (1919) treat it as *C. laxiflora* Lam. (misapplied to this species). Late April to early June. *1384* (US, Grfa); *Holm s.n., Maxon & Standley 325, Ward s.n.* (US).

*Carex gracillima* Schweinitz

Infrequent. In rich, dry-mesic forests along tributary streams to the Potomac and in mesophytic alluvial terrace forests along the Potomac's main stem. Found at Bear Island, Great Falls Park (Virginia), and in the ravines of Cabin John Creek, Bullneck Run, and Pimmit Run. Early May to early June. *1374* (MARY); *956* (GMUF); *1451* (Frost).

*Carex granularis* Muhlenberg *ex* Willdenow var. *granularis*

Frequent. In moist, scoured woodlands and open floodplain forests. Primarily at Chain Bridge Flats. Early May to late-June. *813* (US); *1057, 1577* (MARY); *962, 1124* (Tawes); *1936* (Frost); *730* (Aacc).

*Carex granularis* Muhlenberg *ex* Willdenow var. *haleana* (Olney) Porter

Infrequent. Chain Bridge Flats and Roosevelt Island, in habitat similar to that of, and usually with, the typical variety. Well-marked specimens occur in the gorge and are clearly differentiated from typical *C. granularis* (and have been confused with other taxa). As is reported from elsewhere, intermediate forms (e.g., *1937* [US, MARY, Tawes]) often are found growing with this and the typical variety and cast some doubt upon the validity of this taxon. This is the first record of var. *haleana* for the District of Columbia. Mid-May to late June. *1127, 1938, Ward s.n.* (US); *1938* (MARY); *1938* (GMUF); *1102* (MICH); *961, 1100* (Tawes); *1936* (Frost); *1056* (Aacc).

*Carex grayi* Carey

Frequent. In floodplain forests, most frequently on fine-textured (silt loam) soils and in shade. Most plants seen would fit the more southern var. *hispidula* Gray (see Fernald, 1950), a dubious taxon (Mohlenbrock, 1999). We report the species, for the first time, from the District of Columbia and Arlington County. Late May to mid-July. *1076*; *1121, 1703* (US); *1149, s.n.* (MARY); *1122* (Frost); *1077* (Aacc).

*Carex grisea* Wahlenberg

Common. In floodplain forests, open, moist woodlands, and disturbed areas. This species, sometimes treated as *Carex amphibola* Steudel var. *turgida* Fernald, is distinguished from *C. amphibola* by its more inflated perigynia, which are rounded (not trigonous) in cross-section. It is more restricted to floodplains than is *C. amphibola*. Early May to mid-June. *993, 1018, 1021, 1047* (US); *1050, 1155* (MARY); *1051, 1131* (MICH); *1103, 1458* (GMUF); *472, 1017, 1046, 1078, 1092, 1132* (Tawes); *995, 997, 1200, 1450* (Frost); *1019, 1049* (Aacc).

*Carex hirsutella* Mackenzie

Infrequent. In bedrock terrace forests. Found only at Bear Island, where somewhat common. Mid-May to early June. *1582* (US); *1584* (MARY); *881* (Tawes).

*Carex hirtifolia* Mackenzie

Infrequent. In rich bedrock terrace and mesophytic alluvial terrace forests. Turkey Run Park, Great Falls Park (Virginia), Bear and High Islands, and ravine of Cabin John Creek. Early May to mid-June. *1447, 1459* (US); *1462* (GMUF); *731, 1027* (Tawes); *1559* (Grfa); *884* (Aacc).

*Carex hitchcockiana* Dewey

Rare. Mesophytic alluvial terrace forests and dry-mesic upland forests over amphibolite. Found only at Turkey Run Park and at Turkey Island. A species of calcareous or mafic soils. Early May to early June. *Vasey s.n.* (US); *1941* (GMUF); *759* (Tawes).

*Carex hystericina* Muhlenberg *ex* Willdenow

Historical. Found below Chain Bridge in 1881 and at Lock 5 in 1899. A species of open, nutrient-rich wetlands. Late May to early June. *Steele s.n., Ward s.n.* (US).

*Carex intumescens* Rudge

Frequent. Edges of forested vernal pools, where it is a characteristic species. Early May to late July. *450, 1236, 2084* (US); *1245* (MARY); *1714* (Grfa).

*Carex jamesii* Schweinitz

Common. In floodplain forests and open channel-shelf woodlands, most frequently on finer-textured (silt loam) soils. A species of calcareous soils that is narrowly restricted to the Potomac River corridor in this area. Late April to mid-June. *464, 1337* (US); *465, 1137* (Tawes); *1560* (Grfa); *1044B* (Frost).

*Carex laevivaginata* (Kükenthal) MacKenzie

Frequent. In wet, often mucky soils in swamps, floodplain forests, and seepages, and along spring runs. Usually in more shaded situations than the similar *C. stipata*. Mid-May to late June. *960, 1206, 1219* (US); *972* (MARY); *1564* (Grfa).

*Carex laxiculmis* Schweinitz var. *copulata* (Bailey) Fernald

Rare. In rich mesophytic forests on alluvial terraces. Found at Turkey Run Park and Bear Island. This somewhat obscure taxon appears morphologically intermediate between typical *C. laxiculmis* and *C. digitalis*, with pistillate spikes like those of the former and leaf width and color like those of the latter. Fernald (1950) considered it to be a hybrid between those two species, a view not shared by Mackenzie (1931), nor supported by limited systematic research (Manhart, 1986). Rhoads and Klein (1993) consider it a calciphile; its habitat here and that given for specimens at GMUF from other Virginia locations support this evaluation. This is the first record of *C. laxiculmis* var. *copulata* for the Potomac Gorge and for Maryland. Late April to early June. *1942, 1945* (US); *1463* (GMUF); *1946* (MICH); *1376, 1921* (Tawes).

*Carex laxiculmis* Schweinitz var *laxiculmis*

Common. In dry-mesic, often rich, upland forests and in mesophytic alluvial terrace forests. Late April to early June. *885, 1142* (US); *891* (Tawes); *1470* (Grfa).

*Carex laxiflora* Lamarck

Infrequent. In rich dry-mesic forests, often in ravines or on steep slopes with bare soil exposed. Found at High Island, in the Gold Mine Tract, and in several tributary stream valleys on the Virginia side, usually in small numbers. Both wide and narrow-leaved plants occur. Treated as *C. anceps* Muhlenberg by Hitchcock and Standley (1919). *C. laxiflora* of Hitchcock and Standley (1919) evidently refers to *C. gracilescens*. Late April to early June. *1383, 1453* (US); *1379* (MARY); *1024* (Tawes).

*Carex leavenworthii* Dewey

Infrequent. In low, disturbed areas, including open, channel-shelf woodlands, dry riverside prairies, and in openings in floodplain forests. Found at Bear, High, and Roosevelt Islands, Great Falls Park (Virginia), and Fletchers Floodplain. Has been listed as historical for Maryland (Maryland Natural Heritage Program, 1994), but probably has been overlooked or misidentified. Mid-May to late June. *1084, 1140, 1153, 2097* (US); *1579* (MARY); *1060, 1085, 1249* (Tawes); *1563* (Grfa); *1144* (Frost).

*Carex leptalea* Wahlenberg ssp. *leptalea*

Rare. Spring runs and seepages. One station, at Great Falls Park (Virginia). Also, two historical collections—one from apparently the same location as the current station and one from Difficult Run. Mid-May to mid-June. *2087* (US, Grfa); *Leonard 2176*, *Standley 11668* (US).

*Carex lupuliformis* Sartwell *ex* Dewey

Rare. Edge of forested vernal pool, near Widewater. Very similar to, and often confused with, the more common *C. lupulina*. This is the first report of the species for the Potomac Gorge, Montgomery County, and the Maryland Piedmont. Mid-June to early July. *2092* (US); *1259* (MARY); *1258* (GMUF); *1256* (MICH); *1260* (Tawes); *1257* (Dnhp).

*Carex lupulina* Muhlenberg *ex* Willdenow

Common. Moist, partially shaded to open areas, including swales in floodplain forests, scoured channel shelf woodlands and edges of ponds, the C&O Canal, and forested vernal pools. Early June to late July. *1096*, *1238*, *1265*, *1266* (US); *552*, *1128* (MARY); *1097* (Frost).

*Carex lurida* Wahlenberg

Common. In a variety of open wet areas, including scoured channel shelf woodlands, open floodplain forests, wet meadows, edges of ponds and the C&O Canal, and edges of forested vernal pools. Late May to mid-July. *1095*, *1239*, *2096* (US); *553* (Frost).

*Carex muhlenbergii* Schkuhr *ex* Willdenow var. *enervis* W. Boott

Infrequent. Habitat similar to that of *C. aggregata*. Locations include near Plummers Island and Cropley. Var. *enervis* generally has the perigynium nerves less evident than in the typical variety, but, in some specimens, this difference is not distinct. Mid-May to late June. *1486*, *1487* (US); *1918* (Frost).

*Carex muhlenbergii* Schkuhr *ex* Willdenow var. *muhlenbergii*

Historical. A single collection in 1895 from High Island. The habitat is most likely dry woods. Dates unknown; probably as for the var. *enervis*. *Holm s.n.* (US).

*Carex nigromarginata* Schweinitz

Frequent. In dry-mesic to xeric upland forests and rich bedrock terrace forests. This is the first report of the species for Arlington County. Mid-April to early May. *977*, *1382* (US); *784*, *796* (MARY); *776* (Tawes); *791*, *949* (Frost); *976* (Aacc).

*Carex normalis* Mackenzie

Frequent. In moist swales in open channel shelf woodlands, wet areas in riverside prairies, pond edges, and edges of forested vernal pools. Mid-May to mid-June. *1570*, *1712* (US); *1146*, *1147*, *1589* (MARY); *1157* (Tawes); *1569* (Grfa); *1158* (Frost); *1061* (Aacc).

*Carex oligocarpa* Schkuhr *ex* Willdenow

Infrequent. In rich mesophytic forests on alluvial terraces. Found at Bear and High Islands, along Cabin John Creek, and at Turkey Run Park. We report *C. oligocarpa* for the first time for Fairfax County. Early May to early June. *1013*, *1375*, *1481* (US); *1026*, *1449* (MARY); *1456* (GMUF); *1010* (Tawes); *1029*, *1375* (Frost); *1014*, *1025* (Aacc).

*Carex pallescens* Linnaeus

Historical. Known from a single collection in 1893 from "dry fields on the Potomac shore near Aqueduct Bridge, Virginia" (near present-day Key Bridge in Arlington County). This species, known from several late nineteenth century collections in the District of Columbia, has not yet been found in Maryland and is considered highly rare in Virginia (Killeffer, 1999). It is apparently a sedge of fields and meadows, and, because of forest succession, may be today locally less numerous or extirpated. Late May. *Holm s.n.* (US).

*Carex pellita* Muhlenberg *ex* Willdenow

Historical. Two collections at US (as *C. lanuginosa* Michaux, a misapplied name) from two nearby locations (Lock 5, High Island) on the same date in 1898. A species of nutrient-rich fens and other open wetlands. Mid-May. *Steele s.n.* (US).

*Carex pensylvanica* Lamarck

Frequent. Primarily in rich bedrock terrace forests, also dry-mesic upland forests. Some plants appear as *forma gracilifolia* (Peck) Kükenthal. Late April to mid-May. *438, 443, 785, 991, 1344* (US); *430, 846, 979, 1341* (MARY); *980, s.n.* (Tawes); *446, 1339* (Frost); *792, 982* (Aacc).

*Carex planispicata* Naczi

Frequent. Rich, dry to mesic forests. Locally common at Bear Island and Great Falls Park (Virginia). Widespread in the eastern United States, but obscured by nomenclatural and typification problems. The species was recently described by Naczi (1999), who first reported it from the gorge, based on an old collection at US from Plummers Island. The very similar *C. oligocarpa*, which occurs in similar habitat, has generally fewer perigynia per spike, with the perigynia having distinct beaks. Mid-May to early June. *1043, 1067* (US); *1011, 1082, 1139* (MARY); *1707* (GMUF); *1045* (MICH); *879, 1042, 1068, 1141* (Tawes); *1708* (Grfa); *1044A* (Frost); *1069* (Aacc).

*Carex platyphylla* Carey

Rare. On steep slopes, often on bare soil, in rich, dry-mesic forests, evidently over amphibolite. Found at Turkey Run Park, in the ravine of Cabin John Creek, and near Donaldson Run. In our area, an indicator of neutral to basic soils. Late April to late May. *1114, 1446, 1461* (US); *1115* (GMUF).

*Carex prasina* Wahlenberg

Frequent. In mucky soil along spring runs and in seepage swamps, also in wet swales in floodplain forests. Early May to late June. *847, 957, 1205* (US); *874, 1264* (Tawes); *1467* (Grfa).

*Carex radiata* (Wahlenberg) Small

Common. Primarily in low floodplain forests, open-channel shelf woodlands, edges of forested vernal pools, and edges of spring runs. Also occurs in disturbed situations in upland habitats, such as young forests, along trails, and in mowed areas. One of our most common species. Plants treated as *C. rosea* Schkuhr by Hitchcock and Standley (1919) and Fernald (1950) and many at US so identified follow the treatment of Mackenzie (1931) and are referable to this species (Webber and Ball, 1979, 1984). Early May to late June. *483, 1086, 1133, 1442, 1471* (US); *1490* (MARY); *1464* (GMUF); *1016* (Tawes); *1468* (Grfa); *1041* (Aacc).

*Carex retroflexa* Muhlenberg *ex* Schkuhr

Infrequent. In rich bedrock terrace forest, Bear Island, where locally common. Early to late May. *871, 890* (US); *1578* (MARY); *Strong 87-042* (GMUF); *887, 1591* (Tawes).

*Carex rosea* Schkuhr *ex* Willdenow

Frequent. In dry-mesic upland forests, generally in drier and less disturbed habitats than *C. radiata*. *C. convoluta* MacKenzie of Hitchcock and Standley (1919) and Fernald (1950) is referable to this species (Webber and Ball, 1979, 1984). Mid-May to mid-June. *1117, 1172, 1592* (US); *1173* (GMUF); *1203* (Tawes).

*Carex scoparia* Schkuhr *ex* Willdenow var. *scoparia*

Frequent. In moist swales in open channel-shelf woodlands, temporary pools in scoured bedrock, edges of ponds and the C&O Canal, and along spring runs. Several specimens appear as *forma subturbinata* (Fernald and Wiegand) Fernald. Early June to early July. *1143, 1231, 1930* (US); *1230, 2093* (MARY); *1706* (Grfa); *1225* (Frost).

*Carex seorsa* Howe

Historical. Two collections at US made from two nearby locations — Lock 5 (historically called First Lock) and the C&O Canal Feeder Dam (near High Island) — on the same date in 1898. Restricted in Maryland primarily to the Coastal Plain, where it is common on floodplain forests. Mid-May. *Steele s.n.* (US).

*Carex shortiana* Dewey

Infrequent. In moist swales in channel shelf woodlands at Chain Bridge Flats and Fletchers Floodplain. Also at edge of pond, Great Falls Park (Virginia). In Maryland and northern Virginia, primarily restricted to rich soils along the Potomac. Mid-May to early June. *1566* (US); *Tanaka s.n.* (NA); *1190, 1689* (Tawes); *Grimshaw 842a* (Grfa).

*Carex sparganioides* Muhlenberg *ex* Willdenow

Infrequent. In rich, dry-mesic forests and mesophytic alluvial terrace forests. Plummers Island area, Bear Island, Turkey Run Park, Great Falls Park (Virginia), and, historically, from the Virginia side of Chain Bridge. Occurs in less disturbed habitats than the similar *C. aggregata*. Early May to mid-June. *1565* (GMUF, Grfa); *Tanaka s.n.* (NA); *1480, 1583* (Tawes).

*Carex squarrosa* Linnaeus

Frequent. In moist swales in open floodplain forests or channel-shelf woodlands; also edges of forested vernal pools. Mid-May to late July. *551* (US); *1129* (Tawes).

*Carex stipata* Muhlenberg *ex* Willdenow var. *maxima* Chapman

Infrequent. Tidal and non-tidal swamps. Found at Roosevelt Island, Chain Bridge Flats, and near C&O Canal Lock 5. Although specimens intermediate with the typical variety can be found, very wide-leaved plants clearly represent var. *maxima*. These are the first reports for the taxon for Montgomery County, the District of Columbia, and the Potomac Gorge. Mid-May to late June. *1080* (US); *1079, 1576* (MARY); *1130, 1575* (MICH); *1073* (Tawes); *1074* (Frost).

*Carex stipata* Muhlenberg *ex* Willdenow var. *stipata*

Frequent. In wet swales in open floodplain forests and channel shelf woodlands. Also along edge of C&O Canal and in other disturbed wetlands, in more generalized habitats than var. *maxima*. Mid-May to mid-June. *458*, *963*, *1476* (US).

*Carex straminea* Willdenow *ex* Schkuhr

Rare. Found at a single station, along rocky pools in scoured riverside prairies, Great Falls Park (Virginia). Historically collected in 1886 from the Maryland side of Great Falls (specimen was originally identified as *C. tenera* and later determined by K. K. Mackenzie to be *C. richii* Mackenzie, a synonym for *C. straminea*). Also collected in 1983 from Bear Island, in habitat similar to that of the current occurrence. *C. hormathodes* Fernald of Hitchcock and Standley (1919) is referable to this species (= *C. hormathodes* Fernald var. *richii* Fernald). *C. straminea* has been misapplied to *C. albolutescens* by some older treatments (e.g., Hitchcock and Standley, 1919). Considered highly rare in Maryland (Frye and Lea, 2001) and in Virginia (Killeffer, 1999). Mid-May to early July. *Knowlton s.n.* (US); *1705* (GMUF, Grfa); *Boone s.n.* (Tawes).

*Carex striatula* Michaux

Rare. In xeric oak-pine bedrock terrace forest. Seen only at Bear Island, with several historical collections elsewhere in the gorge. Within the gorge, specimens seem fairly distinct from *C. laxiflora*, although difficult intermediates between the two occur elsewhere in Maryland. *C. striatula* has been considered historical in Maryland (Maryland Natural Heritage Program, 1994). This assessment may have been because of misidentifications or from the species being overlooked. Late April to early June. *1922*, *Shreve 1467*, *Ward s.n.* (US); *1378* (MARY).

*Carex stricta* Lamarck

Rare. Forested seepage swamp. A single location, at Great Falls Park (Virginia). All previous material collected from the gorge as *C. stricta* at US and at the Great Falls Park herbarium (single specimen, *Grimshaw 842*) has been determined to be *C. emoryi*. *C. stricta* is more characteristic of swamps and riparian wetlands with low current velocities. Locally, at least, it tends to grow in discrete, dense clumps that are not extensively stoloniferous. This represents the first confirmed report of *C. stricta* for the Potomac Gorge. Early May. *1472* (US, Grfa).

*Carex styloflexa* Buckley

Rare. Along seepages, spring runs, and edges of forested vernal pools. In the Gold Mine Tract and at Great Falls Park (Virginia). Early May to mid-June. *1489*, *1595*, *Shreve 1441* (US); *1489*, *1594* (MARY); *2086* (GMUF); *2085* (Grfa).

*Carex swanii* (Fernald) Mackenzie

Frequent. In dry-mesic upland forests, rich bedrock terrace forests, and along edges of vernal pools. Mid-May to late June. *876*, *964*, *1170* (US); *1233* (MARY); *1163* (Tawes); *1713* (Grfa).

*Carex tenera* Dewey

Rare. Floodplain forest, Fletchers Floodplain. This represents the first confirmed record from the Potomac Gorge for this regionally rare species, although collections of other species have been attributed to it, including one from Great Falls reported by Shreve et al. (1910). See also entries for *C. festucacea* and *C. straminea*. This is the only known extant occurrence in the District of Columbia, and it is presently considered historical for Maryland (Maryland Natural Heritage Program, 1994) and highly rare in Virginia (Killeffer, 1999). Late May. *1697* (US, Tawes).

*Carex tonsa* (Fernald) Bicknell var. *rugosperma* (Mackenzie) Crins

Rare. Seen only at Bear Island among rock outcrops in xeric oak-pine bedrock terrace forest. Very similar to *C. umbellata*, but has a longer perigynium beak. Largely confined to the Appalachian Mountains in Maryland. We report the taxon here for the first time for the gorge and for Montgomery County. Early May. *Frye and Lea s.n.* (Tawes).

*Carex tonsa* (Fernald) Bicknell var. *tonsa*

Infrequent, but perhaps overlooked. In rocky riverside prairies, xeric oak-pine terrace forest, and on rock outcrops in upland forests. Seen in Gold Mine Tract and at Bear and High Islands and is likely elsewhere. Mid-April to early May. *973* (US); *1001* (Tawes).

*Carex torta* F. Boott *ex* Tuckerman

Rare. One station found during this study, along rocky banks and depositional bars of Cabin John Creek — apparently the same location as the specimen at GMUF. Terrell (1970) reported a second station along the main stem Potomac. Observations suggest that it may be declining in the area because of impacts of watershed development on stream flows. Late April to early May. *1443*, *Terrell 4222* (US); *1444* (MARY); *Miller* 152 (GMUF).

*Carex tribuloides* Wahlenberg var. *tribuloides*

Common. In moist swales in open channel-shelf woodlands, open fresh tidal swamps, open floodplain forests, and edges of ponds and the C&O Canal. Some atypical specimens have been found (see *C. projecta* and *C. tribuloides* var. *sangemonensis* under excluded and hypothetical taxa, respectively). Late May to early July. *1126, 1210, 1234, 1242, 1929, 1939, 1944* (US); *508, 1193, 1196, 1221, 1241* (MARY); *966, 1222, 1248* (Tawes); *2252* (Grfa); *1228* (Frost); *1156, 1209* (Aacc).

*Carex typhina* Michaux

Rare. Edges of forested vernal pools, Bear Island and Fletchers Floodplain. These are the first records for the species for the Potomac Gorge and for the District of Columbia. Late May to mid-July. *549, 1690* (US).

*Carex umbellata* Schkuhr *ex* Willdenow

Frequent. In rocky riverside prairies, xeric oak-pine terrace forest, rich bedrock terrace forests, and dry upland forests. Evidently included under *C. tonsa* by Hitchcock and Standley (1919). Mid-April to early May. *974* (US); *1336* (MARY); *777, 789, 800* (Tawes); *1334* (Grfa); *975* (Frost).

*Carex virescens* Muhlenberg *ex* Willdenow

Common. In dry-mesic upland and rich bedrock terrace forests, less frequently in xeric forests. One of our most frequently encountered upland forest carices. Mid-May to late June. *1112, 1164* (US); *435* (MARY); *434, 882* (Tawes); *1034* (Frost).

*Carex vulpinoidea* Michaux

Common. In open, wet, often disturbed, areas, including open channel-shelf woodlands, open fresh tidal swamp, banks of C&O Canal and ponds, and ditches. Mid-May to early July. *534, 1099, 1123* (US); *1152* (MARY); *1148, 1154* (Tawes); *1562* (Grfa); *1134* (Frost); *740* (Aacc).

*Carex willdenowii* Schkuhr *ex* Willdenow

Frequent. In upland forests and rich bedrock terrace forests. Late April to mid-June. *1380, 2089* (US); *768* (Tawes); *1465* (Grfa); *1335* (Frost).

*Carex woodii* Dewey

Frequent. In rich, dry forests on bedrock terraces from Bear Island (where locally common) to Vaso Island; not found on Virginia side. This early flowering species occurs in several Maryland locations in large stoloniferous colonies reminiscent of, and often along with, *C. pensylvanica*, and it has likely been overlooked as that species. Sterile *C. woodii* plants have longer leaves that appear more blue-green than do those of *C. pensylvanica*. Recently considered historical for Maryland (Maryland Natural Heritage Program, 1994). We report *C. woodii* for the first time for the gorge. Late April to mid-May. *431, 1377* (US); *951, 1381* (MARY); *756, 762* (Tawes); *1342* (Frost); *758* (Aacc).

## Excluded Taxa

*Carex crebriflora* Wiegand

A specimen at GMUF labeled collected from the area of Dead Run (a Potomac tributary in the gorge) in 1987 and labeled *C. crebriflora* (*Strong 87-044*) was determined to be *C. laxiflora*. Inspections of specimens collected as *C. crebriflora* at GMUF suggest that many reports of the species from northern Virginia are likely to be based on collections of similar members of section *Laxiflorae*. *C. crebriflora* is a southern species that has not been reported for Maryland and which collections suggest extends north only into southeastern Virginia, a range consistent with that given by Fernald (1950).

*Carex flaccosperma* Dewey

Grimshaw and Bradley (1973) attributed *C. flaccosperma* to the flora of Great Falls Park (Virginia). The voucher specimen so labeled (*Grimshaw 930*; Grfa) is actually *C. grisea*. *C. flaccosperma* (*sensu stricto*) is a southern taxon known to range north only to southeastern Virginia (Fernald, 1950), while *C. glaucodea* (= *C. flaccosperma* Dewey var. *glaucodea* (Tuckerman *ex* Olney) Kükenthal) historically has been recorded from the gorge.

*Carex interior* Bailey

Hitchcock and Standley (1919) attributed *C. interior* to the Plummers Island area based on a collection at US made in 1915 (*Standley 11663*). This and a similarly labeled specimen from Great Falls, Maryland at US (*Morris s.n.*) were both determined to be *C. atlantica* ssp. *atlantica*. *C. interior* is presently known from only one Maryland site (Frye and Lea, 2001).

*Carex nigra* (Linnaeus) Reichard

Hitchcock and Standley (1919) reported *C. goodenovii* Gay for the Washington area based on Ward's (1881) citing of a report of *C. vulgaris* Fries by Vasey from Chain Bridge. Both names are apparently synonyms for *C. nigra*, a coastal species ranging from Greenland to

Rhode Island (Fernald, 1950). No specimens were seen at US by Hitchcock and Standley (1919) or by us. The most likely explanation for the Vasey report is a misidentification of *C. emoryi*, a species in the same section as *C. nigra* that is frequent in the vicinity of Chain Bridge, and is apparently not otherwise accounted for by Ward (1881).

*Carex projecta* Mackenzie

Two collections of plants appearing to be *C. tribuloides*, but somewhat small, with the lower spikes fairly well separated from one another, and with tips of the perigynia somewhat spreading (thus, fitting some descriptions of this taxon) were made from Chain Bridge Flats and Roosevelt Island during this study. A similar specimen was collected in 1888 by Holm (*s.n.*; NA) in the gorge from "shady woods near the Aqueduct Bridge, Virginia" (near present-day Key Bridge in Arlington County) and identified as *C. tribuloides* Wahlenberg var. *reducta* Bailey, a synonym of *C. projecta*. A. A. Reznicek has determined the current collections to be *C. tribuloides*, and the 1888 specimen appears to be the same. The Holm specimen seems to be at least part of the basis for the listing of *C. projecta*, which is otherwise restricted to the Appalachian Plateau in Maryland, in the vicinity of Washington, D.C., by Hitchcock and Standley (1919). We conclude that all material from this area purported to be *C. projecta* represents depauperate or atypical *C. tribuloides*. See entry for *C. tribuloides* var. *sangemonensis* in Hypothetical Taxa.

*Carex tetanica* Schkuhr

*C. tetanica* has been attributed to the Potomac Gorge on the basis of two duplicate specimens collected by Ward *s.n.* (US) in 1879 at High Island. One of these had been annotated as *C. granularis* var. *haleana* by F. J. Hermann, and the second was so determined by this study. No Washington, D.C. area specimens of *C. tetanica* have been seen, and reports of its occurrence there (Hitchcock and Standley, 1919) appear to be based on these previously misidentified specimens or *C. woodii* (= *C. tetanica* Schkuhr var. *woodii* [Dewey] Bailey).

## Hypothetical Occurrences

*Carex albicans* Willdenow *ex* Sprengel var. *australis* (Bailey) Rettig

The possible occurrence of this taxon, frequently treated as *Carex physorhyncha* Liebman, in our area is problematic. It is a southern Coastal Plain taxon, said to range north to southeastern Virginia (Fernald, 1950). Plants appearing much as *C. albicans* var. *albicans*, but more robust, and with short rhizomes, a loosely, rather than densely, cespitose habit, and wider leaves have been found in the gorge. A specimen collected by Ward in 1880 from Great Falls, Maryland had been annotated by K. K. Mackenzie as *C. physorhyncha*, and was (apparently) subsequently annotated by Mackenzie as *C. varia* Muhlenberg (a synonym for *C. albicans* var. *albicans* or, possibly *C. albicans*, *sensu lato*). We have since found similar specimens in the gorge that compare well with syntypes of *C. varia* Muhlenberg var. *australis* Bailey (= *C. albicans* var. *australis*) at US and at NY (as a photograph at the CASSIA web site; Tracy *s.n.*). These are fairly restricted to rather xeric oak-pine forests consistent with that published for *C. physorhyncha* (Fernald, 1950, Mohlenbrock, 1999); though they are sympatric with var. *albicans*, the typical variety tends to be allotopic in adjacent, more mesic forests. A. A. Reznicek (pers. comm.) has examined these questionable specimens and indicated that similar-appearing plants occur in the Midwest, north of the published range of var. *australis*. He has concluded that, using a narrow circumscription of

*C. albicans* var. *australis* (perhaps necessary to give the taxon validity), such plants would most likely be considered var. *albicans*. He acknowledges that the Potomac Gorge plants are clearly atypical for var. *albicans* and that the situation may merit taxonomic review. Specimens in question include *Ward s.n.* (US), *Lea 981* (Tawes), *Lea 1331* (GMUF, US), and *Lea 1332* (MICH).

*Carex louisianica* Bailey

A single collection of what is possibly this species (*Lea 1201*, Tawes) was made at Chain Bridge Flats during this study; the specimen may also be a depauperate *C. lupulina*. *C. louisianica* is primarily restricted to the Coastal Plain in Maryland. It is known historically from the nearby Anacostia River (*Steele s.n.*, US) and has been recently reported from the Piedmont of northern Virginia (G. Fleming, pers. comm.).

*Carex mesochorea* Mackenzie

Hitchcock and Standley (1919) reported *C. mesochorea* from High Island. We have seen no specimens from the gorge. It has been found in a number of Piedmont and Coastal Plain counties in Maryland, usually in dry and open, often disturbed habitats, and it may well occur in the gorge. It is easily confused with several similar species.

*Carex molesta* Mackenzie *ex* Bright

A single collection was made by Terrell *s.n.* in 1969 (US, det. F. J. Hermann) from along the Potomac about 8 km upstream from the study area. The species may well occur in the Potomac Gorge.

*Carex tribuloides* Wahlenberg var. *sangemonensis* Clokey

Mackenzie's (1931) description of this taxon, purported to be a small, primarily southern form of *C. tribuloides*, may apply to plants from the lower part of the gorge which key toward *C. projecta*, including *Lea 1194* (MICH), *Lea 1211* (MARY), and the 1893 collection by *Holm s.n.* (NA; see discussion under Excluded Taxa). The identity and validity of var. *sangemonensis*, however, is presently too unclear to us for making such a determination. *C. tribuloides* var. *sangemonensis* is reported to be highly rare in Virginia (Killiffer, 1999).

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## LITERATURE CITED

BARTGIS, R., D. FELLER, C. SIMOES, E. THOMPSON, AND R. WIEGAND, 1993. State and nationally significant natural areas of the Chesapeake and Ohio Canal National Historical Park. Unpublished report to National Park Service. Maryland Department of Natural Resources, Natural Heritage Program, Annapolis.

BROWN, M. L. AND R. G. BROWN. 1984. Herbaceous Plants of Maryland. Port City Press, Baltimore.

FERNALD, M. L. 1950. Gray's Manual of Botany, 8th ed. 1987 reprint. Dioscorides Press, Portland, OR.

FRYE, C. T. AND C. LEA. 2001. Atlas and annotated list of *Carex* (Cyperaceae) of Maryland and the District of Columbia. In press, Maryland Naturalist.

GLEASON, H. A. AND A. CRONQUIST. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada, 2nd ed. New York Botanical Garden, the Bronx, NY.

GRIMSHAW, S. AND T. R. BRADLEY. 1973. The vascular flora of Great Falls National Park, Fairfax County, Virginia. Castanea 38: 229-261.

HARVILL, JR., A. M. 1973. Phytogeography of the carices of Virginia. Rhodora 75: 248-257.

HARVILL, JR., A. M., T. R. BRADLEY, C. E. STEVENS, T. P. WIEBOLDT, D. M. E. WARE, D. W. OGLE, G. W. RAMSEY, AND G. P. FLEMING. 1992. Atlas of the Virginia Flora, 3rd ed. Virginia Botanical Associates, Burkeville, VA.

HITCHCOCK, A. S. AND P. C. STANDLEY. 1919. Flora of the District of Columbia and vicinity. Contributions of the U.S. National Herbarium 21: 1-329.

HOLMGREN, P. K., N. H. HOLMGREN AND L. C. BARRETT. 1990. Index Herbariorum. Part 1, edition 8. Regnum Veg. 120: x + 1-693.

KILLEFFER, S. E. 1999. Natural Heritage resources of Virginia: rare vascular plants. Natural Heritage Technical Report 99-11. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. Unpublished report.

LEA, C. 2000. Plant communities of the Potomac Gorge and their relationship to fluvial factors. George Mason University, Fairfax, VA. M.S. thesis.

MACKENZIE, K. K. 1931. North American Flora. 18. Cyperaceae, tribe 2, Caricae. New York Botanical Garden, New York.

MANHART, J. R. 1986. Foliar flavenoids of the North American members of *Carex* section *Laxiflorae* (Cyperaceae). Biochemical Systematics and Ecology 14: 85-90.

MARYLAND NATURAL HERITAGE PROGRAM. 1994. Rare, Threatened, and Endangered Plants of Maryland. Maryland Department of Natural Resources, Annapolis.

MCATEE, W. L. 1918. A sketch of the natural history of the District of Columbia, together with an indexed edition of the United States Geological Survey's 1917 map of Washington and vicinity. Bulletin of the Biological Society of Washington 1: 1-142.

MOHLENBROCK, R. H. 1999. Sedges: *Carex* (The illustrated flora of Illinois). Southern Illinois University Press, Carbondale and Edwardsville, IL.

NACZI, R. F. C. 1999. *Carex planispicata*, a widespread and frequent new species of *Carex* section *Griseae* (Cyperaceae) from the eastern United States of America. Journal of the Kentucky Academy of Science 60: 37-44.

OSTERKAMP, W. R. AND C. R. HUPP. 1984. Geomorphic and vegetative characteristics along three northern Virginia streams. Geological Society of America Bulletin 95: 1093-1101.

RAWINSKI, T. J., 1989. Notes on riverside vegetation. The Nature Conservancy Magazine 69: 24-25.

REED, J. C., JR., R. S. SIGAFOOS, AND G. W. FISHER. 1970. The river and the rocks: the geological story of Great Falls and the Potomac River gorge. 1984 Reprint of U.S. Geological Survey Bulletin 1471. Parks and History Association, Washington, DC.

RETTIG, J. H. 1990. Correct names for the varieties of *Carex albicans* / *C. emmonsii*. Sida 14: 132-133.

REZNICEK, A. A. 1989. New England *Carex* (Cyperaceae): Taxonomic problems and phytogeographical considerations. Rhodora 91: 144-152.

REZNICEK, A. A. AND P. W. BALL. 1974. The taxonomy of *Carex* series ***Lupulinae*** in Canada. Canadian Journal of Botany 52: 2387-2399.

RHOADS, A. F. AND T. A. BLOCK. 2000. The Plants of Pennsylvania: an Illustrated Manual. University of Pennsylvania Press, Philadelphia.

RHOADS, A. F. AND W. M. KLEIN, JR. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. The American Philosophical Society, Philadelphia.

SCHMIDT, M. F., JR. 1993. Maryland's Geology. Tidewater Publishers, Centreville, MD.

SHREVE, F., M. A. CHRYSLER, F. H. BLODGETT, AND F. W. BESLEY. 1910. The Plant Life of Maryland. Maryland Weather Service Special Publication Vol. III. The Johns Hopkins Press, Baltimore.

TERRELL, E. E. 1970. Spring flora of the C&O Canal area, Washington, D.C. Castanea 35: 1-25.

TORMEY, B. B., 1980. Geomorphology of the falls stretch of the Potomac River. Pennsylvania State University, State College, PA. PhD. Dissertation.

WARD, L. 1881. Guide to the flora of Washington and vicinity. Bulletin of the United States National Museum No. 22. U.S. Government Printing Office, Washington, DC.

WEAKLEY, A. S. 1999. Flora of Virginia and the Carolinas, working draft of 19 January 1999. The Nature Conservancy, Chapel Hill, NC. Unpublished manuscript.

WEBBER J. M. AND P. W. BALL. 1979. Proposals to reject *Carex rosea* and *Carex radiata* of eastern North America (Cyperaceae). Taxon 28: 611-616

WEBBER J. M. AND P. W. BALL. 1984. The taxonomy of the *Carex rosea* (section *Phaestoglochin*) in Canada. Canadian Journal of Botany 62: 2058-2073.

WHEELER G. A. AND G. B. OWNBEY. 1984. Annotated list of Minnesota carices, with phytogeographical and ecological notes. Rhodora 86: 151-231.

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# Rare Plants in the Middle Branch of the Forked River Watershed, Lacey Township, Ocean County, New Jersey

ALFRED E. SCHUYLER
*Academy of Natural Sciences of Philadelphia*
*1900 Benjamin Franklin Parkway, Philadelphia PA 19103*
*schuyler@acnatsci.org*

TED GORDON
*Pine Barrens Inventories, 31 Burrs Mill Road, Southampton NJ 08088*

During the spring and summer of 1998, we conducted a field survey to obtain information about rare plant species and their distributions in the Middle Branch Forked River watershed. To get information about rare plants previously known from the watershed, we recorded data from herbarium specimens collected there that are in the herbarium of The Academy of Natural Sciences. Gordon also supplied data from notes made on previous visits to the area. We made visits to the area on 27 May, 21 July, 13 August, and 17 September 1998.

Plant nomenclature in this paper follows that in the *Manual of Vascular Plants of Northeastern United States and Adjacent Canada* (Gleason and Cronquist 1991). We determined rarity from listings provided by the New Jersey Department of Environmental Protection and the Association for Biodiversity Information (www.natureserve.org), although the rank and status for some of the species have changed from what they were in the past.

## DESCRIPTION OF THE STUDY AREA

The Middle Branch of the Forked River is one of three branches that join to form the Forked River about 2 km west of where it enters Barnegat Bay. It drains a small watershed that extends inland to the west for about 7 km with an average north/south width of about 2 km. Our survey extends from the headwaters of the Middle Branch, near the abandoned Tuckerton Railroad grade, downstream to the bridge for Route 9 (Fig. 1), which is about 2 km upstream from the junction of the Middle and North Branches. The Garden State Parkway and a powerline along its west side bisect the area.

The New Jersey Conservation Foundation owns the land west of the Parkway. The land between the Parkway and Route 9 is privately owned except for a strip along the stream corridor, which is owned by the township. The northern portion of this area is residential. At the southeast end there is an industrial park.

For convenience of reference, we have divided the watershed into three zones from the headwaters to Route 9. The headwaters portion west of the railroad grade is zone 1, the area between the railroad grade and the Parkway is zone 2, and the area between the Parkway and Route 9 is zone 3. In zones 2 and 3, we recognize north and south portions

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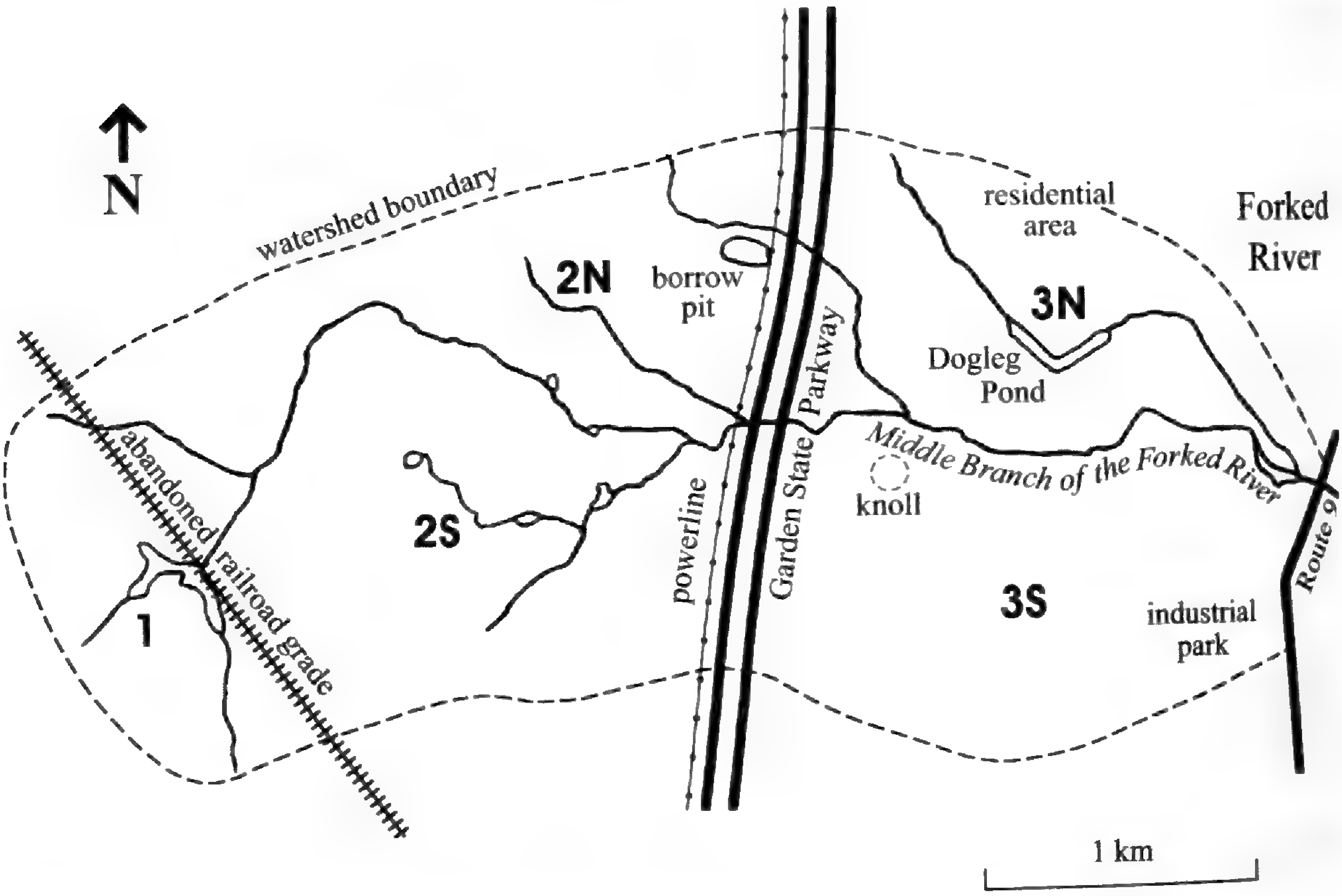


Figure 1. Sketch map of watershed, Middle Branch of the Forked River. Characters in boldface indicate the zones employed in the survey, which are delineated by the river, the Parkway, and the railroad grade.

separated by the main stem of the Middle Branch. We have listed the rare plants found throughout the area in Table 1 and those found in each zone in Table 2.

## Search Results

**Zone 1: Headwaters of the Middle Branch west of the railroad grade.**
The Middle Branch is flooded on the west side of the embanked railroad grade that functions as a dam. The many dead trees in this extensive pond-like habitat indicate that conditions must have been drier in the past. We searched carefully for *Helonias bullata* and *Scirpus longii*, two globally rare species collected here in 1915 by Academy Curator Bayard Long. Our searches for them and other rare species known from the watershed were unsuccessful.

**Zone 2N: North of the Middle Branch between the railroad grade and the Garden State Parkway.**
We confined our searches in this zone to the powerline clearing along the west side of the Parkway and a large shallow borrow pit. In or along the edges of the powerline clearing north of the borrow pit there were scattered stands of *Rhynchospora knieskernii* and *Calamovilfa brevipilis*. Extensive stands of *Sagittaria teres*, *Nymphoides cordata*, and *Utricularia resupinata* occurred in shallow water of the borrow pit. In damp sand around the edge of the pit, there were scattered stands of *Rhynchospora knieskernii*, and a small stand of *Schizaea pusilla*. In drier sand, there were scattered small stands of *Gentiana autumnalis*.

TABLE 1. Rare Plants of the Middle Branch of the Forked River Watershed

*Calamovilfa brevipilis* (Torr.) Scribn.—pine barren reedgrass
*Carex barrattii* Schwein & Torr.—Barratt's sedge
*Carex livida* (Wahlenb.) Willd.—livid sedge
*Gentiana autumnalis* L.—pine barren gentian
*Helonias bullata* L.—swamp-pink*
*Juncus caesariensis* Coville—New Jersey rush
*Leiophyllum buxifolium* (Berg.) Ell.—sand-myrtle
*Lobelia canbyi* Gray—Canby's lobelia
*Muhlenbergia torreyana* (Schultes) A. Hitchc.—pine barren smoke grass
*Narthecium americanum* Ker-Gawler—bog asphodel
*Nymphoides cordata* (Ell.) Fern.—floating-heart
*Rhynchospora knieskernii* Carey—Knieskern's beaked-rush
*Rhynchospora nitens* (Vahl) Gray—short-beaked baldrush
*Rhynchospora pallida* M. A. Curtis—pale beaked-rush
*Sagittaria teres* Wats.—slender arrowhead
*Schizaea pusilla* Pursh—curly-grass fern
*Scirpus longii* Fern.—Long's bulrush*
*Scleria minor* W. Stone—slender nutrush
*Utricularia purpurea* Walt.—purple bladderwort
*Utricularia resupinata* B. D. Greene—resupinate bladderwort
*Uvularia puberula* var. *nitida* (Britt.) Fern.—pine barren bellwort
*Xerophyllum asphodeloides* (L.) Nutt.—turkey-beard

*Our 1998 searches for *Helonias bullata* and *Scirpus longii* were unsuccessful. They were last collected in 1915.

*Carex barrattii* and *Muhlenbergia torreyana* were collected or observed nearby in 1985 by Gordon. We did not search for them in 1998. We presume they are still present because they are in an area where habitat conditions have not changed.

**Zone 2S: South of the Middle Branch between the railroad grade and the Garden State Parkway.**

We searched the main stem of the Middle Branch and adjacent wetland and terrestrial habitats in the western portion of this zone. There were occasional stands of *Juncus caesariensis* in cedar swamp openings. *Xerophyllum asphodeloides* was frequent in open pine forest bordering swamps. A few small stands of *Calamovilfa brevipilis* occurred in open damp sandy/peaty depressions. We also searched along a southern tributary in the eastern portion of this zone where *Narthecium americanum* occurred in two large stands of approximately 200 × 30 meters and 100 × 20 meters. *Schizaea pusilla* was abundant on hummocks in the larger stand.

**Zone 3N: North of the Middle Branch between the Garden State Parkway and Route 9.**

We searched the main stem of the Middle Branch for a distance of about 1 km in the eastern portion of this zone. Over 10,000 stems of *Narthecium americanum* occurred in wet areas along the stream. *Carex livida, Juncus caesariensis*, and *Schizaea pusilla* were frequent here too. In the low, open, pine forest at the eastern end of the zone, there were a few small stands of *Uvularia puberula* var. *nitida* along with scattered stands of *Calamovilfa brevipilis* and *Leiophyllum buxifolium*. *Xerophyllum asphodeloides* was scattered through

TABLE 2. General Locations of Rare Plants in the Middle Branch of the Forked River Watershed.

Zone 1: Headwaters West of Railroad Grade

| | |
|---|---|
| *Helonias bullata*[1] | *Scirpus longii*[1] |

Zone 2N: North Portion between Railroad Grade and Parkway

| | |
|---|---|
| *Calamovilfa brevipilis* | *Rhynchospora knieskernii* |
| *Carex barrattii*[2] | *Sagittaria teres* |
| *Gentiana autumnalis* | *Schizaea pusilla* |
| *Muhlenbergia torreyana*[3] | *Utricularia resupinata* |
| *Nymphoides cordata* | |

Zone 2S: South Portion between Railroad Grade and Parkway

| | |
|---|---|
| *Calamovilfa brevipilis* | *Schizaea pusilla* |
| *Juncus caesariensis* | *Xerophyllum asphodeloides* |
| *Narthecium americanum* | |

Zone 3N: North Portion between Parkway and Route 9

| | |
|---|---|
| *Calamovilfa brevipilis* | *Rhynchospora knieskernii* |
| *Carex livida* | *Rhynchospora nitens*[4] |
| *Juncus caesariensis* | *Schizaea pusilla* |
| *Leiophyllum buxifolium* | *Uvularia puberula var. nitida* |
| *Lobelia canbyi* | *Xerophyllum asphodeloides* |
| *Narthecium americanum* | |

Zone 3S: South Portion between Parkway and Route 9

| | |
|---|---|
| *Calamovilfa brevipilis* | *Schizaea pusilla* |
| *Juncus caesariensis* | *Scleria minor* |
| *Leiophyllum buxifolium* | *Utricularia purpurea* |
| *Narthecium americanum* | *Xerophyllum asphodeloides* |
| *Rhynchospora pallida* | |

[1]Collected in 1915. Not relocated in 1998 after careful searching.
[2]Observed in 1985. Not searched for in 1998, presumed still extant.
[3]Collected in 1985. Not searched for in 1998, presumed still extant.
[4]Collected in 1985. Not searched for in 1998, status uncertain. Site is in heavily disturbed residential area.

portions of open pine forest bordering the extensive swamp along the Middle Branch. We also searched along the northernmost tributary of the Middle Branch in this zone. Here we found *Juncus caesariensis* and *Schizaea pusilla* in swamp openings adjacent to the stream. The former also occurred abundantly with numerous plants of *Lobelia canbyi* at the upper end of Dogleg Pond. In a sandy dug depression near the western end of Dogleg Pond, there were stands of *Rhynchospora knieskernii*. A small stand of *Calamovilfa brevipilis* occurred along the edge of a sand road south of Dogleg Pond. In 1985, Gordon collected *Rhynchospora nitens* in a pond heavily disturbed by residential development in the northern portion of this zone. We did not visit this pond in 1998.

**Zone 3S: South of the Middle Branch between the Garden State Parkway and Route 9.**

South of the extensive cedar swamp that borders Middle Branch is a maze of unimproved sand roads, dug ditches, dug ponds, and extensive deposits of dredged sand. There are scattered stands of dead small trees of *Chamaecyparis thyoides* that were killed by fire. Despite this disturbance, the area has a diverse terrestrial/wetland flora. Scattered stands of *Juncus caesariensis, Narthecium americanum*, and *Schizaea pusilla* were in or along the margins of dug ditches and ponds. *Utricularia purpurea* was abundant in a long canal-like broad ditch south of the knoll. A small stand of *Scleria minor* was on a moist sandy-peaty slope bordering a ditch northwest of the knoll. *Rhynchospora pallida* was abundant in moist open sandy depressions in the southeastern portion of the zone. *Calamovilfa brevipilis* primarily occurred along the edges of roads in damp sand throughout lower parts of the zone. *Leiophyllum buxifolium* and *Xerophyllum asphodeloides* were scattered throughout lower parts of the area in dry sand.

## CONCLUSIONS

The Middle Branch of the Forked River harbors a diverse assemblage of globally and state-rare plant species. It is an area that clearly merits some form of protection and management to maintain proper conditions for the continued existence of these species.

In some parts of the area, human disturbance has been beneficial for the rare plants. The large borrow pit, powerline clearing, numerous sand roads (some heavily used by recreational vehicles), dug ditches and ponds, and extensive deposits of dredged sand all provide early-successional habitats for rare plants. Periodic logging and fires also create such habitat conditions.

Some forms of human disturbance, however, are more severe and detrimental to rare plants. Extensive landscaping associated with residential and industrial development is in this category. The area between the Parkway and Route 9 is zoned for such development. We think steps should be taken to prevent this from happening.

Because so many rare species grow in early successional habitats created by human disturbance, it is not enough to merely protect land by allowing it to stay in a wild state. Without disturbance, the stronger competitors that grow in late successional habitats would replace rarer species. Therefore, a management plan should be designed for the entire watershed that allows for a balance between human disturbance and the survival of rare species.

## ACKNOWLEDGMENTS

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## LITERATURE CITED

GLEASON, H. A. AND A. CRONQUIST. 1991. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada*. 2nd ed. The New York Botanical Garden, Bronx.

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# The Vascular Flora of Statue of Liberty National Monument, New York Harbor

RICHARD STALTER AND NELSON TANG
*Department of Biological Science, St. John's University, Jamaica NY 11439*

ABSTRACT. The vascular flora of Statue of Liberty National Monument, a 4.86 hectare island in New York Harbor, consists of 97 species in 82 genera and 40 familes. The largest families in the flora are the Asteraceae (18 species) and Poaceae (16 species). Together these families comprise 34% of the flora. Non-native species, 65% of the flora, are a major component of the natural vegetation. A list of the 97 species of vascular plants is included in an appendix.

## INTRODUCTION

The Statue of Liberty National Monument, New York County, New York, is located on Bedloes Island, an island in the upper bay of New York Harbor (Anonymous 1999). Bedloes Island is named after its first owner, Isaac Bedloe, who acquired the island as a grant from the governor of New York prior to 1670. The island's ownership passed through several families before it was purchased by New York City to be used as a quarantine station. During the 1790s, the federal government expresed an interest in the site as a port, and in 1800 the title to the island was transferred from New York State to the federal government. By 1808, construction began on an 11-point star fort, which was completed in 1811. The fort was named Fort Wood, in 1814, in honor of Colonel Eleazer D. Wood, an officer killed in the War of 1812. Until the Civil War began in 1861, the fort was garrisoned with infantry and artillery; in 1861 it became a recruiting station and ordnance depot. After the end of the Civil War, from 1865 to 1877, the fort was garrisoned by a small number of soldiers. In 1877 the fort was selected as the site for the new statue, "Liberty Enlightening the World" (Anonymous 1999).

With the exception of an 1886 photograph showing what probably is *Ailanthus*, there are no photos of sufficient quality and clarity to identify the vegetation at the island. There are references to "Horse Chestnut" in old reports, but no vegetation lists exist for the island. The designer of the statue, Auguste Bartholdi, envisioned the statue protruding from a tree-covered island. But trees and people were not compatible and the vegation at the site today consists of a well maintained lawn, hedges of *Taxus cuspidata* and *Euonymus atropurpurea* and arborescent plantings of *Acer platanoides*, *Platanus acerifolia*, *Prunus serrulata* and *Tilia cordata*.

A literature search and consultation with park personnel indicate that there is no published or "in house" list of the vascular flora of Statue of Liberty National Monument. The objective of this study is to identify the vascular flora at the monument and compare the non-native and native vascular plants at this site.

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## METHODS

Six collecting trips were made to the study area during the growing season from 9 September 1999 to 15 August 2000. Objectives for each trip included collecting voucher specimens and accumulating information on abundance and apparent habitat preference for each species. Gleason and Cronquist (1991) was consulted to determine the native status of each taxon.

More than 250 specimens form the basis for this study. Taxonomically problematic specimens were sent to various experts for annotation; experts consulted are listed in the acknowledgments section. A complete set of voucher specimens has been deposited at the National Park Service (NPS) herbarium at Ellis Island, New York, and partial duplicate sets have been deposited in the herbaria of Brooklyn Botanic Garden (BKL), Missouri Botanical Garden (MO), and the University of South Florida (USF). Accession numbers will be assigned by the National Park Service to the primary set of specimens at the herbarium at Ellis Island and will be available upon request from the National Park Service.

Nomenclature follows Gleason and Cronquist (1991). Ornamental shrubs and trees were classified according to Rehder (1990).

## RESULTS AND DISCUSSION

The vascular flora of Statue of Liberty National Monument consists of 97 species in 82 genera and 40 families (Table 1). The major families of the total flora are the Poaceae (16 species) and Asteraceae (18 species); 34% of the species comprising the total flora are contained in these families. Sixty-three species, or 65% of the flora, are not native to New York State (Gleason and Cronquist 1991). Seventeen families represented in this survey are cmprised exclusively of non-native species. Families with large numbers of non-native plants are the Poaceae (11 species) and Asteraceae (10 species). Most species, native and non-native, occur principally in disturbed soil near the maintenance building, lawns, the drain surrounding the base of the statue and along the edge of the sea wall.

By comparison, New York State's vascular flora consists of 3,603 species, including 115 pteridophytes, 31 gymnosperms and 3,457 angiosperms. The most recent checklist of persisting vascular plants, compiled by Mitchell and Tucker (1997), includes 3,195 species; of these 2,078 (65%) are native and 1,117 (35%) are non-native.

Information in the Cultural Landscape Report (Anonymous 1999) lists several woody species that have been planted by the National Park Service: oriental cherry (*Prunus serrulata*), Norway maple (*Acer platanoides*), London plane tree (*Tilia cordata*), Japanese black pine (*Pinus nigra*). Horse-chestnut (*Aesculus hippocastanum*), oaks (*Quercus* spp.) and maples (*Acer* spp.) were present at the island when it was used as a military post. A photograph of the pedestal in 1886 includes *Ailanthus altissima*; this taxon is represented by a few small saplings today. Of the planted trees, only *Tilia cordata* and *Gleditsia triacanthos* are reproducing at the site.

Notable planted shrubs include a hedge of Japanese yew (*Taxus cuspidata*) and burning-bush (*Euonymus atropurpurea*). Additional shrubs planted in the 1960s were Amur privet (*Ligustrum amurense*), cockspur hawthorn (*Crataegus crus-galli*), English ivy (*Hedera helix*), and periwinkle (*Vinca* sp.). *Ligustrum amurense* and *Crataegus* hedges were removed in the mid-1980s. *Ligustrum amurense* is represented by a few naturally reproducing individuals near the sea wall.

TABLE 1. Statistical summary of the vascular flora of Liberty Island, New York.

| | Ferns | Gymnosperms | Dicots | Monocots | Total |
|---|---|---|---|---|---|
| Families | 1 | 1 | 33 | 5 | 40 |
| Genera | 1 | 1 | 66 | 14 | 82 |
| Species | 1 | 1 | 75 | 20 | 97 |
| Native Species | 1 | 0 | 26 | 7 | 34 |
| Introduced Species | 0 | 1 | 49 | 13 | 63 |

## ANNOTATED CHECKLIST OF SPECIES

The vascular plant taxa have been arranged according to the following categories: pteridophytes, gymnosperms, dicots, and monocots. Within each category, families and lower taxa are arranged alphabetically. The concept of families follows Cronquist (1988). Nomenclature primarily follows Gleason and Cronquist (1991), but taxonomic revisions in Kartesz (1994) were consulted to update the nomenclature. Each entry includes notes on habitat and frequency in the study area using the categories rare (less than 5 occurrences), infrequent (5 to 20 occurrences), frequent (more than 20 occurrences).

### POLYPODIOPHYTA

**Onocleaceae**

*Onoclea sensibilis* L. One individual at southeast base of statue; rare.

### PINOPHYTA

**Taxaceae**

**Taxus cuspidata* Sieb. & Zucc. Occasional seedlings, living quarters area; rare.

### MAGNOLIOPHYTA-MAGNOLIOPSIDA

**Amaranthaceae**

**Amaranthus crispus* (Lesp. & Thev.) N. Terrac. Disturbed soil, maintenance area; rare.
**Amaranthus hybridus* L. Disturbed soil near maintenance area; rare.

**Anacardiaceae**

*Rhus copallina* L. Disturbed sites near snack bar, one plant; rare.
*Toxicodendron radicans* (L.) Kuntze [*Rhus radicans* L.]. Japanese black pine grove; infreq.

**Apiaceae**

**Daucus carota* L. Lawns and disturbed sites; infreq.

**Apocynaceae**

*Apocynum cannabinum* L. Japanese black pine grove; rare.

*Introduced

**Asteraceae**

**Achillea millefolium* L. subsp. *lanulosa* (Nutt.) Piper. Lawn and disturbed sites; freq.
*Ambrosia artemisiifolia* L. Disturbed soils, maintenance area; rare.
**Arctium minus* Schk. Disturbed sites, near Japanese black pine grove; rare.
**Artemisia vulgaris* L. Disturbed sites; freq.
*Aster dumosus* L. Disturbed soils, maintenance area; rare.
*Baccharis halimifolia* L. Near base of statue; rare.
*Cirsium arvense* (L.) Scop. Disturbed soil, maintenance area; infreq.
*Conyza canadensis* L. (Cronq.) var. *canadensis* [*Erigeron canadensis* L. var. *canadensis*]. Gardens and disturbed sites; freq.
*Erigeron strigosus* Muhl. Disturbed soil; infreq.
*Eupatorium rugosum* Houtt. Disturbed soil near park headquarters; rare.
*Galinsoga quadriradiata* Ruiz & Pavon. Disturbed sites; freq.
**Hieracium caespitosum* Dumort. Disturbed sites and lawns; freq.
**Lactuca serriola* L. [*L. scariola* L.]. Disturbed soils, Japanese black pine grove; infreq.
**Matricaria discoidea* DC. [*Matricaria matricarioides* auct. non (Less.) Porter]. Disturbed sites and lawn near living quarters; infreq.
**Senecio vulgaris* L. Gardens, lawns, disturbed sites; freq.
**Sonchus asper* (L.) Hill. Disturbed sites; infreq.
**Sonchus oleraceus* L. Disturbed sites; infreq.
**Taraxacum officinale* Weber. Lawns and disturbed sites; freq.

**Brassicaceae**

**Alliaria petiolata* (Bieb.) Cavara & Grande. Japanese black pine grove; infreq.
**Barbarea vulgaris* R. Br. Near sea wall; rare.
**Capsella bursa-pastoris* (L.) Med. Disturbed sites; infreq.
*Lepidium virginicum* L. Disturbed soils; infreq.

**Caprifoliaceae**

**Lonicera japonica* Thunb. Under Japanese black pine; rare.

**Caryophyllaceae**

**Arenaria serpyllifolia* L. Disturbed soils and pathsides; freq.
**Cerastium fontanum* Baumg. subsp. *vulgare* (Hartman) Greuter & Burdet [*C. holosteoides* Fries var. *vulgare* (Hartman) Hylander, *C. vulgatum* L.]. Lawns and disturbed sites; infreq.
**Cerastium glomeratum* Thuillier [*C. viscosum* L.]. Disturbed sites; infreq.

**Caesalpiniaceae**

**Gleditsia triacanthos* L. Seedlings from cultivated plants; infreq.

**Chenopodiaceae**

**Atriplex patula* L. Near sea wall, maintenance area; rare.
**Chenopodium album* L. Gardens and waste areas; freq.
**Chenopodium ambrosioides* L. Disturbed soils; infreq.

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*Introduced

**Clusiaceae**
*Hypericum punctatum* Lam. Lawn near living quarters; infreq.

**Convolvulaceae**
**Convolvulus arvensis* L. Disturbed sites and on lawns; freq.

**Euphorbiaceae**
*Acalypha virginica* var. *rhomboidea* (Raf.) Cooperider [*Acalypha rhomboidea* Raf.]. Disturbed soils; infreq.
*Chamaesyce maculata* (L.) Small [*Euphorbia maculata* L., *E. supina* Raf.]. Gardens and disturbed soil; freq.

**Fabaceae**
**Medicago lupulina* L. Disturbed soil near maintenance area; rare.
**Trifolium aureum* Pollich. Lawns; infreq.
**Trifolium hybridum* L. Roadsides and lawns; rare.
**Trifolium repens* L. Roadsides, lawns and waste places; freq.

**Lamiaceae**
**Lamium amplexicaule* L. Disturbed soils and lawns; infreq.

**Malvaceae**
**Abutilon theophrasti* Medik. Disturbed soils, maintenance area; rare.
**Hibiscus syriacus* L. Seedlings from planted specimens, living quarters; rare.
**Hibiscus trionum* L. Disturbed soil, work area near snack bar; rare.
**Malva neglecta* Wallr. Gardens and disturbed sites; infreq.

**Molluginaceae**
**Mollugo verticillata* L. Gardens and disturbed sites; infreq.

**Moraceae**
**Morus alba* L. Near sea wall and Japanese black pine grove; rare.

**Oleaceae**
**Ligustrum amurense* Carr. Near sea wall, maintenance area; rare.

**Oxalidaceae**
*Oxalis dillenii* Jacq. Gardens and disturbed sites; infreq.

**Phytolaccaceae**
*Phytolacca americana* L. Disturbed sites; rare.

**Plantaginaceae**
**Plantago lanceolata* L. Lawns and disturbed sites; freq.
**Plantago major* L. Lawns and disturbed sites; infreq.

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*Introduced

**Platanaceae**
**Platanus acerifolia* (Ait.) Willd. Occasional seedlings from planted trees; rare.

**Polygonaceae**
*Polygonum aviculare* L. Disturbed sites; infreq.
*Polygonum pensylvanicum* L. Disturbed soil, maintenance area; rare.
*Polygonum ramosissimum* Michx. var. *ramosissimum*. Near sea wall; rare.
**Rumex acetosella* L. Disturbed soils and lawns, living quarters; infreq.
**Rumex crispus* L. Disturbed soil, Japanese black pine grove; infreq.

**Portulacaceae**
**Portulaca oleracea* L. Disturbed sites, and lawns; freq.

**Ranunculaceae**
**Delphinium ajacis* L. Disturbed soil, maintenance area; rare.
*Ranunculus abortivus* L. Japanese black pine grove, 5 individuals; rare.

**Rosaceae**
**Prunus avium* L. Gardens, living quarters, one tree; rare.
*Prunus serotina* Ehrh. Near sea wall, maintenance area; rare.

**Salicaceae**
**Populus deltoides* Marshall. One plant, base of statue; rare.

**Simaroubaceae**
**Ailanthus altissima* (P. Mill.) Swingle. Several individuals, Japanese black pine grove; rare.

**Solanaceae**
**Lycopersicon esculentum* L. Flower garden, maintenance area; rare.
**Solanum dulcamara* L. Disturbed sites; freq.
*Solanum nigrum* L. var. *virginicum* L. [*S. americanum* Miller]. Disturbed sites; rare.

**Tiliaceae**
**Tilia cordata* L. Disturbed sites; rare.

**Ulmaceae**
*Celtis occidentalis* L. Japanese black pine grove; rare.
**Ulmus pumila* L. Near sea wall, maintenance area; rare.

**Violaceae**
*Viola sororia* Willd. [*V. papilionacea* Pursh]. Lawns, disturbed soils; freq.

**Vitaceae**
*Parthenocissus quinquefolia* (L.) Planchon. Japanese black pine grove; rare.

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*Introduced

MAGNOLIOPHYTA-LILIOPSIDA

**Commelinaceae**

**Commelina communis* L. Disturbed sites, lawns; infreq.

**Cyperaceae**

*Cyperus esculentus* L. Disturbed soil, maintenance area; infreq.

**Iridaceae**

*Sisyrinchium angustifolium* Miller. Lawn near path around statue; rare.

**Liliaceae**

**Allium vineale* L. Lawns; infreq.
**Ornithogalum umbellatum* L. Lawn near living quarters; infreq.

**Poaceae**

*Agrostis perennans* (Walt.) Tuckerman. Disturbed sites; infreq.
**Aira caryophyllea* L. Disturbed soils; infreq.
**Bromus tectorum* L. Disturbed soils; infreq.
**Bromus racemosus* L. Lawn near living quarters; rare.
**Dactylus glomerata* L. Lawn near living quarters; rare.
**Digitaria sanguinalis* (L.) Scop. Lawns and disturbed sites; freq.
**Eleusine indica* (L.) Geartn. Disturbed sites; infreq.
*Festuca rubra* L. Lawns and disturbed soils; freq.
**Lolium perenne* L. Disturbed soils; infreq.
*Panicum dichotomiflorum* Michx. Disturbed soil, maintenance area; rare.
*Phragmites australis* (Cav.) Trin. [*P. communis* Trin.]. Growing on base of statue; rare.
**Poa annua* L. Lawns, disturbed soil; freq.
**Poa pratensis* L. Lawns; infreq.
**Setaria glauca* (L.) Beauv. Disturbed soils, maintenance area; infreq.
*Setaria viridis* (L.) Beauv. Disturbed soils; infreq.
**Sorghum halepense* (L.) Pers. Disturbed soil, maintenance area; infreq.

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*Introduced

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## Literature Cited

Anonymous. 1999. Cultural Landscape Report for Liberty Island, Statue of Liberty National Monument. History, Analysis and Treatment Recommendations. Olmstead Center for Landscape Preservation, National Park Service, Boston. 89 pp.

Cronquist, A. 1988. The Evolution and Classification of Flowering Plants. 2nd ed. The New York Botanical Garden, Bronx. 555 pp.

Gleason, H.A. and A. Cronquist. 1991. Manual of Vascular Plants of the Northeastern United States, Canada, and Greenland. 2nd ed. The New York Botanical Garden, Bronx. 910 pp.

Kartesz, J.T. 1994. A Synonymized Checklist of the Vascular Flora of the United States, Canada, and Greenland. 2nd ed. Volume 1. Timber Press, Inc., Portland, Oregon. 622 pp.

Mitchell, R.S. and G.C. Tucker. 1997. Revised Checklist of New York State Plants. Bulletin No. 490. New York State Museum, State Education Department, Albany. 400 pp.

Rehder, A. 1990. Manual of Cultivated Trees and Shrubs. Dioscorides Press, Portland, Oregon. 996 pp.

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# Pteridophyte Distribution by Township in Venango County, Pennsylvania

CARL F. CHUEY
*Herbarium, Biological Sciences, Youngstown State University, Youngstown, OH 44555*

The distribution of the pteridophyte flora in Venango County, Pennsylvania was investigated as part of an ongoing study of pteridophyte distribution by township or district in western Pennsylvania, northern West Virginia and eastern Ohio (Chuey 1976, 1980, 1983; Chuey and Sturm 1969; Isaac and Chuey 1992a, 1992b).

Venango County, formed in 1800, contains 1,740 $km^2$ (679 sq. mi.) and is located in northwestern Pennsylvania. The 1990 population was 59,381. The density, 34.1 persons $km^{-2}$ (87.9 persons per sq. mi.), is the tenth largest in western Pennsylvania. Major population centers include Franklin, the county seat, Oil City and Polk. Venango County increased in population with every census except two through 1940 (Riesenman 1943); this trend continued with only two declines in the succeeding censuses (Andriot 1980).

All but the western edge is unglaciated (Wherry et al. 1979). Thus, it is in both the Glaciated and the Unglaciated Allegheny Plateau physiographic provinces. Located in the Allegheny River basin, the major tributaries in the county include French Creek, Oil Creek, Sandy Creek and East Sandy Creek. According to Braun (1950), it is at the interface of the Hemlock-White Pine-Northern Hardwoods Region and Mixed Mesophytic Forest Region; Kuchler (1964) put it at the interface of Northern Hardwoods and Appalachian Oak Forest.

## METHODS

At the Herbarium of Youngstown State University (YUO), the fourth largest herbarium in Ohio, Venango County is represented by the largest holding from one county, with 1,403 specimens out of the 13,344 specimens from Pennsylvania. Carnegie Museum (CM), the largest herbarium in western Pennsylvania with 567,000 specimens (Holmgren et al. 1990), has 2,350 specimens from Venango County. Information on species distribution presented in this paper (Table 1) is based solely on these specimens. The classification hierarchy is based on Crabbe et al. (1975) and the nomenclature follows that of the *Flora of North America* (Flora of North America Editorial Committee 1993).

## RESULTS AND DISCUSSION

Despite the county's relatively high population density, some taxa such as *Equisetum arvense, Dryopteris intermedia, Polystichum acrostichoides* and *Onoclea sensibilis* have been found in all townships (Table 1). With additional fieldwork I would expect *Diphasiastrum*

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Table 1. Distribution by township in Venango County, Pennsylvania, of pteridophyte specimens at the Herbarium of Youngstown State University (YUO) and the Carnegie Museum (CM). Codes are: **Y**, specimen at YUO, collected since 1965; **C**, specimen at **CM** collected since 1965, **C***, specimen at CM collected between 1900-1965; C**, specimen at CM collected before 1900.

| | Allegheny Twp. | Canal Twp. | Cherry Tree Twp. | Clinton Twp. | Cornplanter Twp. | Cranberry Twp. | French Creek Twp. | Irwin Twp. | Jackson Twp. | Mineral Twp. | Oakland Twp. | Oil Creek Twp. | Pine Grove Twp. | Plum Twp. | President Twp. | Richland Twp. | Rockland Twp. | Sandy Creek Twp. | Scrubgrass Twp. | Sugar Creek Twp. | Victory Twp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *D. digitatum* (Dill.) Holub | C Y | Y | Y | Y | Y | C Y | Y | C* Y | Y | C* Y | Y | | Y | C* Y | Y | C* Y | C* Y | | C* Y | | Y |
| *D. tristachyum* (Pursh) Holub | | | | | | C Y | | | | | | | | C* | | | C* | C* | | | |
| *Huperzia lucidula* (Michx.) Trevisan | | | | Y | Y | C Y | Y | C* | C* | C* Y | | C* | Y | C* Y | Y | C* Y | C* Y | | C* Y | C* Y | C |
| *Lycopodium annotinum* L. | | | | C* | | | C* | | | | | | | | Y | C* | | | | | |
| *L. clavatum* L. | C Y | | | C* | Y | Y | | | | Y | | | | | | C* | Y | | Y | | |
| *L. dendroideum* Michx. | C Y | | Y | C* | | C Y | | | | C* Y | Y | | Y | C* | Y | C* | | | C* Y | | Y |
| *L. obscurum* L. | | C* | Y | Y | Y | C Y | C* Y | Y | | C* Y | Y | C* | Y | | C* Y | C* Y | Y | Y | C* Y | Y | Y |
| *Selaginella apoda* (L.) Spring | | | | C* | | | C* | | | | | | | | | | | | C* Y | | |
| *Equisetum arvense* L. | Y | Y | Y | C* Y | Y | Y | C* Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | C* Y | Y |
| *E. fluviatile* L. | | | | C | | | | | | | | | | | | | | | | | |
| *E. hyemale* L. | | Y | | | | | Y | | | | | | | Y | | | | | | | |
| *Botrychium dissectum* Spreng. | Y | | | C* Y | | C Y | | C* | | | | | | C* | Y | C* | C* Y | | | | |
| *B. matricariifolium* (Coll) A. Braun | | | | | | | | | | | | | | | | | | | C* | | |
| *B. oneidense* (Gilbert) House | | C* | | | | Y | | | | | | | | | Y | | | | | | |
| *B. virginianum* (L.) Sw. | | | | | | Y | | | | | | | | | | | | | Y | | Y |
| *Ophioglossum vulgatum* L. | | | | | | Y | | | | | | | | | | | | | | | |
| *Osmunda cinnamomea* L. | C* Y | Y | Y | Y | C Y | C Y | C* Y | Y | | C* Y | Y | Y | Y | C* Y | Y | Y | Y | Y | C* | C* | C** Y |

| | *O. claytoniana* L. | *O. regalis* L. | *Adiantum pedatum* L. | *Polypodium appalachianum* Hauf. & Wind | *P. virginianum* L. | *Asplenium montanum* Willd. | *A. platyneuron* (L.) Oakes | *A. rhizophyllum* L. | *A. trichomanes* L. | *Athyrium filix-femina* (L.) Roth | *Cystopteris protrusa* (Weath.) Blasd. | *C. tenuis* (Michx.) Desv. | *Dennstaedtia punctilobula* (Michx.) Moore | *Deparia acrostichoides* (Sw.) M. Kato | *Dryopteris carthusiana* (Vill.) Fuchs | *D. cristata* (L.) A. Gray |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Victory Twp. | Y | | Y | C** | Y | | Y | | | | | C** | Y | | | |
| Sugar Creek Twp. | C* Y | | | | Y | | C* | | | C* | | | C* | C Y | Y | |
| Scrubgrass Twp. | C* Y | | C* Y | Y | Y | | | | C* | C* | | C* | C* Y | C* | C* | |
| Sandy Creek Twp. | C* Y | | C* Y | | Y | C* | C* | | | | | | Y | Y | Y | |
| Rockland Twp. | Y | | Y | | | | C* | Y | | C* | C* | C* Y | Y | | Y | Y |
| Richland Twp. | Y | C | C* | | C* | | | | | C Y | | | | | C* | |
| President Twp. | C Y | | C Y | | C Y | | | | | C Y | | | Y | C | Y | |
| Plum Twp. | Y | | | | | | | | | C* Y | | | C* | | | |
| Pine Grove Twp. | Y | | | | | | | | | Y | | | Y | | Y | |
| Oil Creek Twp. | C* Y | | | | C* | | | | | | | | Y | | Y | |
| Oakland Twp. | Y | | | | | | Y | | | Y | | Y | Y | | | |
| Mineral Twp. | C* Y | | C* | | C* Y | | | | | C* | | | C* Y | | C* | C* |
| Jackson Twp. | Y | | | | | | C* | | | | | | Y | | | |
| Irwin Twp. | C* Y | | C* Y | | | | | | | C* | | | C* | | | |
| French Creek Twp. | C* Y | C | C* | C* | Y | | | | | C* | | | C* | | | |
| Cranberry Twp. | C* Y | Y | Y | Y | C* Y | | Y | | | Y | | | C Y | | Y | Y |
| Cornplanter Twp. | C Y | | Y | | | | Y | | | Y | | | Y | | C | |
| Clinton Twp. | C** Y | Y | C Y | C | Y | | | | C** | C Y | | C* | C Y | Y | Y | |
| Cherry Tree Twp. | Y | | | | | | | | | Y | | | Y | | | |
| Canal Twp. | | C | | | | | Y | | | C* | | | | | Y | C Y |
| Allegheny Twp. | C Y | | | C | | | | | | C Y | | | C* | | C | |

| | *D. goldiana* (Hooker) A. Gray | *D. intermedia* (Muhl.) A. Gray | *D. marginalis* (L.) A. Gray | *Gymnocarpium dryopteris* (L.) Newm. | *Matteuccia struthiopteris* (L.) Todaro | *Onoclea sensibilis* L. | *Phegopteris connectilis* (Michx.) Watt | *P. hexagonoptera* (Michx.) Fee | *Polystichum acrostichoides* (Michx.) Schott | *Pteridium aquilinum* (L.) Kuhn | *Thelypteris noveboracensis* (L.) Nieuwl. | *T. palustris* Schott |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Victory Twp. | | C** Y | | | | C* Y | | | Y | C* Y | | |
| Sugar Creek Twp. | | Y | Y | | | Y | | | C Y | C* Y | C* Y | |
| Scrubgrass Twp. | | C* Y | | | C* | C* Y | C* | | C* Y | C* | C* | C* |
| Sandy Creek Twp. | | Y | C* | | | Y | | | C* Y | | C* Y | |
| Rockland Twp. | | Y | C* Y | | | Y | | | Y | Y | Y | |
| Richland Twp. | | Y | Y | C* | | Y | | | Y | Y | | |
| President Twp. | | C Y | C Y | | C | C Y | C | | C Y | Y | Y | |
| Plum Twp. | C* | C* Y | Y | | | C* Y | | | Y | Y | C* | |
| Pine Grove Twp. | | Y | | | | Y | | | Y | Y | Y | |
| Oil Creek Twp. | | Y | | | | Y | | | Y | C Y | Y | |
| Oakland Twp. | | Y | | | | Y | | | Y | Y | Y | |
| Mineral Twp. | | C* Y | C* | | | C* Y | | C* | C* Y | C Y | C* | |
| Jackson Twp. | | Y | C* | | | Y | | | Y | Y | Y | |
| Irwin Twp. | | Y | | | | Y | | | C* Y | C* | C* | |
| French Creek Twp. | | C* Y | Y | | C* Y | C* Y | | | C* Y | C* Y | C* Y | |
| Cranberry Twp. | | C Y | C* Y | | | C* Y | | | C Y | C Y | C Y | |
| Cornplanter Twp. | | C Y | Y | | | Y | | | C Y | | Y | |
| Clinton Twp. | | C* Y | C Y | | C | Y | C | | C Y | Y | C Y | |
| Cherry Tree Twp. | | Y | | | | Y | | | Y | Y | Y | |
| Canal Twp. | | C Y | | | Y | Y | | | Y | Y | Y | |
| Allegheny Twp. | | C Y | C Y | | | C* Y | | | C Y | C Y | C Y | |

*digitatum*, *Lycopodium obscurum*, *Osmunda cinnamomea*, *O. claytoniana*, *Athyrium filix-femina*, *Dennstaedtia punctilobula*, *Pteridium aquilinum* and *Thelypteris noveboracensis* also to be found in all townships.

Based on the herbarium label data, some of the more unusual taxa such as *Asplenium montanum*, *A. trichomanes*, *Dryopteris goldiana*, *Gymnocarpium dryopteris*, *Phegopteris hexagonoptera*, *P. connectilis*, *Ophioglossum vulgatum* and *Botrychium matricariifolium* have not been found since the mid-1960s or occur only in isolated locations. Some may no longer be present in the flora. Rhoads and Klein (1993) reported *Botrychium lanceolatum*, *B. simplex*, and *Ophioglossum pusillum* for the county and Parks (1989) reported that *Vittaria* and *Trichomanes* gametophytes are found in Venango County; however, there are no specimens at either CM or YUO. *Lycopodium hickeyi*, *Equisetum fluviatile*, *E. sylvaticum*, *Lygodium palmatum*, *Pelleae atropurpurea*, *Cystopteris bulbifera*, *C. fragilis*, *Dryopteris clintoniana*, *Woodsia obtusa*, *Woodwardia areolata* and *W. virginica* have been found in adjacent counties (Rhoads and Klein 1993) and could reasonably be expected in Venango County, although there are no specimens from the county at CM or YUO. None of the taxa represented by specimens at CM or YUO is listed as endangered or threatened (Wild Resource Conservation Fund 1995).

With increased population pressures requiring more land for homes, shopping malls and roads, the fern and fern allies can be expected to be reduced in numbers. But Venango County has an abundance of wild land, including State Game Lands No. 39, No. 45, No. 47, No. 96, and No. 253 (collectively containing 9,123 ha [22,542 acres]), the Allegheny River area of Clearfield State Forest (1,281 ha [3,165 acres]), Oil Creek State Park (2,843 ha [7,026 acres]), Two Mile Run County Park (1,091 ha [2,695 acres]), and conservation easements of the Western Pennsylvania Conservancy in President Township (4,570 ha [11,300 acres]). We should expect most, if not all, of the taxa to remain a part of the flora of Venango County.

## Literature Cited

ANDRIOT, J. L. 1980. *Population Abstract of the United States.* Andriot Associates, McLean, VA.

BRAUN, E. L. 1950. *Deciduous Forests of Eastern North America*, Hafner Publishing Co., New York.

CHUEY, C. F. 1976. Tricounty pteridophytes: a catalog of ferns and their allies occurring in Trumbull, Mahoning, and Columbiana Counties, Ohio. *Laitsch Herbarium Publications of Youngstown State University* 1: 1-26.

CHUEY, C. F. 1980. Pteridophyte distribution: study of the ferns and their allies in the upper Ohio River basin. *Laitsch Herbarium Publications of Youngstown State University* 2: 1-57.

CHUEY, C. F. 1983. Pteridophyte flora of Ashtabula County, Ohio by township. *Laitsch Herbarium Publications of Youngstown State University* 3: 1-48.

CHUEY, C. F. AND N. STURM. 1969. Pteridophyte checklist of Ashtabula, Trumbull and Mahoning Counties, Ohio. *American Fern Journal* 59: 41-44.

CRABBE, J. A., A. C. JERMY, AND J. T. MICKEL. 1975. A new generic sequence for the pteridophyte herbarium. *Fern Gazette* 11: 141-162.

FLORA OF NORTH AMERICA EDITORIAL COMMITTEE. 1993. *Flora of North America North of Mexico, Vol. 2, Pteridophytes and Gymnosperms.* Oxford University Press, New York.

HOLMGREN, P. K., N. H. HOLMGREN, AND L. C. BARNETT. 1990. *Index Herbariorum*, Part 1, *The Herbaria of the World* (8th ed.). New York Botanical Garden, Bronx, NY.

ISAAC, B. L. AND C. F. CHUEY. 1992a. Distribution of the pteridophyte flora of Brooke County, West Virginia, by district. *Laitsch Herbarium Publications of Youngstown State University* 5: 3-6.

ISAAC, B. L. AND C. F. CHUEY. 1992b. Pteridophyte flora of Forest County, Pennsylvania by township. *Laitsch Herbarium Publications of Youngstown State University* 5: 7-11.

KÜCHLER, A. W. 1964. *Potential Natural Vegetation of the Conterminous United States.* American Geographical Society, New York.

PARKS, J. C. 1989. Distribution of gameotophytic populations of *Vittaria* and *Trichomanes* in Pennsylvania. *Rhodora* **91**: 201-06.

RIESENMAN, J., JR. 1943. *History of Northwestern Pennsylvania.* Lewis Historical Publishing Co., New York.

RHOADS, A. F. AND W. MCK. KLEIN, JR. 1993. *The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas.* American Philosophical Society, Philadelphia.

WHERRY, E. T., J. M. FOGG, JR. AND H. A. WAHL. 1979. *Atlas of the Flora of Pennsylvania.* Morris Arboretum of the University of Pennsylvania, Philadelphia.

WILD RESOURCE CONSERVATION FUND. 1995. *Endangered and Threatened Species of Pennsylvania.* Wild Resource Conservation Fund, Harrisburg, PA.

# Joseph Andorfer Ewan (1909–1999)

With the death of Joe Ewan, the world lost a scientist with enormously broad interests and experience. His expertise ranged across plant systematics and other fields of botany, the history of natural history and of the European exploration of the non-European world, bibliography, biography, etymology, and the history of the world's museums, libraries, and botanical gardens. Joe had a rare ability to carry out rigorous research with joy and enthusiasm. Colleagues found him a charming and stimulating collaborator and mentor, and he touched countless other careers in his long life. When Joe's career began, histories of science and biographies of scientists were almost always the leisure-time productions of scientists, and few contributed as much to the professionalization of these fields as he did.

Joe was born in Philadelphia on 24 October 1909. At the age of three, he moved to Los Angeles, where he lived until he was 24. It was here, in the sunny mountains and valleys of southern California that Joe's interest in the natural world developed. The Ewan Collection at the Missouri Botanical Garden includes a series of notebooks from his high school years, full of detailed observations on the birds, trees, and general natural history of the area. As a senior at Belmont High School, he was president of the Belsci Science Club, and contributed to the Belmont Sentinel. It was in high school, too, that Joe discovered the human side of natural history. The used bookstores of Los Angeles provided him with his first rare books, and authors' dedications and previous owners' names piqued his curiosity. He tried to trace some of these names, and was quickly led to view books, not just as passive containers of data, but as living links between the reader and a chain of previous owners, publishers, authors and their teachers, colleagues, libraries, and correspondents. This view of books as connecting threads running through the fabric of scholarship was one of the defining themes of Joe's career.

Joe's interests found greater focus when he entered UCLA in 1928. His first professional publications appeared in southwestern birders' journals in his freshman year, but, influenced by plant taxonomist Carl Epling, his primary interest soon turned forever to botany. It was at UCLA also that Joe met fellow student Nesta Dunn, whom he married in 1935. Nesta was (and is) a talented biologist who shared Joe's interests in botany and history. She would be a collaborator on much of his life's work, as well as a stimulating and supportive partner in all the major endeavors of his life.

On the advice of his UCLA mentors, Joe transferred to the University of California at Berkeley in 1933, where he finished his A.B. in 1934 and began graduate work. Here, he worked four hours a day, 8 to 12 a.m., on the Flora of California project under Berkeley's brilliant but emotionally unstable taxonomist, Willis Lynn Jepson, and began his own research on the taxonomy of the large, predominantly western genus *Delphinium*. Like many others before and after him, Joe found Jepson a rewarding but very difficult person to work with. An immensely talented botanist, Jepson had broad interests and a splendid way with words (he also published poetry), and he could be a wonderful teacher and companion, but he was irrationally suspicious and regularly feuded with most of the people around him, often working himself up into frightening bouts of vehemence. Joe learned much about the biology of plants and the practice of taxonomy from Jepson and other Berkeley botanists (notably H. L. Mason), but he also suffered much from Jepson's shortcomings, especially the suspicion Jepson felt when Joe became friendly with other faculty members and other botanists whom Jepson distrusted. Joe's work in Berkeley taught him a great deal, but it ended unhappily, as Joe left in 1937 without completing a graduate degree.

After leaving Berkeley, Joe took up a position as Instructor at the University of Colorado, Boulder, where he remained until 1944. Joe continued to publish on the botany of western North America and Hawaii and the taxonomy of *Delphinium*. The Colorado years were marked by field trips and collaborative work with other Rocky Mountain biologists, notably Frederick Clements and Aven Nelson, and by the births of Joe and Nesta's three daughters. Joe also wrote a series of articles on early botanical explorers of Colorado for the journal *Trail and Timberline*, work that opened the line of research that Joe is best remembered for — tracing the history of biological exploration of the New World and the development of an independent American tradition of academic biology.

Like many botanists of the time, Joe joined the wartime botanical inventories of economic plants, spending 13 months in 1944 and 1945 inventorying wild stands of *Cinchona* in the Andes of southern Colombia, in and around the department of Nariño, for the Foreign Economic Administration. Conditions were difficult and the long separation from his family was frustrating, but this work introduced Joe to the biota and culture of tropical America, which remained a lifelong interest.

The end of the war brought a difficult and uncertain time for the Ewans. The job at Colorado was no longer available. Through the help of Ray Fosberg, a friend from student days at UCLA, Joe held temporary positions with the Smithsonian Institution and with the Bureau of Plant Industry, where he served as acting curator of the herbarium of the U. S. National Arboretum. In 1947 he accepted a permanent position at Tulane University, where he remained for the rest of his career.

At Tulane, Joe continued his research in plant systematics, working primarily on South American ferns, Gesneriaceae and Clusiaceae, and keeping in touch with the growing involvement of U.S. botanists in tropical America. The experience many scientists gained in the wartime botanical inventories and the greater availability of grant money stimulated a great increase in field research in Central and South America. New Orleans was the main transfer point for travel to the south in those days, and Joe kept in close touch with scientists working all over the Neotropics. More and more, however, Joe's interests turned to the process of scientific exploration itself, its history and the way it is shaped by social and political trends.

Academic bibliography was transformed in the 1950s and 1960s by the appearance of affordable photo-offset reproduction and high quality color printing, and many old books and sets of unpublished drawings, previously rare and in some cases almost unobtainable, became available and affordable for libraries and scientists. Joe was at the center of this transformation. He edited, and wrote substantial introductions for, many important botanical and zoological reprints for several publishers. Most important among these were eight titles in Hafner's photo-offset series *Classica Botanica Americana*, which made many major early works on North American botany available to the modern scientist, and *William Bartram: Botanical and Zoological Drawings, 1756 – 1788*, published by the American Philosophical Society in 1968. Joe published his own books as well as other people's. Chief among these are *Rocky Mountain Naturalists* (1950), *John Banister and his Natural History of Virginia* (with Nesta Ewan, 1970), *Biographical Dictionary of Rocky Mountain Naturalists* (with Nesta Ewan, 1981), and a still-unpublished biography of Benjamin Smith Barton, also a collaboration with Nesta. In the end, his bibliography grew to include more than 400 books, articles, and reviews (a complete bibliography is provided by Dorr and Holland in an issue of *The Archives of Natural History* dedicated to Joe).

Throughout the Tulane years, Joe and Nesta traveled widely, attending meetings, visiting libraries and archives, and meeting new people everywhere. A Guggenheim Fellowship allowed them to spend a year at the British Museum (Natural History) in 1954–1955, and summers teaching at Swarthmore and the University of Hawaii further broadened their experience and contacts. Joe valued a "sticky mind" — one that retained facts and recalled them at appropriate moments — and his was one of the stickiest. Interesting observations, significant associations, and odd details that shed light on scientists and their work were a joy to Joe, and he displayed them, admired them, and traded them with the zeal of a diamond merchant in a melodrama. He met and corresponded with numerous biologists, archivists, librarians, historians, and book dealers, and many whose interests and work included the history of biology found that Joe had become a unique and important part of their lives. His charm and enthusiasm drew many people into the field; his encouragement stimulated many casual enthusiasts to begin working systematically; and his willingness to share his incredible knowledge of the field aided the work of many a professional. Joe received awards from a suitably diverse array of academic organizations, the most notable being the Eloise Payne Luquer Medal of the Garden Club of America, the Founder's Medal of the Society for the History of Natural History, and the Henry Shaw Medal of the Missouri Botanical Garden. He was named Ida Richardson Professor of Botany at Tulane in 1972 and Fellow of the Linnaean Society (London) in 1976, and received honorary Sc. D. degrees from the College of William and Mary in 1972 and Tulane in 1980.

Joe continued to collect books, and his library grew into a unique collection of great significance. Most important is the huge collection of early travel narratives and reports from all parts of the non-European world but especially tropical America, invaluable alike for tracing the provenance of early collections and recording the impressions that early Western visitors formed of non-European cultures and environments. The collection of biographies, textbooks, and floras, both historical and modern, are also notable. The library is given particular significance and charm by numerous association volumes and annotated working copies of past experts. A stroll through the collection turns up a seemingly endless series of unique books and papers: Henry Hurd Rusby's copy of Bates' *The Naturalist in the River Amazons*, battered and water-damaged from crossing Brazil and Bolivia with Rusby in 1885-1886, which Joe bought for $1.00 in 1928; Richard Spruce's copies of Boussingault's *Viaje Científicos a los Andes Ecuatoriales* and Markham's *Expeditions into the Valley of the Amazons, 1539, 1540, 1639,* both copiously annotated by Spruce with comments and corrections based on his nineteenth-century travels in the same areas; the copy of Edgar Anderson's *Plants, Man, and Life* that Anderson marked up when planning a revised edition that was never written; a set of student notes from John Lindley's Systematical (sic) Botany class at University College, London, written by Lindley's nephew, who took the class in 1845-1846; the manuscript of Carl Epling's massive *Flora of Northern Idaho*, which Joe and Nesta tried, unsuccessfully, to find a publisher for in the depths of the Depression; and many others. For Joe, each volume carried some of the personality of its author and former owners. He delighted in sharing these treasures with his colleagues — and anyone who was interested was a colleague. Casual conversations over lunch often turned into explorations of the stacks, as Joe seldom hesitated to down his lunch in mid-sandwich to answer a question, check a fact, or acquaint his fortunate companions with a useful or interesting reference that they had not seen before. "Book openeth book," Joe was fond of saying, and by one o'clock the table was often stacked with volumes, every one of them a treasured old friend to Joe and an enticing new acquaintance to his companions.

Almost as important as the Ewan library are the Ewan papers. Joe maintained — and preserved — a correspondence with numerous botanists and historians, and he preserved masses of ephemeral material — articles in newspapers and newsletters, old road maps (valuable for finding field sites obscured by the renaming or relocation of roads and towns), photographs, handwriting samples, book jackets, and pamphlets and flyers of all kinds. Here also are notes and drafts of unfinished projects, especially the massive "Andes and Amazon," a huge file that Nesta and Joe assembled on scientific explorers of tropical South America that was intended to become a big brother to *Rocky Mountain Naturalists*, but is available only as a massive and well-organized file of notes.

Joe retired from Tulane in 1977, but he continued to be active in research and teaching. He served as visiting professor at the University of Oregon in 1978 and 1981 and Ohio State University in the spring of 1982, and was Regent's Fellow at the Smithsonian Institution in 1984-85. In 1986, Joe and Nesta sold their library and papers to the Missouri Botanical Garden. They followed the collection to St. Louis, where they continued to work with and add to it. Here at a large research institution (the Garden had a permanent staff of more than 40 research botanists throughout this period), the Ewans were surrounded by people who could appreciate their unique knowledge and expertise, and the constant stream of visiting botanists coming to use the herbarium and library, work with the staff botanists, and attend the annual Systematics Symposium, brought a volume of personal contact with colleagues that they had not known since New Orleans ceased to be a major transfer point for travel to the south. Joe and Nesta quickly became valued members of the Garden community, and lunch with the Ewans and their collection (then housed in the ornate 1859 Museum Building) was a delight that brought together a diverse group of botanists, historians, and bibliophiles who still meet regularly to share their views on plants and the scientists who study them.

Joe suffered a cerebellar stroke in December of 1996. His intellect and memory were unaffected by the stroke, but his motor skills were seriously impaired, and he tired very easily, so he was no longer able to live without professional aid. He and Nesta moved to a nursing home in Mandeville, Louisiana, where they were close to Kathleen and Dick Harris, their eldest daughter and son-in-law. Joe retained his humor and enjoyment of his colleagues and the work they were doing, but he was unable to do any significant amount of work himself, and he quickly grew frustrated with his monotonous, unproductive life in the nursing home. He left strict instructions that there should be no extraordinary medical effort made to save him in case of illness, and told people, with perfect good humor and in perfect earnestness, that he hoped he wouldn't live much longer. He came down with the flu on Thanksgiving Day, 1999. When his overall condition deteriorated about a week later, he refused hospitalization very forcefully; when asked what should be done if his heart stopped, he said, tell everybody goodbye. When he died, Nesta was with him, and Kathleen and Dick were nearby.

Joe was a charming companion and valued resource to numerous friends and correspondents. He loved history as a vista of the myriad ideas and viewpoints on the natural world that have been held at different times and places, and of the virtues and foibles of the people who have held them. He loved books as windows into other times and other minds, and most of all he loved sharing his discoveries with anyone who would truly appreciate them. With joy and enthusiasm he brought together biologists, historians, librarians, archivists, and bibliophiles, starting productive collaborations and enduring friendships among people who would never have become acquainted with one another — and with one another's viewpoints and fields of study — without Joe. The Ewan library and archive at the Missouri Botanical Garden are unique treasures, and we who knew Joe can never see the library and papers without seeing him, flitting from shelf to shelf, his face alight with pleasure. "Book openeth book," but scholar openeth scholar, too, and Joe's greatest legacy is the ever-expanding array of people whose minds have been broadened by contact with him, who have gone on to pass a bit of his understanding and enthusiasm to other colleagues.

## Ada Nesta Ewan (1908–2000)

Since these words were written, Nesta Ewan has also died. She was born Ada Nesta Dunn in northern Saskatchewan on 8 November 1908. She grew up in Saskatoon and Calgary, then the family moved to Los Angeles, where she attended UCLA. Like Joe, she was strongly influenced by Carl Epling (she not only studied with him, but frequently babysat for his children). Nesta met Joe in botany classes at UCLA and they were married when she joined him in Berkeley after finishing her masters' degree. In the early decades of their marriage Nesta worked as a librarian, as well as raising their three daughters and collaborating with Joe on research projects. Later, Nesta left her library job and devoted her full time to research and bibliography, collaborating with Joe on many projects. Nesta lacked Joe's flamboyant exterior but she shared his broad interests, high standards for academic work, and willingness to offer her time and expertise to help other workers. Life alone in the nursing home held few rewards for Nesta. When complications from antibiotics prevented effective treatment of a serious infection, she requested that the medication be discontinued and said goodbye to her family. Joe and Nesta were a united couple and an effective team who will be remembered with respect and affection by hundreds of colleagues.

Alan T. Whittemore
Missouri Botanical Garden

*Current address*:
U.S. National Arboretum
3501 New York Avenue NE
Washington, DC 20002-1958

# Elizabeth Miner Woodford
# (22 May 1916–26 November 1999)

The death of Elizabeth "Betty" Woodford of Medford Township, New Jersey, has left a great void in my heart and in the hearts of many others whom she also inspired and whose lives she enriched. Her death at age 83 at Virtua Health-West Jersey Hospital in Berlin resulted from complications related to Alzheimer's disease. She is survived by her two children, Richard Wurster of Topanga, California, and Jeanne Woodford of Medford Township; a brother, Robert Miner of Rancocas; a sister, Julia Grayham of Edgewater Park; four grandchildren; and two great-grandchildren.

Born on a Burlington County farm on Bustleton Road in Florence Township, New Jersey, Betty moved to Delanco at age four and in 1933 was a graduate of nearby Palmyra High School. Deeply involved in the outdoors, she nurtured her botanical interests by completing a three-year course at the Arboretum School of the Barnes Foundation in Merion, Pennsylvania, in 1956. She also studied at the Morris Arboretum in Philadelphia. In the late 1950s, Betty became a member of the Philadelphia Botanical Club and, much to her delight, was selected to honorary membership in March 1994. It was in 1957 when she and her husband Jim built their home on a lake in a 184-acre parcel of pinelands in Medford Township. On a portion of the land, they developed Cedar Run Wildlife Refuge to nurse back to health injured and orphaned animals with the intention of releasing them back to the wilds. Gradually the refuge added an environmental education component where thousands of local children as well as adults received their introduction to the beauty concealed in an ecosystem of scrub pines. Betty steadily developed an extensive library on birds, insects, mammals, herptiles, and natural history that became the envy of local naturalists, who were graciously encouraged to use it. Both Woodfords became licensed bird banders, enabling them not only to attract more supporters to the refuge but also to make substantial contributions to our knowledge of regional bird life. At present, the highly successful work of the refuge and education center is being continued under the direction of their daughter, Jeanne.

In the 1960s and 1970s, many residents statewide who did not know Betty Woodford by name knew her simply as "the Pine Barrens Lady." Her reputation as a champion of Pinelands protection and preservation and as a premier naturalist was hard earned, well deserved, and widely known. World renowned wildlife photographer Leonard Lee Rue III, a close friend who influenced her photography and at times accompanied her in the field, praised Betty for her broad botanical knowledge. Much to the delight of pine barren scholars and enthusiasts, she lobbied for the republication of two classics long out of print and hard to obtain. She persuaded Dover Publications to reissue in 1970 John W. Harshberger's *The*

*Vegetation of the New Jersey Pine-Barrens* (1916) and Quarterman Publications to reissue in 1973 Witmer Stone's *The Plants of Southern New Jersey* (1911). She wrote the foreword to the Stone reprint. In a book called *Medford Pioneering Township*, published in 1975, she authored a chapter titled "In Fields and Woodlands." Also the same year, the Medford Township Environmental Commission published her illustrated pamphlet, *A Home in the Pines*, focusing on landscaping with native plants to protect this fragile ecosystem. For years, Betty wrote a weekly nature column that appeared as "Wild and Free" in the *Burlington County Times* and later as "Ways of the Wild" in *The Central Record* of Medford. These articles reveal her broad knowledge of the regional flora and fauna and her understanding of conservation and environmental issues.

I met Betty in 1968 on a field trip she led into the heart of Wharton State Forest. The following year I was a participant in her spring evening course on the Pine Barrens of New Jersey, offered at Lenape Regional High School. It was the beginning of a long friendship, forged while engaged in mutual exploration and photographic documentation of the flora of the barrens. On excursions in forest and field, no nuance escaped Betty's detection. From her I learned to see afresh, and her influence on my photographic technique, particularly in composition, was great.

Betty Woodford's ethic emanated from an innate desire to protect all things wild. In cherishing nature and admonishing all whose lives she touched to preserve it, she lived Thoreau's dictum, "in wildness is the preservation of the world."

TED GORDON
31 Burrs Mill Road
Southampton, NJ 08088

# The Schuyler Herbarium Internship

In the spring of 2000, the Philadelphia Botanical Club initiated a campaign to raise $100,000 for an internship in the herbarium of The Academy of Natural Sciences. The internship was named for Academy botanist Alfred E. (Ernie) Schuyler, and announced at his retirement party given by the club at the Morris Arboretum on 27 April 2000. Dr. Schuyler, who served as a curator in the Academy's Botany Department from 1 September 1962 to 31 July 2000, is now Curator Emeritus of Botany at the Academy. He edited the club's journal Bartonia from 1970 to 1999.

The intern will be expected to perform work related to the care and maintenance of the Academy's Local Herbarium/Herbarium of the Philadelphia Botanical Club, which covers counties in Pennsylvania, New Jersey, Delaware, and Maryland that are within 50 miles of Philadelphia. The work includes: (1) routine herbarium chores such as mounting specimens, filing specimens, and identifying specimens, (2) arranging loans for botanical researchers at other institutions, (3) working with Academy staff to computerize selected portions of the herbarium, (4) field exploration to update our holdings of plants growing in the local area, (5) conducting research on problematic plant groups, and (6) participation in botanical club meetings, field trips, and projects.

Initially this is intended to be a one-year part-time position for college graduates with backgrounds in botany, and who want to pursue careers dependent on knowledge of botany. We envision this will ultimately become a full-time position. The work will provide useful experience for those who want to go on to graduate school, continue with museum work, or do environmental work for government agencies or private consulting firms.

The Philadelphia Botanical Club has had a close relationship with the Local Herbarium/Herbarium of the Philadelphia Botanical Club since its founding in 1891. Goals of the club and the Academy's Botany Department are the same in many respects. The Schuyler Herbarium Internship will enable both organizations to work toward their mutual goals more effectively.

Thanks to the donors in the gift categories listed below, over $30,000 was contributed to the Schuyler Herbarium Internship Fund between its inception in April 2000 and 15 December 2000 (over 30% of our goal of $100,000). Many contributions have been received since then. To make donations, checks should be payable to the Philadelphia Botanical Club and mailed to: Schuyler Herbarium Internship Fund, The Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia PA 19103-1195.

TED GORDON
Chairman
*Schuyler Herbarium Internship Fund Committee*

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# *Amaranthus pumilus* Raf. (Seabeach Amaranth, Amaranthaceae) Rediscovered in Sussex County, Delaware

In August of 2000, *Amaranthus pumilus* was rediscovered in Sussex Co., Delaware after 125 years without a sighting. It was first collected in Delaware in 1875 by Albert Commons (10 September 1875, *A. Commons*, s.n., "seabeach, Baltimore Hundred, Delaware," PH).

*Amaranthus pumilus* was federally listed as threatened by the U.S. Fish and Wildlife Service in 1993. Historically, this species was known from Massachusetts south to South Carolina (Weakley et al. 1996). *Amaranthus pumilus* was reported as rediscovered at Assateague Island National Seashore, Worcester County, Maryland in 1998 (Ramsey 2000). Prior to rediscovery on Assateague Island and in Sussex County, *A. pumilus* was extant on Long Island, New York, and in North Carolina and South Carolina.

Lisa Marie Kendall of the Delaware Natural Heritage Program, Division of Fish and Wildlife, Delaware Department of Natural Resources discovered the first plants on 7 August 2000. Subsequent surveys revealed a total of 41 individuals scattered over 22 kilometers of Atlantic shoreline. All plants found are within the boundaries of Delaware Seashore and Fenwick Island State Parks. The largest number of plants (28) was found within a 1.5-km stretch of shoreline near the swimming beach at Delaware Seashore State Park. This section of beach is the only area where *A. pumilus* was found that is off-limits to vehicular traffic. This area provides the best habitat for the long-term survival of *A. pumilus*.

Individual plants were found growing on relatively open sand near the base of the primary foredune. Though overall plant cover was quite sparse, common associates include *Ammophila breviligulata, Cakile edentula* (most prevalent), *Cenchrus tribuloides, Chamaesyce polygonifolia, Salsola kali,* and *Triplasis purpurea*. Plants of *A. pumilus* were often associated with a wrack line, which appeared to be composed primarily of broken and decomposing canes of *Phragmites australis*. Chris Lea, ecologist at Assateague Island National Seashore, speculates that wrack lines may be acting as a seed trap for *A. pumilus* (pers. comm.).

Soon after the rediscovery of *A. pumilus*, seeds were collected from August to September and sent to the Mt. Cuba Center for the Study of Piedmont Flora in Greenville, Delaware. Rick Lewandowski, Director of the center and his staff will attempt to germinate and rear plants of this annual species for planting next season in the areas where seeds were collected.

In addition to seeds, fresh leaf material was also collected from several plants and sent to Dr. Kim Hunter at Salisbury State University where comparative DNA studies will be done. The rediscovery of *A. pumilus* on the Delmarva Peninsula (Worcester County, Maryland and Sussex County, Delaware) could be the result of propagules being deposited from southern populations (currents run south to north), or from the unearthing of dormant soil seed banks. DNA studies may help to answer these questions.

In addition to the rediscovery of *A. pumilus* in Sussex County, another exciting find was made by Frank Hudson, ecologist at Assateague Island National Seashore. Frank, along with others from Assateague Island were visiting the Sussex County population and found *Polygonum glaucum* growing near individuals of *A. pumilus*. *P. glaucum* is considered to be globally rare by The Nature Conservancy and was last collected in Delaware in 1936 (31

August 1936, *E. Larson*, 1216, "sandy beach, 3 miles north of Broadkill Beach," Sussex County, Delaware, PH).

The Delaware Natural Heritage Program performs annual surveys for listed and candidate plant species in Delaware using funds from the U.S. Fish and Wildlife Service.

WILLIAM A. MCAVOY
Delaware Natural Heritage Program
Delaware Department of Natural Resources
Division of Fish and Wildlife
4876 Haypoint Landing Road
Smyrna, DE 19977

## LITERATURE CITED

WEAKLEY, A., M. BUCHER AND N. MURDOCK. 1996. Recovery Plan for Seabeach Amaranth (*Amaranthus pumilus* Raf.). U.S. Fish and Wildlife Service, Atlanta, GA.

RAMSEY, S., W. TYNDALL AND C. LEA. 2000. Scientific note: the federally threatened *Amaranthus pumilus* Raf. (seabeach amaranth, Amaranthaceae) rediscovered on Assateague Island after 31 years. *Castanea* **65**: 165-167.

# Pine-Barren Golden-Heather (*Hudsonia ericoides* L.) Reported for the First Time in Maryland

On 24 May 2000, while searching for rare plants in Anne Arundel County, Maryland, I made a significant discovery along a Baltimore Gas & Electric Company's transmission line right-of-way off Marley Station Boulevard. I chanced upon a new woody vascular plant for Maryland, the pine-barren golden-heather (*Hudsonia ericoides* L.). I returned to the site on 3 June to conduct a more extensive search for the heather. I found additional clumps of 11, 2, and 15 plants as I progressed farther along a 230-foot stretch of the right-of-way.

Vascular plants growing at or near these clumps of golden-heather included blackberry (*Rubus* sp.), sheep-sorrel (*Rumex acetosella*), matting rosette grass (*Dichanthelium meridionale*), broom panic grass (*D. scoparium*), glaucous greenbrier (*Smilax glauca*), frostwort (*Helianthemum* sp.), broomsedge (*Andropogon virginicus*), Virginia pine (*Pinus virginiana*), creeping bush-clover (*Lespedeza repens*), a tall hairy bush-clover (*Lespedeza* sp.), sassafras (*Sassafras albidum*), old-field toadflax (*Linaria canadensis*), southern red oak (*Quercus falcata*), sweet vernal grass (*Anthoxanthum odoratum*), white thoroughwort (*Eupatorium album*), dwarf dandelion (*Krigia virginica*), horseweed (*Erigeron canadensis*), poverty wild oat grass (*Danthonia spicata*), forked rush (*Juncus dichotomus*), and wavy hair grass (*Deschampsia flexuosa*). The tree species in both plots were merely scrub-like due to periodic maintenance cutting. The soil in the area is Evesboro loamy sand, a very sandy upland soil (Kirby and Matthews 1973). The forest on both sides of the right-of-way is dominated by Virginia pine and Virginia pine-mixed oak.

Voucher specimens (*Sipple 2032, 2033*, and *2034*) of the pine-barrens golden-heather have been submitted to herbaria at Delaware State University, the Philadelphia Academy of Natural Sciences, and the Anne Arundel County Community College.

According to the Maryland Natural Heritage Program (Lynn Davidson, pers. comm., 2000) and the Delaware Natural Heritage Program (Bill McAvoy, pers. comm., 2000), this species has never been reported from Maryland and is considered extremely rare in Delaware. It was not listed by Steiber (1967, 1971) in his Anne Arundel County flora, and Brown and Brown (1972) state that it "has never been reported in Maryland, but has been found in Delaware and adjacent Virginia." Tatnall (1946) cites only Delaware collections. Fernald (1950) mentions its presence in Delaware but suggests that reports from Virginia need verification. Although McAtee (1918) reported it from the Norfolk-Virginia Beach area, it is not listed for Virginia by Harvill et al. (1992). Gleason & Cronquist (1991) cite only Delaware for the Delmarva Peninsula. The Natural Resources Conservation Service's PLANTS database (http://plants.usda.gov/ plants/) lists this species from all of the New England states, as well as New York, New Jersey, Delaware, and South Carolina, but not from Maryland or Virginia.

On my two earlier visits and a 10 June 2000 visit to the site, I searched the Virginia pine and Virginia pine-mixed oak forests on both sides of the right-of-way hoping to find some openings in the pines supporting the heather, but found none. The nature of the forest in some areas astride the right-of-way suggests that they were more open in the past, and xeric forested knolls do exist. Given the topography in the area and the sandy soils, I suspect that the heather once occurred here independent of the right-of-way.

A more detailed account of this discovery and commentary on the significance of rights-of-way, particularly if they are maintained in natural vegetation by cutting or burning, can be found in *The Maryland Naturalist* (Sipple, in press).

William S. Sipple
512 Red Bluff Court
Millersville, MD 21108

ACKNOWLEDGMENTS

The author appreciates the cooperation of Bill McAvoy (Delaware Natural Heritage Program), Kathy McCarthy, and Lynn Davidson (Maryland Natural Heritage Program) in providing information on the known distribution of the pine-barren golden-heather in Delaware and Maryland. Bill McAvoy, Charlie Davis, and two unidentified reviewers also commented on the larger manuscript cited above from which this note was derived. I appreciate their input. I likewise appreciate cooperation of Joel Snodgrass, the editor of *The Maryland Naturalist*, in allowing this shorter note on the pine-barren golden-heather to appear in *Bartonia*.

LITERATURE CITED

BROWN, R.G. AND M.L. BROWN. 1972. *Woody Plants of Maryland*. Port City Press, Inc., Baltimore.

FERNALD, M.L. 1950. *Gray's Manual of Botany*. Van Nostrand Reinhold Company, New York.

GLEASON, H.A. AND A. CRONQUIST. 1991. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada*. New York Botanical Garden, New York.

HARVILL, A.M. JR., T.R. BRADLEY, C.E. STEVENS, T.F. WIEBOLDT, D.M.E. WARE, D.W. OGLE, G.W. RAMSEY, AND G.P. FLEMING. 1992. *Atlas of the Virginia Flora*. Virginia Botanical Associates, Farmville, VA.

KIRBY, R.M. AND E.D. MATTHEWS. 1973. *Soil Survey of Anne Arundel County, Maryland*. U.S. Department of Agriculture, Soil Conservation Service, Washington, DC.

MCATEE, W.L. 1918. A sketch of the natural history of the District of Columbia. *Bulletin of the Biological Society of Washington* 1: 1-142.

SIPPLE, W. S. (In press.) Pine-barren golden-heather (Cistaceae: *Hudsonia ericoides* L.): range extension and a new woody plant for Maryland. *Maryland Naturalist.*

STEIBER, M.T. 1967. An annotated checklist of the vascular flora of Anne Arundel County, Maryland. Master's Thesis, Catholic University of America, Washington, DC. 70 pp.

STEIBER, M.T. 1971. The vascular flora of Anne Arundel County, Maryland: an annotated checklist. *Castanea* 36: 263-312.

TATNALL, R.R. 1946. *Flora of Delaware and the Eastern Shore: An Annotated List of the Ferns and Flowering Plants of the Peninsula of Delaware, Maryland and Virginia*. The Society of Natural History of Delaware, Wilmington.

# What's New at the Department of Botany, Academy of Natural Sciences

Many changes are underway in the Academy's Department of Botany (PH), involving both personnel and physical plant. *Bartonia* editor Dr. Roger Latham has invited us to provide you with a brief overview of developments. We are delighted to share our enthusiasm for plants and the plant collection here with you and we look forward to interacting with the readers of the journal over the coming years.

*Lucinda McDade*

I will begin by telling you a bit about myself, Lucinda McDade. As the newest staff member in the Department of Botany, I am still finding my way around and have a great deal to learn. I arrived here at the beginning of the year from the University of Arizona where I was curator of the herbarium and associate professor in the Department of Ecology and Evolutionary Biology and the Department of Plant Sciences. My research interests have focused on three areas: systematics of the family Acanthaceae, plant reproductive biology, and hybridization as a mode of evolution and a problem (or not) for phylogenetics. Most recently, I have been involved in some rewarding collaborative efforts to straighten out our understanding of relationships among the major lineages of Acanthaceae (reprints available on request!). Since my graduate student days, I've done a great deal of field work in the New World tropics. More recently, I've begun to work in Africa as well; I spent three very productive months in South Africa last year.

My focus on the tropics perhaps is a natural result of my having grown up in South Florida. I did my undergraduate work at Tulane University and then went to Duke for my Ph.D. After completing my doctorate, I had a productive year as a postdoctoral associate at the Smithsonian Tropical Research Institute in Panama. Before I moved to the University of Arizona, I worked for the Organization for Tropical Studies. O.T.S. is a consortium of universities that has field stations in Costa Rica (some readers may have heard of La Selva Biological Station) and offers field courses in Costa Rica, Brazil and Peru. I was in charge of all of O.T.S.'s educational programs and, although my main location was at the North American office of O.T.S. at Duke in North Carolina, I spent a great deal of time in Costa Rica. Accepting a faculty position at the University of Arizona represented a move to more research and teaching, both of which I missed in my position at O.T.S. Moving here represents another change in professional focus although I intend to continue to be active in training graduate students; an appointment at U. Penn will make this feasible. Accepting the position here of course brings many challenges and I look forward to working with many of you toward meeting these challenges.

I share curatorial responsibility here with Dr. Richard McCourt who writes:

"With the recent arrival of Dr. Lucinda McDade (Associate Curator and Chair) and Dr. James Macklin (Collection Manager) I have become an old-timer in the department, although I've been here only four years. I moved here from DePaul University in Chicago where I was an Associate Professor of Biological Sciences. My background and research are in phycology, the

Rick McCourt

study of algae. Although the collections of algae here are small in comparison to those of land plants, the Academy has a long record of research in algae. The Academy has been the home of Dr. Ruth Patrick and Dr. Charles Reimer, experts on diatom systematics and ecology, and Dr. Francis Drouet, a botany curator who was a world authority on blue-green algae. I worked on brown seaweeds in the Gulf of California while studying for my Ph.D. at the University of Arizona. Later I moved into the systematics of conjugating green algae (*Spirogyra* and relatives) and Characeae (*Chara* and *Nitella*), which occur in the Philadelphia region and worldwide. These green algae are among the closest living algal relatives to primitive land plants, such as liverworts and mosses. My laboratory has many cultures of these algae, which I observe and use in my molecular systematic research. I extract DNA and sequence genes from green algae to decipher the evolutionary tree of green plants. Ultimately, my research relates to the origin of land plants and the genetic novelties that accompanied their transition from a wet to a dry habitat some 400 to 500 million years ago.

"Working at the Academy also satisfies my avid interest in historical botany, specifically the early exploration of the western United States by Lewis and Clark and others. I'm eager to develop public outreach programs for the upcoming bicentennial celebration (2003-2006) of the Lewis and Clark expedition. This pioneering trip began in Philadelphia, where Meriwether Lewis trained with the preeminent botanists of his day. In a sense it also ended here, when the scientific specimens came back to the city with the explorers. Lewis and Clark's specimens are but the tip of the iceberg in terms of historically important collections here, and we hope to use the bicentennial as a springboard to increase awareness of the contributions of botany to our national history. I look forward to working with the Philadelphia Botanical Club on various projects, not least among them the development of the Schuyler Internship program for the enhanced care of our collections."

Dr. James Macklin is the new collection manager in Botany. He comes to us from Canada after receiving his Ph.D. in plant systematics from the University of Western Ontario in London, Ontario. Currently, James's research focuses on the patterns of variation in *Crataegus* (Maloideae, Rosaceae). He is interested in the interaction of native and invasive species in eastern North America. Here at the Academy, James plans to become involved in teaching and outreach projects. He is also a strong proponent of bioinformatics and looks forward to creating a database that will vastly improve access to information in the botany collections.

*James Macklin, James Lendemer, and Rachel Wilson*

Dr. Rachel Wilson has been a research collaborator in Rick McCourt's lab since January, when she began an eight-month sabbatical leave from teaching to investigate cellular, biochemical, and reproductive features of the alga *Spirogyra* and a closely related species

*Sirogonium*. Her work in the Botany Department began several summers ago, when she spent a day or two each week in Rick's lab learning DNA purification and amplification techniques. She plans to continue her current project at the Academy part-time after returning to teaching in September at Philadelphia University, where she is an associate professor of biology.

Sarah Corbett has been the Flora of Pennsylvania Intern since June 2000, after graduating magna cum laude with a B.S. in biology from Valdosta State University in Georgia. Half of the internship is herbarium work at the Academy and the other half is a research project on the Pennsylvania flora supervised by Dr. Ann Rhoads and Dr. Tim Block at the Morris Arboretum. Sarah's research is a floristic inventory of a recent addition to French Creek State Park near the Pine Swamp Natural Area. She has collected about 250 species and mapped the plant associations of the tract, which harbors at least six rare plant species. Sarah writes:

*Sarah Corbett*

"I have come to know the Academy herbarium as few do. My duties here have included preparing specimen labels, mounting, accessioning specimens, processing loans, filling information requests, and many other routine herbarium activities. In addition, I've been an extra set of hands for moving cabinets, specimens, etc., during recent drastic changes in the herbarium. The internship is a year-long appointment, and I will be heading to graduate school in the fall to study paleobotany at the University of Florida."

We are very fortunate to have the faithful assistance of one of the Academy's most active volunteers, James Lendemer. James is a junior in high school but he has already been working here for more than three years. James writes:

"When I first began my work in the Department of Botany in early 1998 under the guidance of Earle Spamer I set out on a total reorganization of the paleobotany collection. The reorganization resulted in the recovery of numerous type specimens of fossil plants as well as the recovery of an interesting collection of fossil plants identified by Leo Lesquereux and included in his work *The Coal Flora* [see article in this issue on page 55]. Since that time I have taken up the task of electronically cataloging the type collection of extant lichens, bryophytes, and fungi. This work has also led me to actively search and retrieve the many unrecognized type specimens in the general herbarium. Currently, I am preparing a catalog of the type lichens at PH for eventual publication."

We are happy to say that Curator Emeritus A. E. (Ernie) Schuyler continues to be active in the department and in teaching. He is pursuing his research interests in the systematics and ecology of rare plants, relationships between plant diversity and environmental quality, and the history of botanical exploration in North America. He periodically teaches university, college, and adult education courses in plant systematics, ecology, and environmental issues.

Finally, we would like to bring you up-to-date on physical changes that are underway at the herbarium. The new Lewis and Clark Types Room, across the hall from the previous types room, is essentially complete. It has been outfitted with its own HVAC system, a state-of-the-art fire suppression system, and special dust-free ceiling tiles. This room will house all of our type specimens and other specimens of special historical significance. Cabinets designed specifically to house the Lewis and Clark collection are on order. We have acquired a large chest freezer and are hard at work freezing portions of the herbarium where bugs have been active. Five days at –20°C has been shown to kill these pests. Once specimens are freed of bugs we will hold as many of them as we can on the fifth floor in herbarium cases with tightly sealing, gasketed doors. We have begun a program of baiting and trapping the beetles that are the culprits. This should enable us to diagnose the problem and make short-term plans to reduce further damage as much as possible. The longer-term, and only real, solution is to replace all of the cabinetry with herbarium cases with sealed doors. We anticipate submitting a proposal to the National Science Foundation in September for this project.

We have made some changes to the fifth floor with the goal of providing better space for working with plant specimens. There is a new extensive work area in the alcove, with windows and lots of space for spreading out and studying specimens. John Kunsman from The Nature Conservancy has already used it and pronounced it most excellent. We have also reclaimed one of the areas hidden away behind the compactors for use as a reading room.

The fifth floor will shortly have two labs up and functioning — one dry lab for microscope and specimen work and one wet lab for molecular and other work. These will complement other facilities in the Department of Botany and in the other biodiversity departments and give us the capacity to accommodate research by ourselves, postdocs, and students. We anticipate an active and vibrant community of researchers sharing the botany floors with us. We look forward to showing many of you the changes that are underway!

LUCINDA MCDADE
*Associate Curator and Chair*
Department of Botany
Academy of Natural Sciences of Philadelphia
June, 2001

# 1997–1999 FIELD TRIPS

## 1997 Field Trips

**2 April:** Valley Forge National Historic Park, PA. This was a joint trip with the Perkiomen Valley Watershed Association on a cold rainy day. Growing on a bank, an unusually large patch of *Epigaea repens*, with only a single plant in bloom, had been severely browsed by deer. This patch was associated with many plants of *Hieracium venosum*. Following a path along the Schuylkill River from Betzwood Bridge west, we observed the usual common spring flora including *Viola, Glechoma, Oxalis,* and *Sanicula*. Trip leaders: Val Udell and Ann Newbold.

**17 May:** Bowman's Hill Wildflower Preserve, Bucks County, PA. The wildflower preserve offers a unique opportunity to see a large number of species in one location in a natural setting. We explored the many trails of the preserve, beginning at the headquarters garden where we observed *Antennaria solitaria, Epigaea repens, Dodecatheon medea, Trillium cernuum, T. grandiflorum, and T. sessile.* On the Parry Trail, we saw *Jeffersonia diphylla, Hydrophyllum virginianum, Claytonia virginica, Cardamine concatenata, Caulophyllum thalictroides, Mertensia virginica, Polemonium reptans, Mitella diphylla,* and *Viola striata.* We also saw the two varieties of *Phlox divaricata*, var. *laphamii* with entire corolla lobes and var. *divaricata* with notched corolla lobes. On the Azalea Trail, we saw *Gaylussacia brachycera, Viola hirsutula, Anemone quinquefolia, Phlox stolonifera, Saxifraga virginiensis, Packera aurea* (*Senecio aureus*), *Rhododendron periclymenoides,* and *Cercis canadensis.* We also saw very poor specimens of *Galax aphylla.* On the Bluebird Trail, *Hydrophyllum canadense* was seen with *H. virginianum* and *Allium tricoccum.* The weedy, introduced *Ranunculus ficaria* was also observed. The violets on the Violet Path included *Viola striata, V. sororia,* and *V. pubescens.* On the Gentian Trail, we observed *Itea virginica, Saxifraga pensylvanica, Ranunculus hispidus* var. *nitidus, Carex prasina, Chelone glabra, Caltha palustris, Iris versicolor, Hypericum pyramidatum, Acorus calamus, Carex trichocarpa, Saururus cernuus, Euphorbia purpurea, Stellaria pubera, Chrysogonum virginianum, Sedum ternatum,* and *Meehania cordata.* Along the Harshberger Trail was *Euonymus americana, Meehania cordata, Jeffersonia diphylla, Trillium sessile, T. cuneatum, Dicentra eximia, Cypripedium calceolus,* and *Uvularia grandiflora.* Along the Medicinal Trail we saw *Deparia acrostichoides, Hydrastis canadensis, Moehringia lateriflora, Cystopteris protusa, Erigenia bulbosa,* and *Zanthoxylum americanum.* The Pocono Laurel Trail had *Pyrularia pubera.* The Fern Trail was explored more for spring wildflowers than ferns, although, a few fern species were observed. These included *Cystopteris fragilis* and *C. bulbifera.* Flowering species included *Packera obovata (Senecio obovatus), Brachyelytrum erectum, Viola conspersa, V. canadensis, V. palmata, Thalictrum thalictroides, Geranium robertianum, Dentaria diphylla,* and *Streptopus roseus.* In the bog, we observed *Helonias bullata* and *Chamaecyparis thyoides.* The Marsh-marigold Trail had *Stylophorum diphyllum, Collinsia verna, Cypripedium calceolus, Veratrum viride, Symplocarpus foetidus* and *Mitella diphylla. Clethra acuminata* was observed on the Cornus Bend, and *Lupinus perennis* was seen on the Aster Walk. Attendance: 13. Leader: Bill Olson.

**31 May**: Funks Pond Recreational Area north of the Conowingo Dam, Cecil County, MD. From the Route 1 parking lot, we proceeded down the gravel and woodland trails leading into the young thickets and forested ravines that dissect this corner of Cecil County. Along the trails we encountered unusual species such as *Carex jamesii* (abundant), *Veratrum viride*, *Triosteum perfoliatum* (in a pipeline cut), *Hydrastis canadensis*, *Hydrophyllum virginianum*, *H. canadensis*, *Scutellaria nervosa*, and a colony of *Lithospermum latifolium* in bloom. An adult and hatchling box turtle, a caerulean warbler, and a fawn were among the fauna seen. After lunch the party circled Funks Pond, encountering such species as *Orobanche uniflora*, *Phlox divaricata*, *Caulophyllum thalictroides*, and several escaped goats that were chewing up the vegetation. We concluded the trip with a long rugged hike up a steep ridge. At the top we were rewarded by the sight of a large healthy population of *Hybanthus concolor* in bloom along with other rarities and unusual species such as *Piptochaetum avenaceum*, *Tradescantia virginiana*, and *Cheilanthes lanosa* on the dry edge and rocks of the bluff. Attendance: 15. Leaders: Janet Ebert and Jack Holt.

**14 June**: Sadsbury Woods, Chester County, PA. This newly established preserve of the Natural Lands Trust includes one of the largest tracts of continuous forest cover remaining in western Chester County. Geologically, the site consists of a ridge of Chickies Quartzite surrounded by gneiss. Small lenses of serpentinite and pegmatite dikes are also present in the vicinity. Buck Run borders the woods on the south. Sadsbury Woods includes mature red oak-mixed hardwood forest, palustrine forest along Buck Run, areas of successional forest, woodland seeps, and a former quarry with successional old-field species. Traces of earlier habitation including stone walls and an early hand-dug well are present in parts of the woods. We added at least 59 species to lists compiled during previous visits, with the results that combined lists included 62 woody taxa (trees, shrubs, and vines), 21 ferns and fern allies, and 166 herbaceous taxa for a total of 249. A sampling of species on the site includes *Dryopteris carthusiana*, *Huperzia lucidula*, *Thelypteris hexagonoptera*, *Corylis americana*, *Fagus grandifolia*, *Angelica venenosa*, *Carex glaucodea*, *C. laxiculmis*, *Chamaelirium luteum*, *Cimicifuga racemosa*, *Isotrea verticillata*, *Prenanthes altissima*, *Rhexia virginica*, *Trillium cernuum* var. *cernuum*, and *Viola hirsutula*. Leader: Ann Rhoads.

**22-26 June:** Shenandoah National Park, VA. The joint field meeting of the Philadelphia Botanical Club, the Torrey Botanical Society, and the Northeast Section of the Botanical Society of America took place in the central district of Shenandoah National Park. Most of the participants were housed at historic Skyland Lodge at milepost 41.7 on the Skyline Drive. Field trips to Hawksbill Mountain, Big Meadows, Millers Head, and Hoover Camp yielded panoramic vistas, billion-year old granite rocks, a hybrid moss *Huperzia appalachiana* × *lucidula*, nine species of orchids including *Habenaria (Platanthera) orbiculata*, *H. viridis*, and *Liparis liliifolia* in bloom, and the only known station for *Arctostaphylos uva-ursi* in Virginia. Larry Klotz of Shippensburg University, with assistance from other botanists, maintained a plant list for all sites, and this was sent to the National Park Service for the record. Several uncommon plants were found including *Aconitum reclinatum*, *Streptopus amplexifolius*, and *Botrychium matricariifolium*. Botanist members led groups of participants on the trails and provided expertise with identification. Chris Ludwig of the Virginia Heritage Program led the foray into the 150-acre Big Meadows site, where grasses, sedges, and ericaceous shrubs dominated the complex of managed, open habitat. Here the group found *Botrychium multifidum*, including one specimen with a precocious fertile frond. Each evening the group heard the perspectives of guest speakers. Robert Johnsson spoke on the flora of the upper Potomac Basin and Shenandoah, emphasizing plants that have unusual or disjunct distribution in the region. Chris Ludwig discussed the rare plants and significant natural communities of Shenandoah. Tom Blount of the National Park Service spoke about Shenandoah ecology and gave insight into the historical value and current problems facing the park. Joan Gottlieb presented "A Portrait of Shenandoah National Park," a retrospective focusing on the flora of the site. Attendance: 69. Chairperson for the field meeting: Joan Gottlieb.

**5 July**: Bulls Island and Prallsville Mills, Hunterton County, NJ. This was a joint trip with the Torrey Botanical Society to visit floodplain forest. Among the typical tree species were box-elder (*Acer negundo*), silver maple (*A. saccharinum*), river birch (*Betula nigra*), green ash (*Fraxinus pennsylvanica*), black walnut (*Juglans nigra*), sweetgum (*Liquidambar styraciflua*), sycamore (*Platanus occidentalis*), and silk-tree *(Albizia julibrissin*), an invasive. Shrubs included wild hydrangea (*Hydrangea arborescens*) and elderberry (*Sambucus canadensis*). Some of the more interesting vines were hogpeanut (*Amphicarpaea bracteata*), Japanese hop (*Humulus japonicus*), hop (*H. lupulus*), everlasting pea (*Lathyrus latifolius*), moonseed (*Menispermum canadense*), climbing false-buckwheat (*Polygonum scandens*), and bur-cucumber (*Sicyos angulatus*). Herbs in bloom included scarlet pimpernel (*Anagallis arvensis*), dog-fennel (*Anthemis cotula*), Chinese mustard (*Brassica juncea*), black mustard (*B. nigra*), hemp-nettle (*Galeopsis tetrahit*), celandine (*Chelidonium majus*), Indian strawberry (*Duchesnia indica*), wormseed mustard (*Erysimum cheiranthoides*), common quickweed (*Galinsoga quadriradiata*), dame's-rocket (*Hesperis matronalis*), dwarf St.-John's-wort (*Hypericum mutilum*), American water-willow (*Justicia americana*), nipplewort (*Lapsana communis*), motherwort (*Leonorus cardiaca),* false-pimpernel (*Lindernia dubia*), fringed loosestrife (*Lysimachia ciliata*), monkey-flower (*Mimulus ringens*), umbrellawort (*Mirabilis nyctaginea*), carpetweed (*Mollugo verticillata*), forget-me-not (*Myosotis scorpioides*), catnip (*Nepeta cataria*), ditch stonecrop (*Penthorum sedoides*), plantain (*Plantago rugelii*), figwort (*Scrophularia marilandica*), giant chickweed (*Stellaria aquatica*), tall meadow-rue (*Thalictrum pubescens*), round-leaved triodanis (*Triodanis perfoliata*), moth mullein (*Verbascum blattaria),* blue vervain (*Verbena hastata*), white vervain (*V. urticifolia*), and European field pansy (*Viola arvensis*). Other herbs were wild chervil (*Anthriscus sylvestris*), annual wormwood (*Artemisia annua*), waterweed (*Elodea nuttallii*), Virginia stickseed (*Hackelia virginiana*), bugleweed (*Lycopus virginicus*), moneywort (*Lysimachia nummularia*), long-styled sweet cicely (*Osmorhiza longistylis*), perilla mint (*Perilla frutescens*), plantain (*Plantago virginica*), curly pondweed (*Potamogeton crispus*), yellow cress (*Rorippa palustris* var. *hispida*), sleepy catchfly (*Silene antirrhina*), American germander (*Teucrium canadense*), rabbit's-foot clover (*Trifolium arvense*), wingstem (*Verbesina alternifolia*), American speedwell (*Veronica americana*), and water speedwell (*V. anagallis-aquatica*). An interesting sedge was *Carex davisii*. Among the ferns and fern allies were scouring-rush (*Equisetum hyemale* var. *affine*), Mackay's brittle fern (*Cystopteris fragilis* var. *mackayi*), purple cliffbrake (*Pellaea atropurpurea*), and blunt-lobed cliff fern (*Woodsia obtusa*). Thanks to William Standaert for compiling the plant list. Attendance: 12. Leader: Patrick Cooney.

**26 July**: Bear Swamp West, Downe Township, Cumberland County, NJ. We hiked into the heart of Bear Swamp. There is convincing evidence that what remains of its ancient forest today has never been cut, probably due to its remoteness and its situation amid extensive swamps and marshes, although nearby large sections of old-growth were destroyed by sand mining activities and commercial extraction of lumber earlier in the twentieth century. Approximately 100 acres of apparently primary forest remain in Bear Swamp West, along with possibly 200 acres of similar antiquity, composition, and structure in nearby Bear Swamp East. Red maple (*Acer rubrum)* is the most abundant tree. In better drained sections sweetgum (*Liquidambar styraciflua)* co-dominates. At the lowest elevations, where standing water is usually present, the co-dominant is blackgum (*Nyssa sylvatica).* Both these trees referred to as "gums" attain heights of as much as 120 feet. Sweetbay magnolia (*Magnolia virginiana)* occurs as a sizeable tree, with diameters at breast height sometimes exceeding 1.5 feet, according to measurements taken by Club members in previous years. American holly (*Ilex opaca)* is conspicuous, and specimens of greater than 60 feet in height are not unusual. Sweet pepperbush (*Clethra alnifolia)* is the most abundant shrub, while sphagnum mosses and cinnamon fern (*Osmunda cinnamomea)* are conspicuous on the forest floor in the wettest areas. Mistletoe (*Phoradendron leucarpum)* is occasionally present, parasitizing only *Nyssa sylvatica* in this locality. Attendance: 5. Leader: Stevens Heckscher.

**27 July**: Whitesbog, Lebanon State Forest, Burlington and Ocean counties, NJ. Near the village of Whitesbog we examined New Jersey's only surviving population of *Schwalbea americana* (chaffseed). At this northernmost limit of the species' range, a few fruiting plants showed damage by herbivory. For more than 20 years the late Louis Hand and the leader helped preserve this population by select-cutting competing plants and by arranging periodic mowing. Since 1993, management (including prescribed burning) and monitoring of the site has been assumed by the Office of Natural Lands Management (N.J. D.E.P.). Growing nearby was *Scleria triglomerata* (tall nutrush), with smooth and shining white nutlets, and the stout culms of *Juncus biflorus*, with fully-grown reddish-brown capsules. Along the shrubby border of a reservoir were a few white plumes of *Platanthera blephariglottis* (white fringed orchid) associated with the showy orange drumheads of *Polygala lutea* (orange milkwort), the pale rose-purple racemes of *P. brevifolia* (short-leaved milkwort), and the delicate blue petals of *Lobelia nuttallii*. The shrubs in flower were *Clethra alnifolia* (sweet pepperbush), *Rhododendron viscosum* (swamp azalea), and *Hypericum densiflorum* (shrubby St.-John's-wort). Still in bud, a lone specimen of *Franklinia alatamaha* in front of the old company store in Whitesbog attracted attention. Other non-native species planted by the late Elizabeth White near her home were noted: *Oxydendrum arboreum* (sourwood), *Xanthoriza simplicissima* (shrub yellowroot), *Galax aphylla* (wandflower), and *Shortia galacifolia* (Oconee-bells). Flowering at the edge of an abandoned blueberry field were two naturalized heaths, *Calluna vulgaris* (ling) and *Erica tetralix* (cross-leaved heather), blending with the native *Rhexia virginica* (Virginia meadow-beauty), *R. mariana* (Maryland meadow-beauty), *Triadenum virginicum* (marsh St.-John's-wort), and *Lilium superbum* (Turk's-cap lily). The surface of nearby Union Pond was dotted with fragrant white water lily including pink forms, *Nymphaea odorata* forma *rosea*. The dull-white, wooly heads of *Lachnanthes caroliniana* (redroot) and the bright white flowers of *Sagittaria latifolia* (broad-leaved arrowhead) occurred as weeds in cultivated cranberry bogs. Planted to stabilize the dams surrounding these bogs, *Eragrostis curvula* (African love-grass) is outcompeting native species. To the south of Big Tank Reservoir, the leader revealed a previously unreported station of the endangered *Stylisma pickeringii* var. *pickeringii* (Pickering's morning-glory) in bloom. Only a single robust specimen, growing in exposed mineral soil devoid of competing plants, had escaped the onslaught of O.R.V.s. An effort to search difficult swampy terrain to rediscover a giant *Chamaecyparis thyoides* (Atlantic white-cedar) and several *Betula lenta* (cherry birch) was suspended. Thanks to Patrick Cooney for compiling a comprehensive list of species. Attendance: 18. Leader: Ted Gordon.

**2 August**: Atsion, Dutchtown, Parkdale, Hampton Furnace in Wharton State Forest, Burlington and Atlantic counties, NJ. In the vicinity of the abandoned railroad tracks south of the dam at Atsion Lake, we searched unsuccessfully for a known population of *Ludwigia hirtella*. Invasion of the site by a dense stand of young pitch pine and shrubs appears to have crowded out these plants. Nearby, long-standing populations of *Fimbristylis puberula, Rhynchospora torreyana, Leiophyllum buxifolium, Gentiana autumnalis, Crotonopsis elliptica,* and *Scutellaria integrifolia* continue to prevail. A few flowering plants of *Platanthera blephariglottis* were seen. Of note was a single flowering spike of *Spiranthes vernalis* along the shoulder of Route 206. More at home along the coast, the spring ladies'-tresses periodically shows up here and in a few other interior pine barrens spots. Southeast of Dutchtown in a fire-prone lowland pitch pine forest, the coppery-yellow flowers of *Hypericum denticulatum* stood out. In and around bog-ore swales, we observed a fine assemblage of sedges: *Carex barrattii, C. bullata, C. debilis, C. livida, C. striata, Eleocharis tenuis, E. microcarpa, E. tuberculosa, Scleria triglomerata, Rhynchospora cephalantha, R. pallida, Scirpus cyperinus,* and *S. longii.* Distinguishing characters of Long's woolgrass were pointed out, particularly the sticky black band at the base of the involucre and the saucer-shaped tussocks of long-established plants. Among the grasses were *Glyceria obtusa, Calamovilfa brevipilis, Amphicarpum purshii, Muhlenbergia torreyana,* and *Erianthus giganteus.* On wet sand a small patch of an endangerd peatmoss, *Sphagnum strictum*, was pointed out. We found plants of *Xyris torta* and *X. difformis*, but no plants of the endangered *X. carolinana*. Our attempt to relocate *Rhynchospora knieskernii* on solid bog-ore "pavement" also was unproductive. No doubt, prolonged drought had impacted this seed-banking population. At Parkdale, site of an abandoned cranberry-blueberry village, we saw a fine stand of *Prunus maritima*, flowering plants of *Arenaria caroliniana, Euphorbia ipecacuanhae*, and in sandy paths, long-established stations of *Crotonopsis elliptica*. A historical occurrence of the root-parasite *Schwalbea americana* (chaffseed) was known from this complex. We inspected a patch of potential habitat, a pitch pine lowland that has been cut back, drum-chopped, and prescribed burned by the office of Natural Lands Management (N.J. D.E.P.) in an effort to encourage the reestablishment of the endangered chaffseed from the seedbank or rootstock. Reintroduction of the species is also being considered. The patch included *Calamovilfa brevipilis, Scleria triglomerata, Aster paternus, Pyxidanthera barbulata, Ilex glabra, Kalmia angustifolia,* and many other heath shrubs. Growing within the adjacent abandoned railroad tracks were a few plants of *Viola sagittata*, a violet rare in the pine barrens along railroads, according to Witmer Stone. Our final stop was at Hampton Furnace and vicinity to check on two populations of *Lygodium palmatum*, both known to several Philadelphia botanists in the early 1900s. The population on the west bank of the Batsto River has severely declined; that farther to the south on the opposite bank was thriving. In a sandy expanse beneath an open canopy on the east side of the river between Hampton Forge and the abandoned railroad were scattered cushions of *Hudsonia ericoides, H. tomentosa*, and *Arenaria caroliniana*. In this pioneer habitat, we conducted an intensive search over about a one-mile stretch for *Stylisma pickeringii* var. *pickeringii*, a state-endangered and federally threatened taxon. While the group retreated to their vehicles, the leader, who persisted, found a single vine of this morning-glory. Clearly, additional vines of the species observed here in the

1980s have vanished. Thanks to Bill Standaert for compiling a comprehensive list of species observed. Attendance: 19. Leader: Ted Gordon.

**3 August**: Lobachsville, Berks County, PA. The site is a successional old field and adjacent wet woods along Pine Creek over which Albright College holds an easement. The site overlies Leithville and Allentown Formation limestones. Our trip was timed to coincide with the blooming period of the cranefly orchid, *Tipularia discolor*, which obliged with a number of flowering stems. Other uncommon species at the site include leatherwood, *Dirca palustris*, swamp lousewort, *Pedicularis lanceolata*, and broom-sedge, *Andropogon glomeratus*. Deer browsing is becoming an increasing problem on the drier wooded portions. *Dirca* is severely affected and other shrubs and herbaceous species are becoming sparse. On a June 1996 trip club members explored the diversity of sedges (more than 30 taxa) in the old field and forest edge and puzzled over a clump of log fern, *Dryopteris celsa*, or was it *D. goldiana* (?), along Pine Creek. Leaders: Susan Munch and Ann Rhoads.

**23 August**: Ferns of the Pinelands of Burlington County, NJ. From the Atsion Ranger Station, we traveled well into the Wharton State Forest on sand roads to see *Osmunda cinnamomea, O. regalis, Lygodium palmatum, Pteridium aquilinum, Woodwardia virginica,* and *W. areolata.* At our next stop along a road just off Route 206, we found a colony of *Thelypteris simulata* to compare with the more common *T. palustris* var. *pubescens.* The common *Onoclea sensibilis* was also found along the road. The last stop for the day was along the Oswego River where we looked for and found *Schizaea pusilla, Pseudolycopodiella caroliniana, Lycopodiella appressa* and *L. alopecuroides.* We looked for, but did not find, the hybrid of the latter two clubmosses. Attendance: 14. Leader: Bill Olson.

**24 August**: Hawk Island, Delanco Township, Burlington County, NJ. Low tide conditions allowed us to walk the intertidal zone about halfway around this 118-acre peninsula at the confluence of the Delaware River and Rancocas Creek. We then explored the interior of the site, taking note of the plant species typical of both recent and older dredge spoils as well as of an area that had seen little disturbance in recent years. Additions to a 1996 plant list prepared for the Citizens United to Save Hawk Island included *Sium suave, Eupatorium pilosum, Helenium autumnale, Solidago juncea, S. gigantea, Hypericum canadense, Eleocharis tenuis, Sicyos angulatus, Pilea pumila, Scutellaria lateriflora, Panicum verrucosum, Rhynchospora capitellata, Lycopodiella appressa,* and *Isoetes riparia*. This brings the total list for the site to 312 species, of which 110 are non-native. A complete list is available from the trip leader. Attendance: 11. Leader: Karl Anderson.

**6 September**: Hamilton and Trenton Marshes, Duck Island Mitigation Site, Mercer County, NJ. This was a joint trip with the Torrey Botanical Society. Our first stop was at the Mercer County Public Boat Launching Area, Lamberton Road and Delaware River. Here we found in bloom tumbleweed (*Amaranthus albus*), umbrella sedge (*Cyperus bipartitus*), late-flowering snakeroot (*Eupatorium serotinum*), and sneezeweed (*Helenium autumnale* var. *parviflorum*). Also found were the rare beggar-ticks (*Bidens bidentoides*), mud-plantain (*Heteranthera reniformis*), American water-willow (*Justicia americana*), false-pimpernel (*Lindera dubia* var. *dubia*), water-purslane (*Ludwigia palustris*), purple loosestrife (*Lythrum salicaria*), mazus (*Mazus pumilus*), dotted smartweed (*Polygonum punctatum* var. *confertiflorum*), and New York ironweed (*Vernonia noveboracensis*). Our exploration at the Duck

Island site, a 90-acre constructed tidal freshwater wetland along the Delaware River, focused only on areas at the southern end accessible by foot. (Frequently visited, the entire complex has produced over 325 species of vascular plants, some of which have been transient.) Trees we observed included ash-leaved maple (*Acer negundo* var. *negundo*), silver maple (*Acer saccharinum*), honey-locust (*Gleditsia triacanthos*), cork-tree (*Phellodendron sp.*), sycamore (*Platanus occidentalis*), and wafer-ash (*Ptelea trifoliata* var. *trifoliata). The shrub false-indigo (*Amorpha fruticosa*) was in fruit. Some of the vines in bloom were virgin's-bower (*Clematis terniflora),* climbing hempweed (*Mikania scandens*), and wild bean (*Strophostyles helvola).* Vines not in bloom were moonseed (*Menispernum canadense*), climbing false-buckwheat (*Polygonum scandens* var. *scandens*), and bur-cucumber (*Sicyos angulatus*). Herbs in bloom included gerardia (*Agalinis purpurea*), water-hemp (*Amaranthus cannabinus),* common ragweed (*Ambrosia artemisiifolia*), giant ragweed (*A. trifida*), annual wormwood (*Artemisia annua*), asters (*Aster pilosus, A. puniceus*), showy bur-marigold (*Bidens laevis*), bull thistle (*Cirsium vulgare*), tick-trefoil (*Desmodium paniculatum*), bottonweed (*Diodia teres*), viper's-bugloss (*Echium vulgare),* the near-flowering elscholtzia (*Elscholtzia ciliata*), willow-herb (*Epilobium coloratum*), hyssop-leaved thoroughwort (*Eupatorium hyssopifolium* var. *hyssopifolium*), white snakeroot (*E. rugosum* var. *rugosum),* late-flowering snakeroot (*E. serotinum*), eyebane (*Euphorbia nutans*), marsh bedstraw (*Galium palustre*), fragrant cudweed (*Gnaphalium obtusifolium* var. *obtusifolium),* sneezeweed (*Helenium autumnale*), sunflower (*Helianthus decapetalus*), Jerusalem-artichoke (*H. tuberosus*), rose mallow (*Hibiscus moscheutos*), dwarf St.-John's-wort (*Hypericum mutilum*), common St.-John's-wort (*H. perforatum*), water horehound (*Lycopus americanus*), winged monkey-flower (*Mimulus alatus),* carpetweed (*Mollugo verticillata*), forget-me-not (*Myosotis laxa*), ditch stonecrop (*Penthorum sedoides*), smartweeds *(Polygonum lapathifolium, P. pensylvanicum, P. persicaria, P. punctatum, P. sagittatum),* pickerelweed *(Pontederia cordata),* arrowhead *(Sagittaria latifolia*), water-parsnip (*Sium suave*), goldenrods (*Solidago canadensis, S. gigantia, S. juncea*), bluecurls (*Trichostema dichotomum*), alsike clover (*Trifolium hybridum*), white vervain (*Verbena urticifolia*), and New York ironweed (*Vernonia noveboracensis*). Herbs not in bloom included water-plantain (*Alisma subcordatum*), spreading dogbane (*Apocynum androsaemifolium*), orache (*Atriplex hastata*), beggars-ticks (*Bidens polylepis, B. connata, B. frondosa*), partridge-pea (*Chamaecrista fasciculata*), Mexican-tea (*Chenopodium ambrosioides*), pilewort (*Erechtites hieraciifolia*), mud-plantains (*Heteranthera reniformis* and the rare *H. multiflora*), Japanese clover (*Lespedeza striata*), perilla mint (*Perilla frutescens),* cocklebur (*Xanthium strumarium* var. *canadense*) and the rare subulate arrowhead (*Sagittaria subulata*). Rushes included *Juncus acuminatus* and *J. effusus* var. *solutus*. Among the sedges were umbrella sedge (*Cyperus bipartitus*), yellow nutsedge (*C. esculentus), C. lupulinus,* straw-colored nutsedge (*C. strigosus*), three-way sedge (*Dulichium arundinaceum*), the spikerushes *Eleocharis acicularis* and *E. ovata*, the rare Smith's bulrush (*Scirpus [Schoenoplectus] smithii*), common three-square (*S. pungens*), woolgrass (*S. cyperinus*), and soft-stem bulrush (*S. validus*). Thanks to William Standaert for compiling the plant list and Patrick Cooney for writng the report. Attendance: 18. Leaders: Mary and Charles Leck.

**7 September**: Central Perkiomen Valley Park, Montgomery County, PA. We explored young and old fields for late summer flowering plants including many asters and goldenrods, *Bidens polylepis, Ipomoea lacunosa,* and at least seven other rampant vines. Among the species in wet spots were *Juncus effusus, Lindernia anagallidea, Lysimachia nummularia,* and *Eclipta* *alba.* A list of 182 species was produced. Attendance: 18. Leaders: Ann Newbold, Heinrich Zoller and Val Udell.

**4 October**: Lakehurst area, Pine Barrens, Ocean County, NJ. Beyond the roadside litter of a parking area at the junction of Route 539 and Route 70 was a spectacular display of *Aster spectabilis* and *Aster linariifolius* in full bloom. *Asclepias amplexicaulis, Aureolaria pedicularia,* and *Chrysopsis mariana* were past flowering. Lichens, the focus of this trip, included a variety of terrestrial *Cladoniae: C. clavulifera, C. chlorophaea, C. cristatella, C. atlantica, C. coneocraea,* and *Cladina subtenuis.* Along a sand road through upland pine forest at the New Jersey Audubon Society's Hovnanian Sanctuary in Berkeley Township, we saw large areas of forest floor dominated by *Cladonia uncialis,* with several other species such as *C. floridana* and *C. rappii. Cladonia bacillaris* and *C. incrassata* were found on decaying wood. Some bark-loving lichens, including *Flavoparmelia caperata, Punctelia decta, P. subrudecta, Parmelia sulcata,* and *Parmotrema hypotropum* were compared. Vascular plants of interest included *Calamovilfa brevipilis, Leiophyllum buxifolium, Pyxidanthera barbulata,* and *Xerophyllum asphodeloides.* The day ended with a visit to Dover Forge, where we were treated to a magnificent display of *Gentiana autumnalis*; about 300 flowers were counted. A hardwood swamp here produced *Imshaugia aleurites* and a few small tufts of *Usnea strigosa,* growing on *Acer rubrum.* A stroll to the banks of Cedar Creek added *Smilax pseudochina, Eupatorium resinosum, Oenothera parviflora, Rhynchospora gracilenta,* and *Bartonia virginica* to the day's list. Attendance: 13. Leader: Karl Anderson.

**13 December:** Exploration of Pinelands plants in their winter aspect, NJ. After a hearty breakfast at the restaurant at Marshalls Corner on the Monmouth-Ocean County border, we headed south on Route 539, never straying very much from this road. Our first stop was in Pasadena along the Pasadena-Woodmansie Road. There we looked at *Andropogon virginicus, Chimaphila umbellata, Helianthemum canadense, Hypericum gentianoides, Lechea* sp., *Lespedeza capitata, Polygonella articulata,* and *Schizachyrium scoparium.* Our next stop was at Webbs Mill and the boardwalk into an Atlantic white-cedar stand, where we saw *Carex exilis, Chamaecyparis thyoides, Chamaedaphne calyculata, Clethra alnifolia, Drosera rotundifolia, D. filiformis, Eleocharis tuberculosa, Juncus pelocarpus, Pseudolycopodiella caroliniana, Narthecium americanus, Rhynchospora pallida, Sarracenia purpurea, Schizaea pusilla,* and *Vaccinium macrocarpon.* Two liverworts common in southern New Jersey were encountered, *Pallavicinia lyellii* and *Odontoschisma prostratum.* Our next stop south of Webbs Mill was in a borrow pit to see *Rhynchospora knieskernii,* the federally endangered beak-rush that is only extant in New Jersey. After a stop in Warren Grove at Lucille's Restaurant for a warm lunch, we continued south on Route 539 to the Lower Plains to see *Corema conradii* and other pine plains vegetation such as *Pinus rigida, Quercus marilandica, Q. stellata,* and *Polygonella articulata.* Attendance: 12. Leader: Bill Olson.

## 1998 Field Trips

**18 April**: Forsythe National Wildlife Preserve, Manahawkin Section, Ocean County, NJ. The federal government bought this parcel of land and made it part of Forsythe Refuge in about the mid-1990s to protect a large population of swamp-pink, *Helonias bullata.* The section that we visited extends from the upper (west) end of Manahawkin Lake and up Mill chose the water route, and the rest went on foot. We did not take an exact count, but numerous early *Helonias* blooms were seen, photographed, and smelled. Their odor is wonderfully sweet. Thanks to William Standaert who produced a comprehensive list of plant species observed. Attendance: 7. Leader: Rob McCombe.

**26 April**: Clayton Park, Upper Freehold Township, Monmouth County, NJ. The habitat of this inner coastal-plain park is mainly upland, dissected by small westward-flowing streams. The uplands are dominated by fine stands of *Fagus grandifolia*, with *Betula lenta* and *Quercus* spp.; lowlands, by *Symplocarpus foetidus* and *Athyrium filix-femina*, with *Lindera benzoin* as a common shrub. The field trip produced a list of 144 species of vascular plants, of which 126 were native. Good finds for the region included *Dryopteris cristata, Huperzia lucidula, Cardamine concatenata, Corydalis flavula, Luzula acuminata, Collinsonia canadensis, Goodyera pubescens*, and *Pyrola rotundifolia*. Of some interest was the scarcity of a few species that might have been expected; *Osmunda cinnamomea* was virtually missing, as were *Veratrum viride, Podophyllum peltatum*, and *Cornus amomum*, each species being represented by only a very few individuals. *Mertensia virginica*, super-abundant in wetlands only a few miles distant, was apparently completely absent. Leader: Karl Anderson.

**2 May**: Goat Hill Preserve, Chester County, PA. Our group proceeded down a powerline cut from the parking lot off Red Lion Road to the Maryland state line. We were greeted by rafts of *Cerastium arvense* var. *villosum* and *Arabis lyrata* in flower; *Sisyrinchium mucronatum* and *Minuartia michauxii* were still in bud. We also observed other typical members of the serpentine barrens flora leafing out including *Quercus prinoides, Q. ilicifolia, Q. marilandica*, and *Ceanothus americanus* among woody plants, and herbs such as *Phlox subulata, Asclepias verticillata* (just emerging), *Oenothera fruticosa*, and *Viola sagittata*. The upland *Carex* flora was disappointing, yielding only a few species such as *Carex umbellata* and *C. nigromarginata*. However, a rich low meadow at a brook crossing yielded *C. interior* (positively identified eight days later) and *C. vestita*. Other unusual species seen included a large specimen of *Amianthium muscaetoxicum* along a trail in upland scrub shrub and several populations of *Lysimachia lanceolata* at its only Chester County locale. It was beginning to rain lightly, and most of the participants had turned back, when Tim Draude found the plant the trip had been especially organized to seek out, the rare disjunct *Carex richardsonii*. Several colonies of this turf-forming sedge, previously unrecorded from Goat Hill and only at its second known Pennsylvania station, were in full fruit right at the state line. After lunch, several trip members made a loop through Nottingham Park in an unsuccessful attempt to locate the first-known Pennsylvania population of *C. richardsonii*. We were able to check on colonies of *C. meadii* and *C. vestita* in the park. Attendance: 11. Leaders: Janet Ebert and Jack Holt.

**16 May**: Meng Preserve, Montgomery County, PA. Joint trip with Valley Forge Audubon Society. Numerous club and society members participated in a leisurely stroll along existing trails and old logging roads through Valley Forge Audubon's new Meng Preserve, an excellent example of a rich woodland community on diabase. Despite recent logging atop the ridge and the presence of a timber staging area used as a parking lot at the base of the slope, the relative absence of alien species in the preserve is notable. The diversity of the lush woody, herbaceous, and graminoid growth was quite high. Notable species included *Corylus cornuta, Trichophorum planifolium, Carex wildenovii, Galearis spectabilis, Smilax* *hispida*, *Cynoglossum virginianum*, and *Hypoxis hirsuta*. The trip ended atop the nearly clear-cut ridgetop, where a discussion was held comparing the surviving flora of the logged area to that on the slopes below and regarding the prospects of recovery of the site. Leaders: Janet Ebert and Jack Holt.

**23 May**: Island Beach State Park, Ocean County, NJ. In the vicinity of the Aeolium, we found both flowering and fruiting *Spergula morisonii*, Morison's sand spurry, an addition to the park's plant list. At the border of a parking lot near Reed Road, we saw a few plants of *Chrysopsis falcata*, sickle-leaved golden aster, one of at least four small occurrences of this state-rare aster within the park. We followed Reed Road to the bay and then walked north along the tidal strip strewn with ribbons of *Zostera marina*, eelgrass. The edge of high tide did not produce a single patch of *Honckenya peploides*, sea-beach sandwort. After a short distance, we entered a coastal dune woodland dominated by *Pinus rigida* with interdunal hollows sheltering *Chamaecyparis thyoides*. This community type is critically imperiled in the state and apparently it is restricted to this pocket in the northwestern section of the Northern Natural Area. In *The Plants of Southern New Jersey* (1911), Witmer Stone cited E. B. Bartram's discovery of *Schizaea pusilla* in back of the sand dunes near Seaside Park "in a moist hollow with a few little White Cedars." This passage prompted the leader to visit this area. Pitch pine groves with canopies to 30 feet occurred in dune depressions surrounded by extensive open *Hudsonia tomentosa* communities in bloom, with scattered *Ilex opaca, Quercus falcata, Q. marilandica, Q. ilicifolia*, and *Juniperus virginiana*. Several interdunal hollows held shallow water and contained both dead snags and living trees of Atlantic white-cedar. These hollows were ringed by a shrub layer of *Myrica pensylvanica, Vaccinium corymbosum, Kalmia angustifolia* (all three in bloom), *Gaylussacia frondosa*, and *Ilex glabra*. Salt spray injury to the tops of a few pines and white-cedars was observed. Successive spraying events could have resulted in the death of the latter. Days later Pete McLain and a student conducted salinity tests of the water in one of these depressions. Their results showed 0.0 ppt for salinity. Of the three white-cedar hollows we examined, none contained suitable curly-grass fern habitat. Although salinity does not appear to have caused its demise, *Schizaea* cannot be declared extirpated without searching all interdunal depressions harboring white-cedar. In sight of the ocean, we next examined a foredune dominated by *Carex kobomugi*, Japanese sedge, first collected on Island Beach by C.W. Townsend in 1929. Aggressive reproduction of this dioecious sedge by rhizomes is believed to have resulted in substantial loss of native plants, particularly in the Southern Natural Area. Control measures of this invasive plant are under consideration. Some associated species sparsely present were *Ammophila breviligulata, Solidago sempervirens, Cakile edentula, Atriplex hastata*, and a handsome patch of the naturalized *Artemisia stelleriana* in flower. In other habitats, widely distributed species still in bloom included *Amelanchier canadensis, Prunus serotina*, and *P. maritima*. A visit to the Coast Guard Station Interpretive Center to examine the Emily de Camp Herbarium of specimens collected in the park concluded our trip. Thanks to Cynthia Coritz and Superintendent Bill Vibbert for arranging our visit and to Bill Standaert for compiling a list of plants observed. Attendance: 8. Leader: Ted Gordon.

**21-25 June**: Johnson State College (J.S.C.), Johnson, in the Green Mountains of north central Vermont. Joint field meeting of the Botanical Society of America, Torrey Botanical Society, and the Philadelphia Botanical Club. On Monday we carpooled to the foot of the toll road in Stowe, where vans took us to the 4,303-foot-high summit of Mount Mansfield.

We came to observe the largest community of arctic-alpine tundra vegetation in the state. Sighted among many more species were *Arenaria groenlandica, Gaultheria hispidula, Habenaria (Platanthera) dilatata, Ledum groenlandicum, Nemopanthus mucronatus, Potentilla tridentata, Ribes glandulosum, Salix pyrifolia, Sambucus racemosa* var. *pubens, Vaccinium uliginosum, V. vitis-idaea, V. boreale* (!), and the ever-present lichen *Rhizocarpon geographica.* Our leaders were Charlie Cogbill (environmental consultant) and Peter Hope (Boston professor at St. Michael's in Winooski, VT), both experts on the flora of the mountain. On Tuesday, J.S.C. professor of environmental sciences John Wrazen and Peter Hope, a fern specialist, were our guides at the Babcock Preserve, 1,000 acres of northern mixed hardwood forest, ponds, fens, and other wetlands owned by J.S.C. A sampling of the plants seen was *Dryopteris compyloptera* and its hybrids, *Coptis trifolia, Drosera rotundifolia, Oxalis acetosella, Polystichum braunii, Potentilla palustris, Scutellaria galericulata,* and *Streptopus amplexifolius.* On Wednesday, sphagnum specialist Cyrus McQueen of J.S.C. and Debbie Benjamin of the Vermont Bird and Botany Club led us to several peat bog communities: South Molly Bog, Percy Bog, and Joes Pond. A big treat was a "meadow-like" mat of sphagnum covered with *Pogonia ophioglossoides, Calopogon tuberosus, Platanthera blephariglottis* (still in bud), *Eriophorum virginicum, Rhynchospora alba,* and *Carex trisperma. Sphagnum* species were numerous, but, due to a great deal of recent rain, many of the attendees did not follow Cyrus into a bog that required wading hip-deep to his destination. Other plants found were *Kalmia angustifolia, Lysimachia terrestris,* and *Sarracenia purpurea.* Three evening slide-illustrated lectures were presented by experts in various fields. David Marvin, forester and owner of Butternut Mountain Farm, which produces maple syrup and other maple products, spoke on the "Production of Maple Syrup in Vermont." Charles Johnson, a charismatic and articulate naturalist, presented "The Nature of Vermont," a delightful overview of the state and its ecology. His book by the same title has just been reprinted. He is also author of the well-known book, *Bogs of the Northeast.* "Aspects of Forest Decline on Camels Hump in the Green Mountains" was the lecture presented by Hubert Vogelmann, the retired head of the University of Vermont's Botany Department. His trail-blazing work in the 1960s led to the awareness of the effects of acid rain on forests. While this work was done three decades ago, it was the foundation of much that has been studied since that time. Trip Chairperson: Ursula Joachim.

**11 July**: Bennetts Mill and Vicinity, Peasle Fish and Wildlife Management Area, City of Vineland and Maurice River Township, Cumberland County, NJ. This county has long been a popular botanical destination. In particular, Bayard Long's forays into Cumberland provide some of the best documentation of its flora. Bennetts Mill is an abandoned farm and small industrial complex at the headwaters of the Manumuskin River. Here our work began in a large old sandy field cultivated every other year by the N.J. D.E.P. Division of Fish and Wildlife. In this early successional habitat we saw *Panicum sphaerocarpon, P. auburne, P. depauperatum, P. scoparium, Schizachyrium scoparium, Carex tonsa, Lespedeza hirta,* and *Tridens flavus.* We inspected the old ruins at the intersection of Bennetts Mill and Old Mays Landing roads. Here we found *Aralia nudicaulis, Asclepias tuberosa, Solidago* spp., and *Crataegus uniflora.* Our second stop was 2.6 miles south of Bennetts Mill. We explored a power line cut from the edge of Union Road to the floodplains of the Manumuskin River. The uplands and wetland of the right-of-way have been repeatedly mowed, reducing woody vegetation to simple basal sprouts. This treatment has provided an open area for plants more common on unplowed habitats devoid of a canopy. Plants of interest included *Scleria* *minor*, *S. triglomerata*, *Sorghastrum nutans*, *Andropogon virginicus*, *Rhynchospora gracilenta*, *Platanthera blephariglottis*, *Polygala brevifolia*, *Drosera rotundifolia*, *D. filiformis*, *Sarracenia purpurea*, and *Pogonia ophioglossoides*. At Cumberland Pond, we stopped at an old field on the south side of Route 49. Here we saw *Gymnopogon ambiguus*, *Desmodium strictum*, and large colonies of *Opuntia humifusa*. From this well-known site we drove to a large clear-cut northeast of Cumberland Pond at the intersection of Hesstown Road and Main Road. In a newly plowed area within a large oak-pine forest, we found *Linum virginianum*, *Panicum villosissimum*, *P. dichotomum*, and *Comandra umbellata* along the forest edge. Leader: Joseph Arsenault.

**23 August**: Barkwoods Pond, Hirst Pond, Goose Ponds, Egg Harbor City vicinity, Atlantic County, NJ. Along a split-rail fence at the head of a trail leading to Barkwoods Pond, we saw a cluster of *Corallorhiza odontorhiza* in full anthesis. *Panicum ensifolium* was along the trail leading to the pond, which we searched unsuccessfully for a known population of *Panicum hirstii*. In shallow water were the filiform leaves with cleistogamous flowers of *Utricularia geminiscapa*. Yellow patches of *Gratiola aurea* occupied exposed pond bottom. Also in bloom were *Polygola lutea*, *Lindernia dubia*, and *Xyris smalliana*. Identifiable by its linear, lanceolate leaf segments was *Bidens coronata*. Among the species obviously common to all of the intermittent ponds we visited were *Eleocharis olivacea*, *E. microcarpa*, *E. robbinsii*, and *Xyris smalliana*. At nearby Hirst (Labounsky) Pond we compared two delicate bladderworts in flower: *Utricularia striata (U. fibrosa)* and *U. subulata*, the latter with peltate bracts. The pink heads with yellow disks of *Coreopsis rosea* were somewhat concealed within stands of *Cladium mariscoides* and *Carex striata*. Also in bloom were *Nymphoides cordata*, *Lycopus uniflora*, *Gratiola aurea*, and a few *Rhexia virginica* and *R. mariana*. We saw scattered tiny seedlings that may have been *Scleria reticularis* var. *reticularis*, generally here in abundance. We did not find *Lobelia boykinii*. The discovery of the "lost" *Eleocharis equisetoides* (fruiting) in Big Goose Pond was a highlight; the state endangered knotted spikerush was in the same spot where it was last pointed out to the leader in 1978 by the late Gil Cavileer. Adjacent was a fine population of *Rhynchospora inundata*. Elsewhere *Lobelia nuttallii*, *Drosera intermedia*, and especially *Utricularia cornuta* made fine displays. At Little Goose Pond, *Lobelia boykinii* eluded us. However, we were rewarded by sighting two state-endangered species: a few flowering stalks of *Rhexia aristosa* and a few fruiting plants of *Sagittaria teres*, slender arrowhead. Associated species in bloom were *Eriocaulon aquaticum* and *Xyris torta*. (The original specimens of awned meadow-beauty discovered in 1888 came from the Egg Harbor City vicinity.) Thanks to Bob Johnsson for compiling a list of species observed. Attendance: 23. Leader: Ted Gordon.

**27 September**: Atsion and vicinity, Burlington County, NJ. The focal point of this trip was the pine-barren gentians that have grown for many years along Route 206, but a good variety of other pine barrens plants was noted. Grasses were particularly abundant and diverse in sandy fields south of the Atsion Ranger Station; about 20 species were found, including *Chloris verticillata*, *Triplasis purpurea*, *Leptoloma cognatum*, *Panicum scoparium*, and *Sorghastrum nutans*. *Gentiana autumnalis* was found in good numbers and fine bloom, south of the old Central Railroad of New Jersey tracks. Nearby were scattered plants of *Spiranthes cernua*, *Trichostema dichotomum*, and *Crotonopsis elliptica*. A drying swale on the west side of Route 206 gave participants a chance to see some plants involved in the process of pond succession, including *Chamaedaphne calyculata*, *Cladium mariscoides*, *Carex striata*, and

*Vaccinium macrocarpon*, along with *Drosera intermedia, Proserpinaca pectinata, Dulichium arundinaceum, Juncus pelocarpus, Eleocharis olivacea*, and *Rhynchospora capitellata*. Lunch was at the Atsion Recreation Area. A short walk from here along a nature trail south of Atsion Lake produced *Polygonella articulata* in some abundance on dry sand, while ditches and the lake shore produced *Woodwardia virginica, Osmunda cinnamomea, O. regalis, Triadenum virginicum, Juncus militaris, Orontium aquaticum*, and *Nymphoides cordata*. The trip ended with a stroll to a stream-bank and wet area along the entrance road to the recreation area, where a few plants of *Rhexia virginica* were still in bloom. Here also were *Pontederia cordata, Peltandra virginica, Juncus biflorus, J. canadensis, Woodwardia areolata, Botrychium dissectum, Thelypteris palustris*, and numerous plants of *Polygala lutea*, this last species still in flower. Attendance: 20. Leader: Karl Anderson.

## 1999 Field Trips

**25 April**: Lebanon State Forest, Ongs Hat, Buffin Meadows, Burlington County, NJ. Near the Lebanon State Forest office, we looked at a fire-protected, advanced growth oak-pine forest dominated by chestnut, black, and white oaks with pitch pine as a minor component. Such mature stands are rare in the Pine Barrens because of frequent fires and premature harvesting. Here, along a path, we saw *Epigaea repens* in bloom. Near the fire tower was a large patch of flowering *Pyxidanthera barbulata.* We noted an old *Pinus resinosa* plantation exhibiting severely retarded growth. In contrast, at Ongs Hat, a *Pinus taeda* plantation was flourishing. On a wet shoulder of the hardtop road were *Carex barrattii* and *C. vestita*, both in bloom. Already in fruit, a few clumps of *Carex nigromarginata* occupied a dry slope. We next visited a hardwood-cedar swamp along Company Branch to assess a *Helonias bullata* population, first reported by Rusk and Svenson in 1933 as "abundant." In 1968 the leader saw about 50 plants in flower; in April 1989 there were at least 43 rosettes, only one in bud. In 1999 we saw a mere 5 vegetative plants in poor condition hugging the stream bank just west of the road that dissects the swamp. Herbivory by deer and, especially, temporary water diversion over an extended period into a canal and the resulting water drawdown have all but eliminated this swamp-pink occurrence. It is of interest that more than 50 scattered large *Betula alleghaniensis (B. lutea)*, a tree rarely encountered in the Pine Barrens, are a well established component of this community. At Cedar Swamp Natural Area back in the Lebanon, we were dismayed by the destruction of a roadside population of the rare *Uvularia puberula* var. *nitida*. At their request, forest personnel had been given the precise location of this station; yet, the maintenance crew scraped it into oblivion. Nearby was a fine stand of *Diphasiastrum (Lycopodium) digitatum*, a clubmoss infrequent in the barrens. In bloom were *Lindera benzoin, Orontium aquaticum, Amelanchier canadensis, Vaccinium corymbosum*, and, with flower buds about to open, *Leiophyllum buxifolium*. With great difficulty we reached more than a dozen vigorous rosettes of *Helonias* with some eight budding stalks six to eight inches tall. These plants occurred on hummocks in a 100-foot stretch of stream channel, persisting despite a relatively closed canopy of white-cedar. At Bear Hole we examined the hard, knuckle-like, fire-scorched bases and roots of *Calamovilfa brevipilis.* Added to our list of plants in bloom were *Chamaedaphne calyculata, Vaccinium angustifolium*, and *Carex stricta*. We monitored a 100-by-30-foot segment of a small *Helonias* population along a streamlet at Buffin Meadows, discovered by the leader in March 1991. Fifteen clumps were seen beneath *Clethra alnifolia* on sphagnous hummocks surrounded by deep pools in an open canopy of *Nyssa* and *Acer*. The population had remained stable, and three specimens of swamp-pink in full anthesis delighted us all. The surrounding white-cedar forest was devoid of *Helonias.* We did not monitor the larger population in the segment to the west. Thanks to Bill Standaert for compiling a list of species observed and to John O'Herron for his input. Attendance: 16. Leader: Ted Gordon.

**8 May**: Sourland Mountain Preserve, Hillsborough Township, Somerset County, NJ. Joint trip with the New Jersey Audubon Society. This 1,600-acre mostly-forested preserve has a diverse flora, and about 100 species were identified during the day. Many woodland spring flowers were in bloom, among them *Podophyllum peltatum, Conopholis americana, Anemonella thalictroides, Actea alba, Geranium maculatum, Asarum canadense, Arisaema triphyllum, Claytonia virginica, Saxifraga virginiensis, Viola palmata, V. sororia,* and *V. pubescens. Orchis (Galearis) spectabilis* was in bloom and was quite abundant in some areas; several white-flowered plants were noted. *Aquilegia canadensis* was found in bloom in partial shade along a pipeline cut, and *Matricaria matricarioides, Geranium pusillum,* and several other ruderals were in bloom around the parking area. Some noteworthy finds were *Obolaria virginica, Cynoglossum virginianum, Panax quinquefolius, and Cardamine angustata,* all of which are threatened species in New Jersey; of these, the *Obolaria* and *Cardamine* were in bloom, and the *Cynoglossum* was in bud. Some identifiable plants that were not in bloom included *Menispernum canadense, Allium tricoccum, Cimicifuga racemosa,* and *Galium lanceolatum*. Ferns seen included *Dryopteris goldiana, D. cristata, Adiantum pedatum, Deparia achrostichoides, and Phegopteris hexagonoptera,* as well as several more common species. A list of plants seen is available from the trip leader. Leader: Karl Anderson.

**25 May:** Greater Forked River Mountains Region, Ocean and Lacey Townships, Ocean County, NJ. The main purpose of this weekday trip was to seek previously unknown occurrences of *Arethusa bulbosa* on sites judged earlier by the leader to contain suitable habitat for this state-rare orchid. Along Cold Brook, a short distance northeast of Wells Mills, we entered a cut-over (perhaps 40 years ago) sphagnum-carpeted cedar swamp with savanna-like openings dotted with magnolia, maple, and Atlantic white-cedar saplings. Four significant species, first recorded here in 1995, were relocated: several rough stems of *Juncus caesariensis,* a clump of *Calamovilfa brevipilis*, a couple of sharp-pointed leaves of *Narthecium americanum,* and numerous fronds of *Schizaea pusilla*. More than a dozen scattered plants of *Arethusa bulbosa* in flower were a new discovery. These five species occupied a hummock zone comprised in part of *Carex exilis, C. atlantica* including var. *capillacea, C. trisperma, Pogonia ophioglossoides, Gaylussacia dumosa,* and other heaths. Two dominant mosses were *Sphagnum pulchrum* and *S. flavicomans*. *Carex collinsii* occupied seeps, and near the base of a shrubby slope was the foliage of eight *Platanthera blephariglottis*. Here we also saw a garter snake. No effort was made to explore this segment of swamp more intensively; however, we re-entered the corridor a few thousand feet upstream and added a new population of about 80 plants of *Arethusa bulbosa* in bloom. *Schizaea pusilla* hugged the vertical cut of the stream bank, and several *Platanthera clavellata* were perched on mats of sphagnum. The adjacent fire-scorched pitch-pine lowland was dominated by a massive stand of *Calamovilfa brevipilis,* and a slightly drier zone, by hundreds of grass-like clumps of *Xerophyllum asphodelloides.* In the upland pine-oak forest, we encountered—all within the space of a hundred yards—a hognose snake, a black widow spider, and a pair of mating pine snakes (a threatened species). A few miles to the northeast, we visited a young regenerating cedar swamp that runs along lower Sprague Branch, a narrow feeder stream of the North Branch of Forked River. At the foot of a slope associated with a pine-oak forest, this sphagnous community comprises a habitat of high species diversity, favored by harvesting, a stable hydrological regime, and browsing of white-cedar saplings by deer. This site and that of our first stop share a number of similarities. We relocated two species discovered in 1995: four plants of *Arethusa* in bloom and *Schizaea*, scattered on several hummocks. Among other species seen were *Sarracenia purpurea*, *Platanthera blephariglottis*, *Aster nemoralis*, *A. novi-belgii*, *Pogonia ophioglossoides*, *Drosera rodundifolia*, *Lilium superbum*, *Aronia arbutifolia*, *Carex exilis*, *Trientalis borealis*, and *Utricularia subulata*, the latter four in flower. Of special significance was finding 13 plants (7 in bloom) of *Uvularia puberula* var. *nitida*, the state-endangered pine barren bellwort. These were well concealed along the shrubby ecotone near the base of the slope. Lastly, we concluded a banner day by briefly handling a pine barren treefrog, *Hyla andersonii*. Thanks to Bill Standaert for compiling a list of species observed and to John O'Herron for sharing his notes for this report. Attendance: 18. Leader: Ted Gordon.

**5 June**: Adkins Arboretum, Caroline County, MD. Joint trip with the Muhlenberg Botanical Society and the Maryland and Delaware Native Plant Societies. We walked the trails of the floristically diverse grounds of the arboretum, which ranges in habitat from upland open fields to waterlogged floodplain forest. In the upland oak-heath forests we observed typical dry-soil, acid-loving species such as *Cypripedium acaule*, *Goodyera pubescens*, and *Chimaphila umbellata*. A loblolly pine plantation yielded the spurges *Euphorbia corollata* and *E. ipecacuanhae* along with *Asclepias amplexicaulis*. In richer areas near the floodplain several species more typical of the Piedmont flora were observed, including *Arabis canadensis*, *A. lyrata*, and *Pycnathemum incanum*. A surprise here was a beautiful flowering plant of *Asclepias variegata*, previously unknown from the property. A few non-flowering plants of *Galearis spectabilis*, along with *Ophioglossum vulgatum*, *Desmodium glutinosum*, *Aristolochia serpentaria*, and *Aquilegia canadensis* grew in a small, rich woods pocket near a back swamp, only a few yards downslope from *Clitoria mariana* and *Opuntia humifusa*. The back swamp itself was host to an enormous population of *Dryopteris celsa*; we saw thousands of plants of this large, uncommon fern. At the far end of the property along a hundred-year floodplain trail grew a large flourishing colony of a shrub more typical of Appalachia and the Midwest, *Viburnum rafinesquianum*. On the way back we walked along the edge of a bare-bottomed wooded slough lined by ericaceous shrubs including *Leucothoe racemosa*, *Vaccinium corymbosum*, and *Rhododendron viscosum*. Attendance: 12. Leaders: Janet Ebert and Jack Holt.

**12 June**: Malaga and Vicinity, Franklin Township, Gloucester County, NJ. This trip concentrated on the genus *Panicum*, a group of grasses that has intrigued the leader. We held a short discussion on the genus, describing the characters that are unique and similar between the subgenera. We compared the various available keys and discussed how this grass group is viewed today. Despite its archaic nomenclature, *Gray's Manual of Botany*, 8th Edition, was recommended over other manuals because the keys and field description were judged superior. Our first stop was a Nature Conservancy property south of Route 40 and east of Route 55 near Malaga. Underlain by a coarse sandy soil typical of the Outer Coastal Plain, this site comprised a pitch pine community characteristic of the frequent fire regimes of the Pine Barrens. We walked the sand trails and found *Panicum virgatum*, *P. depauper-*

*atum, P. clandestinum, P. columbianum, P. commutatum* var. *ashei, P. spretum, P. villosissimum, P. lanuginosum* var. *lindheimeri. P. meridionale. P. mattamuskeetense, P. microcarpon,* and *P. lucidum*. After a brief downpour, we drove to the Glassboro Fish and Wildlife Management Area. This public area is centered on the headwaters of Still Run, a Maurice River tributary and 5.9 miles upstream from the Malaga site. This area has soils with finer texture, typical sandy silt of the Bridgeton Formation, a Pleistocene-era gravel cap covering portions of the Inner and Outer Coastal Plain. Here we identified *Panicum virgatum, P. commutatum* var. *ashei, P. scoparium, P. sphaerocarpon, P. dichotomum, P. clandestinum, P. lanuginosum, P. villosissimum, P. meridionale,* and *P. lucidum*. This assemblage is similar to the species (five common to both sites) observed in Malaga, but the presence of *P. scoparium* in an upland setting with *P. dichotomum* reflects the moist conditions associated with the fine-textured Bridgeton Formation. Heavy downpours during lunch and at the conclusion of fieldwork prevented us from keying specimens as planned. Leader: Joe Arsenault.

**18-20 June**: Pocono Environmental Education Center, PA. Friday night we met at PEEC and a slide show of the leader's trip to Puerto Rico was shown. A trip to Hogback Ridge, a limestone ridge, on Saturday in Pike and Monroe counties provided the group an opportunity to see upland and wetland species growing on limestone. Species included *Adiantum pedatum, Arisaema dracontium, Carex granularis, C. lupulina, C. plantaginea, C. typhina, Callitriche terrestris, Hypericum acyron (H. pyramidatum),* and *Quercus bicolor*. The evening was spent looking at some of the specimens at the lab back at PEEC. On Sunday, we traveled up to Orange County, NY to explore the Rutgers Creek Conservancy of the Paul F. Brandwein Institute. This rocky wooded area with a trout stream flowing through it contained an interesting complex of species on limy soils. The species included *Cardamine diphylla, Carex argyrantha, C. blanda, C. bromoides, C. gracillima, C. granularis, C. pallescens, C. squarrosa, Epigaea repens, Equisetum hyemale* var. *affine, Fraxinus americana, F. nigra, Lobelia cardinalis, L. siphilitica, Trillium erectum, Viola rostrata, V. sororia, and V. labradorica (V. conspersa). Carex davisii,* a sedge seen previously on the site, was looked for, but not found. Attendance: 11. Leader: Bill Olson.

**20-24 June**: Manchester College, North Manchester, northern Indiana. Joint field meeting with the Botanical Society of America and the Torrey Botanical Society. There were three days of field trips. The first site was the Tefft Savanna State Nature Preserve, located in the Kankakee sand plain region in northwestern Indiana. Habitats seen here were oak savanna, sand prairie, and wetlands. Atlantic Coastal Plain species represented an unexpected floristic element in this area. Spinn Prairie, a Nature Conservancy project, gave participants a look at a mesic prairie-savanna mosaic. A brief stop was made at Berns-Meyers Woods, a small fragment of old-growth mesic forest, also a Nature Conservancy site. On the second day the sites visited were Laketon Bog State Nature Preserve, a fen containing the southernmost population of larch in the state, and Ginn Woods, one of the largest stands of old-growth forest in the state, which is owned by Ball State University. The final day of field trips were at Pigeon State Fish and Wildlife Area near Mongo. Here, participants canoed into the Tamarack Bog State Nature Preserve and later visited a fen in the Mongoquinong State Nature Preserve. Field trip leaders were Tom Post (Tefft and Spinn) and Lee Casebere (Pigeon River) of the Indiana Department of Natural Resources, Paul Rothrock of Taylor University (Laketon), and Kem Badger and Don Ruch of Ball State University (Ginn Woods). Evening presentations covered orchids of Indiana, presented by Mike Homoya of

I.D.N.R.; nature photography, by Lee Casabere; and northern Indiana vegetation, by David Hicks of Manchester College. Attendance: only 25, primarily from the eastern states. Field trip assistant: Betty Oldham. Meeting organizer: David Hicks.

**27 June**: Middle and South Branches of the Forked River, Lacey Township, Ocean County, NJ. Participants consolidated into four-wheel-drive vehicles to penetrate to the wildest recesses of the Forked River Mountains region. Shrubs were in bloom along the borders of sand roads and elsewhere were *Ilex glabra, Kalmia angustifolia, Lyonia mariana,* and *Rhododendron viscosum.* A few bushes of *Vaccinium corymbosum* were already bearing blue fruit. South of the central section of the main stem of the Middle Branch and west of the Garden State Parkway, we investigated a white-cedar-dotted *Narthecium americanum* savanna, surveyed in 1998 by A.E. Schuyler and the leader. It is, in part, the subject of a paper in this issue of *Bartonia.* We saw two sizeable pockets of the globally rare and state-endangered bog asphodel, far removed from the core populations in the heart of Wharton State Forest. The majority of these plants were sterile, but scores held aloft their yellow spikes. Associated species also in bloom included *Nymphaea, Pogonia, Sarracenia, Lophiola aurea, Utricularia cornuta, U. striata (U. fibrosa), U. subulata, Drosera filiformis,* and *Calopogon tuberosus.* Among the sedges were *Carex exilis, Cladium mariscoides, Eleocharis tuberculosa, E. tenuis, Rhynchospora fusca,* and immature plants of *R. alba.* Grasses seen were *Andropogon glomeratus, Danthonia sericea* var. *epilis, Muhlenbergia uniflora,* and *Panicum ensifolium.* Young plants of *Juncus pelocarpus* were just beginning to emerge. *Schizaea pusilla* occurred along with *Pseudolycopodiella caroliniana* along a white-cedar-dominated tributary farther south. Earlier in the month the leader discovered 10 flowering stalks of *Arethusa* here; none was seen this time. Farther east near the Parkway, we visited a severely disturbed habitat whose unique flora had been previously documented. Flowering were *Nymphoides cordata, Sagittaria teres, Eriocaulon aquaticum,* and *Proserpinaca pectinata,* while *Utricularia resupinata* was still in bud. On the moist fringe were *Polygala lutea* in bloom, the foliage *of Gentiana autumnalis,* our three *Drosera, Juncus canadensis, Eleocharis olivacea, E. microcarpa, Scirpus pungens, Cyperus dentatus, Amphicarpum purshii,* and old culms of *Rhynchospora knieskernii.* Occupying peaty soil were *Calamovilfa brevipilis* and *Muhlenbergia torreyana.* At our final stop, an open regenerating cedar swamp near the headwaters of the South Branch, we saw two exotic pitcher plants, *Sarracenia minor* and *S. rubra.* Introduced many years ago, these stands blended remarkably with the typical native species *Sarracenia purpurea, Pogonia, Utricularia striata, Juncus caesariensis, J. canadensis, J. marginatus, J. scirpoides, Eriophorum virginicum, Carex striata,* and *Vaccinium macrocarpon.* Thanks to Bill Standaert for providing a fine comprehensive list of the species observed. Attendance: 9. Leader: Ted Gordon.

**10 July**: Whiting and Whitesbog, Lebanon State Forest, Ocean and Burlington Counties, NJ. Joint trip with Torrey Botanical Society. At Whiting Wildlife Management Area we stopped at a mowed field with seepage area and associated damp swales. Here we found flowering *Calopogon tuberosus, Lobelia nuttallii, Polygala lutea, Xyris difformis,* and *X. torta.* This site also produced several interesting sedges, including *Carex barrattii, Eriophorum virginicum, Rhynchospora pallida, Scleria minor,* and *S. triglomerata.* Our next stop was the ruins of a terra-cotta factory on the eastern edge of Lebanon State Forest, where we found *Chimaphila maculata* and *C. umbellata* flowering side-by-side. Also here were a few flowering *Epipactis helleborine,* most in poor condition due to the summer's drought. After lunching at Whitesbog village, we found the ferns *Asplenium platyneuron, Atherium filix-femina,* *Botrychium virginianum, B. matricariifolium, B. dissectum*, and *Ophiogossum vulgatum* in the vicinity of some abandoned buildings. Nearby was a nice clump of *Linum striatum*. Other stops at Whitesbog yielded flowering *Arenaria caroliniana, Asclepias tuberosa, Aster paternus, Calluna vulgaris, Galactia regularis, Platanthera blephariglottis* (with buds), *Pogonia ophioglossoides, Rhododendron viscosum, Schwalbea americana*, and *Stylisma pickeringii*. Thanks to Ted Gordon, Ralph and Ellen Wilen, and Howard Wildman for help with transportation. Leader: Linda Kelly.

**14 August**: Whittingham Wildlife Management Area, Fredon Township, Sussex County, NJ. This 1,600-acre preserve has a diverse flora typical of New Jersey's limestone areas. This trip focused on marshes and intermittent ponds that would normally be almost impenetrable, but that had been made accessible by several weeks of drought. A good variety of ferns was noted, among them *Dryopteris goldiana, D. cristata, D. clintoniana*, several *Dryopteris* hybrids, *Diplazium pycnocarpon*, and such limestone-loving species as *Asplenium rhizophyllum, A. trichomanes, Woodsia obtusa*, and *Cystopteris tenuis*. A good find was a large clone of *Rhamnus alnifolia*, a northern species that reaches its southern limit of range in New Jersey, growing in a dry and rather confusing lowland dominated by *Carex stricta, Toxicodendron vernix*, and *Fraxinus nigra*. *Carex lupiliformis* was seen on the edges of several dry ponds, and several plants of *Platanthera psychodes*, well past bloom, were located in a dry swamp that also contained *Cypripedium calceolus, Smilacina stellata*, and *Equisetum fluviatile*. *Lobelia cardinalis* was almost the only woodland or wetland plant in bloom, but upland fields were ornamented with flowers of *Monarda fistulosa, Dipsacus sylvestris, Carduus acanthoides*, and several species of *Solidago*. Many thank to Ralph Wilen for pointing out some interesting *Dryopteris* hybrids, and to Bill Olson for taking a second look at *Carex lupuliformis*. Leader: Karl Anderson.

**29 August**: Palmyra Cove Nature Park, Palmyra, Burlington County, NJ. This trip included a 300-acre area of landfill, freshwater tidal marsh, and dredge impoundments bordered by the Delaware River, Pennsauken Creek, and Route 73. The flora of this site consists of about 350 species, of which about one-third are non-native. Uplands here are dominated by such species as *Ailanthus altissima* and *Populus deltoides*, with an understory of *Polygonum cuspidatum* and *Urtica dioica*. Also present were *Strophostyles umbellata, Cycloma atriplicifolium, Lycopus europaeus, Verbascum phlomoides, Mirabilis nyctaginea, Leptoloma cognatum*, and many other plants typical of dry, disturbed habitats. Wet ditches had *Ludwigia peploides, Spirodela polyrhiza, Potamogeton crispus, Elodea canadensis*, and *Ceratophyllum demersum*. The intertidal flats along the Delaware River here were surprisingly devoid of vegetation, even though there are extensive vegetated flats just north of the site; however, we did find a few plants that were tentatively identified as *Sagittaria subulata*. A fine stand of *Salix exigua*, a very distinctive willow species, was found on the shore. A brief foray into a freshwater tidal marsh was quite productive, with large stands of *Nuphar advena, Peltandra virginica, Sagittaria latifolia, Pontederia cordata, Polygonum punctatum, Amaranthus cannabinus, Bidens laevis, Heteranthera reniformis, Zizania aquatica*, and other species typical of the habitat. Old dredge spoil produced *Scirpus pungens, Cyperus erythrorhizos, C. strigosus, Eleocharis ovata, Alisma subcordatum*, and *Lindernia dubia*. Two trees of interest were *Acer pseudoplatanus* and *Ulmus procera*. Leader: Karl Anderson.

**4 September**: Cedar Lake Fish and Wildlife Management Area, Monroe Township, Gloucester County, and Buena Township, Atlantic County, NJ. Members gathered in the sand parking lot south of Jackson Road, immediately south of Cedar Lake's spillway to hear the leader give a description of the lake and its history. Because of drought, there was reduced surface water flow into the lake, thus leaving the pond bottom exposed, providing a nearly water-free area to survey. We were able to walk along the narrow stream channel of the original pre-dam watercourse. Our expedition followed the eastern shoreline to the head of the pond, returning to the parking lot briefly to explore the western, smaller arm of Cedar Lake. The exposure of the sandy organic lake sediments provided a great opportunity for emergent graminoids. Normally, when the pond is full of water, only the tips of *Juncus militaris* are exposed. Drought provided habitat for *Juncus canadensis* as well. Between the dominant rushes were numerous noteworthy species. Most of the exposed sediments supported a dense mat of *Rhynchospora (Psilocarya) scirpoides* from the area of the dam to the head of the lake. Among this immense beaked-rush population were colonies of *Xyris smalliana*, *Scleria reticularis* var. *pubescens*, *Rhynchospora chalarocephala*, and *Ludwigia sphaerocarpa*. After a brief lunch we explored the western arm of the lake, finding similar conditions in this separate drainage. The upper edge of the lake truncates into an Atlantic white-cedar swamp too dense for the entire entourage to visit. We ended our day in the exposed bottom of this portion of the lake, noting the high density of *Rhynchospora chalarocephala* to the exclusion of many other plants. Leader: Joe Arsenault.

**18 September**: Roebling Memorial Park and Duck Island of the Hamilton-Trenton Marsh, Mercer County, NJ. Joint trip with the Torrey Botanical Society. Blooming at Roebling Memorial Park were *Ambrosia artemisiifolia*, *A. vulgaris*, *Bidens frondosa*, *Chenopodium album*, *Chrysanthemum leucanthemum*, *Cirsium arvense*, *Commelina communis*, *Daucus carota*, *Erechtites hieraciifolia*, *Eupatorium rugosum*, *E. serotinum*, *Helenium autumnale*, *Impatiens capensis*, *Lathyrus latifolius*, *Linaria vulgaris*, *Lycopus americanus*, *Lythrum salicaria*, *Oenothera biennis*, *Oxalis stricta*, *Plantago lanceolata*, *Polygonum amphibium*, *P. arifolium*, *P. caespitosum*, *P. cuspitatum*, *P. punctatum*, *P. hydropiperoides*, *P. pensylvanicum*, *Pontederia cordata*, *Sagittaria latifolia*, *Taraxicum officianale*, *Trifolium pratense*, *Verbascum thapsus*, and *Zizania aquatica*. At our lunch spot at the Trenton Marina boat dock north of Duck Island, we saw in bloom the rare plant *Bidens bidentoides* (southern estuarine beggar-ticks) along with *Chenopodium ambrosioides*, *Helenium autumnale*, and *Vernonia noveboracensis*. A sampling of the species blooming at Duck Island, a constructed freshwater tidal wetland site, included *Aster puniceus*, *Bidens laevis*, *Helianthus tuberosus*, *Mikania scandens*, *Perilla frutescens*, *Polygonum arifolium*, *P. punctatum*, *P. sagittatum*, *Pontederia cordata*, *Solanum nigrum*, and *Vernonia noveborecensis*. Other species were *Amaranthus cannabinus*, *Carex grayi*, *Eleocharis acicularis*, the threatened mud-plantain *Heteranthera multiflora*, *H. reniformis*, *Myriophyllum spicatum*, *Penthorum sedoides*, *Potamogeton pectinatus*, *Sagittaria subulata*, and an alga species of *Vaucheria*. Attendance: 15, 10 of whom were students in a wetlands course from the University of Pennsylvania. Report prepared by Patrick Cooney. Leaders: Mary and Charles Leck.

# Program of Meetings 2000–May 2002

| Date | Subject | Speaker |
|---|---|---|
| **2000** | | |
| 27 Jan | *Phyllanthus* (Euphorbiaceae) in Hepatitis Virus | David Unander |
| 24 Feb | A Look at the Potomac Gorge and its Flora | Robert G. Johnsson |
| 23 Mar | Selected Plant Communities and Flora of the Engadine Region of Switzerland | Ted Gordon |
| 27 Apr | Retirement Party for Alfred "Ernie" Schuyler | Morris Arboretum of the University of Pennsylvania |
| 25 May | Rare Plants of Bucks County | Ann F. Rhoads |
| 28 Sep | Members' Reports on Summer Botanizing | |
| 26 Oct | Plants, Pests, Poisons, and Pot—Forensic Botany | Meredith A. Lane |
| 16 Nov | Distribution of Aquatic and Wetland Plants in Relation to Land Use in Mullica River Basin streams | Kim Laidig |
| 14 Dec | Botanical Management Strategies in Fairmount Park | Richard J. Horwitz, Alfred E. Schuyler, and Bradley W. Thompson |
| **2001** | | |
| 25 Jan | The Versatile Bartrams and Their Enduring Botanical Legacy | Alfred E. Schuyler |
| 22 Feb | The Sarah P. Duke Gardens: A Jewel in the University's Crown | Richard A. White |
| 22 Mar | Acanthaceae and Other Interesting Plants of South Africa | Lucinda A. McDade |
| 26 Apr | Science, Policy, and Management of an Invasive Plant, Purple Loosestrife | Erik Kiviat |
| 24 May | Highlights on Botanical History and Exploration of Quebec-Labrador | Jacques Cayouette |
| 27 Sep | Members' Reports on Summer Botanizing | |
| 25 Oct | The *Crataegus* Problem | James A. Macklin |
| 15 Nov | More South Florida Goodies | Stevens Heckscher |
| 20 Dec | *Carex polymorpha* and other Botanical Treasures of the Nescopeck Creek Valley, Luzerne County, Pennsylvania | Ann F. Rhoads and Timothy A. Block |
| **2002** | | |
| 24 Jan | A Review of Witmer Stone's Contributions to Botany | Gerry Moore |
| 28 Feb | Sex Life of *Amaranthus cannabinus* | Margo Bram |
| 28 Mar | New York Metropolitan Flora Project | Steven E. Clemants |
| 25 Apr | Evolution and Distribution of *Dendrobium* Orchids | Howard P. Wood |
| 23 May | Limits to Restoring Native Woodlands to Urban Lands | Steven N. Handel |

# 2001–2002 Membership List

**Life Members**

ARSENAULT, JOE — 961 Clark Ave., Franklinville, NJ 08322, njplants@aol.com
GREENLAND, CHRISTINE MANVILLE — 790 E. Street Rd., Warminster, PA 18974, 215-322-4105
HOLT, ROBERT J. — 3032 Taft Rd., Norristown, PA 19401, 610-584-5578
IRETON, MARY LOU — 213 4th Ave., Haddon Heights, NJ 08035, 856-547-1118
LAUER, DAVID — 49 Cornell Ave., Churchville, PA 18966, 215-357-2646, dml100@aol.com
MCLEAN, ELIZABETH — 139 Cherry Ln., Wynnewood, PA 19096, 610-642-4196
MCLEAN III, WILLIAM — 139 Cherry Ln., Wynnewood, PA 19096, 610-642-4196
MOORE, A. GERRY — 367 E. 201st St., Apt. 6B, Bronx, NY 10458, 718-623-7332, gerrymoore@bbg.org
O'HERRON, JOHN — 220 Washington St., Mount Holly, NJ 08060, 609-261-0711, joheerron@voicenet.com
OLSON, WILLIAM — 1005 Lakewood-Farmingdale Rd., Howell, NJ 07727, 732-938-3187, bolson@maserconsulting.com
PATRICK, RUTH — 750 Thomas Rd., Philadelphia, PA 19118
ROBERTS, WILLIAM H. — 1922 Rittenhouse Sq., Philadelphia, PA 19103, 215-569-5632
RYAN, NANCY PETERS — 2355 Oakdale Ave., Glenside, PA 19038
STAILEY, HELEN M — 8701 Macon St., Philadelphia, PA 19152, 215-673-8163
STEVENS, CHARLES E. — 615 Preston Pl., Charlottesville, VA 22903, 804-293-8658
THOMPSON, SUE — 129 E. Sycamore St., Pittsburgh, PA 15211, 412-622-3295
TREADWAY, SUSAN — 1509 Monk Rd., Gladwyne, PA 19035, 610-642-8050, sptreadway@aol.com

**Honorary Members**

FARLEY, ELIZABETH B. — 319 Bala Ave., Bala Cynwyd, PA 19004, 610-667-0625
SCHUYLER, ALFRED E. — Academy of Natural Sciences, 1900 Benj. Franklin Pkwy., Philadelpiha, PA 19103, 215-405-5088, schuyler@acnatsci.org

**Sponsoring Members**

FRICK, JULIA — Blair 213, 1400 Waverly Rd., Gladwyne, PA 19035, 610-645-8863
LIBBY, VALENCIA — 607 Cloverly Ave., Jenkintown, PA 19046, 215-576-5725
TAYLOR, LANE — 207 W. Gravers Ln., Philadelphia, PA 19118, 215-247-2890, ltaylor@stradley.com

**Regular Members**

ALDHAM, ALBERT — 1660 Hemlock Farms, Hawley, PA 18428, 570-775-6773, bertaldham@webtv.net
ALLEVA, DENISE — 1071 Penn Circle, Apt. G-312, King of Prussia, PA 19406, 610-783-6799, denise.alleva@sanofi-synthelabo.com
AMOS, SANDRA — 41 Laurel, Clementon, NJ 08021, 856-346-2242
ANDERSON, KARL — Rancocas Nature Center, 794 Rancocas Rd., Mt. Holly, NJ 08060, 609-267-2195, rancoc@bellatlantic.net
ASPELING, ROGER — P.O. Box 10, Titusville, NJ 08560, 609-397-0084, roissy@juno.com
BAKER, BRAD — P.O. Box 662, Unionville, PA 19375, 610-347-0645
BALDWIN, DON — 4240 Fairview Ave., Newtown Square, PA 19073, 610-353-1550
BAUCHSPIES, JAMES — 4320 Chetwin Terr., Easton, PA 18045, 610-253-8925
BIDDLE, DORRELL — 701 Washington Ave., Palmyra, NJ 08065, 856-829-0748, dell2733@aol.com

BIEN, WALTER — 144 Summit Ave., Langhorne, PA 19047, 215-752-3762, walterb988@aol.com
BLACK, ROBIN R. — 792 Woodlea Rd., Rosemont, PA 19017
BLOCK, TIMOTHY — 1234 Pine Ridge Dr., Perkiomenville, PA 18074, 215-234-0645, block@pobox.upenn.edu
BOWELL, MICHAEL — 2148 Bodine Rd., Malvern, PA 19355, 610-827-1268, mwb@createascene.com
BOYD, HOWARD — 232 Oak Shade Rd., Tabernacle, NJ 08088, 609-268-1734
BRINTON, EDWARD — 896 Roundelay, West Chester, PA 19382, 610-793-1582, ravinehouse@aol.com
BROTHERSON, ROBERT — P.O. Box 179, Revere, PA 18953, 610-847-1005, nellsboy@epix.net
BUCK, WILLIAM — New York Botanical Garden, Bronx, NY 10458, 718-817-8624, bbuck@nybg.org
CAIAZZA, NICHOLAS — 5 Dorothea Terr., Lawrenceville, NJ 08648, ncaiazza@gateway.net
CARR, DEBBIE — 314 E. Highland Ave., Philadelphia, PA 19118, 215-242-0734, wechslercarr@earthlink.net
CHELSVIG, GORDANA — 308 Woodbine Ave., Narberth, PA 19072, 610-667-2581, gchelsvg@fast.net
COOK, BUD — HC 1, Box 1117, Blakeslee, PA 18619
COONEY, PATRICK — 221 Mt. Hope Blvd., Hastings-on-Hudson, NY 10706, 914-478-1803, plcooney@aol.com
COURTNEY, JOHN — 439 Gladstone Ave., Haddonfield, NJ 08033, 856-429-4987
CRICHTON, OLIVER — 726 Loveville Rd., Ctg. 5, Hockessin, DE 19707, 302-235-0571, crichton@magpage.com
DANZENBAKER, JAY — 607 Cloverly Ave., Jenkintown, PA 19046, 215-576-5725, vlibby@temple.edu
DAVIS, CHARLES — 1510 Bellona Ave., Lutherville, MD 21093, 410-252-4154, cadavis@bcpl.net
DECASTRO, LINDA — 1100 Concord Dr., Bridgewater, NJ 08807, ldecastr@rvcc.raritanval.edu
DENNE-HINNOV, BOEL — 1-D Hibben Apt.s., Faculty Rd., Princeton, NJ 08540, 609-921-1272, boel_denne-hinnov@hmco.com
DENNY, GUY — 6021 Mt. Gilead Rd., Fredericktown, OH 43019, 740-694-6087, guydenny@ecr.net
DIEDRICH, ARMON — 502 Highland Terr., Pitman, NJ 08071, 856-589-8455
DODDS, JILL — 56 Tumble Falls Rd., Stockton, NJ 08559, 908-996-3214, jsdodds@worldnet.att.net
DORN, RUTH — 800 Trenton Rd., Apt. 244, Langhorne, PA 19047, 215-702-1433, ruthdorn@hotmail.com
DRAUDE, TIMOTHY — 415 Poplar St., Lancaster, PA 17603, 717-393-7233
DUGGAN, MOIRA CLARE — 316 Wright St., Philadelphia, PA 19128, 215-487-7515, duggan@bbs-law.com
EBERT, JANET — 394 Smith Bridge Rd., Chadds Ford, PA 19317, 610-459-0585
ECKERT, GREG — 137 W. 2nd Ave., 1st Fl., Conshohocken, PA 19428, 610-834-5450, geckert@tnc.org
EDINGER, GREG — 442 Ryan Rd., Greenwich, NJ 12834, 518-692-1725, gedinger@tnc.org
EIGENRAUCH, JANE — P.O. Box 85, Red Bank, NJ 07701, 732-842-0690
EVANS, JANET — Library, Pennsylvania Historical Society, 100 N. 20th St., Philadelphia, PA 19103, 215-988-8779, jevans@pennhort.org
FARNON, CHRISTA — 1418 Surrey Ln., Wynnewood, PA 19096, 610-649-2668, christa.farnon@drexel.edu
FARRELL, JESSIE — 366 Chatham Rd., West Grove, PA 19390, 610-869-4285, jessie@taprootnativedesign.com
FEDERICI, ANTONIO — 911 19th St., Union City, NJ 07087, 201-864-8992, tony_federici@golder.com
FIELD, STEPHEN — 5 Evelyn Ave., Vineland, NJ 08360, 856-691-5868
FIELD, THERESA — 5 Evelyn Ave., Vineland, NJ 08360, 856-691-5868
FINE, HELEN — 73 Nature Ln., Sewell, NJ 08080, 856-218-4809, handnfines@gateway.net
FINE, NORMAN — 73 Nature Ln., Sewell, NJ 08080, 856-218-4809, handnfine@home.com
FINN, ANDREA — 142 W. Thomas Ct., Kennett Square, PA 19348, 610-388-3542

FLANIGAN, TONI — 662 W. Johnson St., Philadelphia, PA 19144, 215-951-9211, ccooper@critpath.org
FLISSER, DANIEL — Dept. of Biology, Camden County College, P.O. Box 200, Blackwood, NJ 08012, 856-227-7200, dflisser@camdencc.edu
FOGARASI, KASIA — 317 Roxborough Ave., Philadelphia, PA 19128, 215-482-3835, kasiankal@aol.com
FREYBURGER, HELEN — 5258 34th Ave. N., St. Petersburg, FL 33710, 747-526-1579
FUSSELL, CATHARINE — 179 Kendal Dr., Kennett Square, PA 19348, 610-388-6523
GARBACK, MARY — 3839 Janice St., Philadelphia, PA 19114, 215-332-7105
GEHRIS, ANNA — 1133 Cameo-Shell Pt. Vlg., Fort Myers, FL 33908, 941-466-6407
GLASS, AMELIA — 135 Washington Ave., Pitman, NJ 08071, 856-589-6435
GODDARD, PAUL — 127 N. Van Pelt St., Philadelphia, PA 19103, 215-557-0187
GOFF, ELINOR — 791 College Ave., Apt. 1, Haverford, PA 19041, 215-247-5777
GOOD, NORMA — 745 Redman Ave., Haddonfield, NJ 08033, 856-428-1396
GORDON, PAT — 31 Burrs Mill Rd., Southampton, NJ 08088, 609-859-3566
GORDON, TED — 31 Burrs Mill Rd., Southampton, NJ 08088, 609-859-3566
GRACIE, CAROL — 19 N. Lake Circle, S. Salem, NY 10590, 914-763-5938, cgracie@optionline.net
GRAY, DENNIS — P.O. Box 206, New Lisbon, NJ 08064, 609-894-8849, gray@imcs.rutgers.edu
GREMBOWICZ, DUANE — 100 Motor Rd., Pine Beach, NJ 08741, 732-349-0364, polarstar@adelphia.net
GRIMES, BRUCE G. — P.O. Box 222, Sumneytown, PA 18084, 215-234-8424, taxkwaxak@cs.com
GRINER, JOSEPH — 25 Millchase Rd., Southampton, NJ 08088, 609-859-9251, joemaggi@netaxs.com
GROSS, MICHAEL F. — Biology Dept., Georgian Court College, 900 Lakewood Ave., Lakewood, NJ 08701, 732-364-2200, gross@georgian.edu
GYER, JOHN — P.O. Box 185, Clarksboro, NJ 08020, 856-423-3889, fernhill@voicenet.com
HALLIWELL, TOM — 19 Kings Rd, Netcong, NJ 07857, 973-347-6071, tbhalliwell@worldnet.att.net
HAMILTON, MARSHALL — 18 Lakewood Dr., Media, PA 19063, mham.12741@aol.com
HAMMERSTROM, FREDERICA — 542 W. Montgomery Ave., Haverford, PA 19041, 610-649-3811
HARDESTY, GAIL — 488 Big Oak Rd., Morrisville, PA 19067, 215-295-4734, evergreen1@aol.com
HARPEL, WILLIAM — 150 E. Winchester Ave., Langhorne, PA 19047, 215-752-0802
HARRIS, JESSIE M. — 4401 W St. N.W., Washington, DC 20007, 202-338-9083, jes405@hotmail.com
HART, ROBIN L. — 5086 Barrington Circle, Sarasota, FL 34234, 941-351-1554
HASSEL, LLOYD V. — 45 Danbury Rd., Lancaster, PA 17601, 717-569-2368
HAUPT, ANDREA — 639 W. Ellet St, Philadelphia, PA 19119, 215-438-8175, reh215@aol.com
HAWK, JEFFREY — 16 Andrea Ln., Hamilton, NJ 08619
HECKSCHER, STEVENS — Natural Lands Trust, 1030 E. Lancaster Ave., Apt. 314, Rosemont, PA 19010, 610-527-6324, heckscher@natlands.org
HEGARTY, DAN — P.O. Box 1244, Chadds Ford, PA 19317, 302-652-4148, dhegarty@mindspring.com
HELD, MICHAEL — Dept. of Biology, St. Peter's College, Jersey City, NJ 18301, 201-915-9187
HERMELY, ALAN — 671 Moore Rd., King of Prussia, PA 19046, 610-337-3666, alan_hermely@urscorp.com
HENRY FOUNDATION FOR BOTANICAL RESEARCH, 801 STONY LN., GLADWYNE, PA 19035, 610-525-2037
HEWITT, DAVID A. — Harvard University, Cambridge, Massachusetts 02138, Dhewitt@oeb.harvard.edu
HIRST, FRANKLIN S. — 5004 Little Mill Rd., Stockton, MD 21864, 410-632-1362
HUGHES, STUART W. — 721 Butler Pike, Maple Glen, PA 19002, 215-646-3873, stuhu@aol.com
HUMBERT, KAREN C. — 2401 Pennsylvania Ave., 7A6, Philadelphia, PA 19130, 215-232-0295
HUNT, LYNN F. — P.O. Box 906, Tuckerton, NJ 08087, 609-296-8022
HUTCHEON, DAVID J. — 25 Caledonia Dr., Warminster, PA 18974, 215-957-0976
INSKEEP, MICHAEL — 113 Cricket Ave., #104, Ardmore, PA 19003, 610-896-0777,

mike@gentlehelpers.com
JANOSKI, JEFFREY F. — 1801 Buttonwood St., #1610, Philadelphia, PA 19130, 215-569-1949, jjfjeh@aol.com
JESS, ROBIN — 55 Lahiere Ave., Edison, NJ 08817, 732-572-5928, c
JOHNSON, ALAN A. — 63 Central Ave., Audubon, NJ 08106, 856-547-3498, aajohnson@bigfoot.com
JOHNSSON, FANNY M. — 7422 Ridge Rd., Frederick, MD 21702, 301-371-5215, johnsson@starpower.net
JUELG, J. RUSSELL —
KAISER, GEOFFREY D. — P.O. Box 222, Sumneytown, PA 18084, 215-234-8424, taxkwaxak@enter.net
KAPLAN, PAULA WEST — 1085 Huntingdon Rd., Abington, PA 19001, 215-884-4829, pwk@home.com
KELLER, ELIZABETH — 114 Wyomissing Blvd., Wyomissing, PA 19610, 610-374-3458, zab12345@aol.com
KELLY, LINDA — 60 Forest Dr., Lakewood, NJ 88701, 732-363-1266, kellylc01@aol.com
KENDIG, JAMES W. — 1212 S. Prince St., Palmyra, PA 17178, 717-832-3899
KIMELMAN, GAY — 2212 St. James Pl., Philadelphia, PA 19103, 215-563-0285
KLOTZ, LARRY — Biology Dept., Shippensburg University, 1871 Old Main Dr., Shippensburg, PA 17257, 717-477-1402, lhklot@ark.ship.edu
KOERBER, JR., WALTER A. — 1380 Valley Green Rd., Etters, PA 17319, 717-938-9618, wakoerber@hotmail.com
KOLAGA, VAL — 186 Dilworthtown Rd., West Chester, PA 19382, 610-399-3136, sfox@axs2000.net
KRAIMAN, CLAIRE T. — 7 Chip Ln., Reading, PA 19607, 610-775-9737
KUNKLE, KARL — 507 Nina Ln., Bear, DE 19701, 302-834-2802, kkkunkle@aol.com
LADEN, MILTON — 1919 Chestnut St., #1407, Philadelphia, PA 19103, 215-568-6599
LAMONT, ERIC — 717 Sound Shore Rd., Riverhead, NY 11901, 631-722-5542, elamont@hamptons.com
LATHAM, ROGER — P.O. Box 57, Wallingford, PA 19086, 610-565-3405, rogerlatham@dca.net
LEA, CHRISTOPHER — 202 Washington St., Berlin, MD 21811, 410-641-1443, chris_lea@nps.gov
LECK, CHARLES — 105 Kendall Rd., Kendall Park, NJ 08824, 732-821-8310
LECK, MARY — 105 Kendall Rd., Kendall Park, NJ 08824, 732-821-8310
LEFEVRE, WILLIAM M. — Historic Bartram's Gardens, 13 Hickory Dr., Doylestown, PA 18901, 267-880-0860, wmlefevre@aol.com
LEVIN, MICHAEL H. — 414 Mill Rd., Havertown, PA 19083, 610-449-7400, mhl6841468@aol.com
LEWANDOWSKI, RICK J. — Mt. Cuba Center, P.O. Box 3570, Greenville, DE 19807, 302-239-7980
LIGHTY, RICHARD — 501 Chandler Mill Rd., Kennett Square, PA 19348, 610-444-2987
LITTLETON, JOHN E. — 331 Station Rd., Wynnewood, PA 19096, 610-642-6755, jlittleton@home.com
LOEFFLER, CAROL — Dept. of Biology, Dickinson College, P.O. Box 1773, Carlisle, PA 17013, 717-245-1360, loeffler@dickinson.edu
LOFURNO, MICHAEL — 2028 Fitzwater St., Philadelphia, PA 19146, 215-732-0849
MACKLIN, JAMES — Academy of Natural Sciences, 1900 Benj. Franklin Pkwy., Philadelphia, PA 19103, 215-405-5088, macklin@acnatsci.org
MARTIN, HARRIS — 5100 Bay Rd., Bensalem, PA 19020, 215-639-3686, martin68@atc-enviro.com
MAURICE, KEITH R. — 63 Union Ave., New Holland, PA 17557, kmaurice@normandeau.com
MCAVOY, WILLIAM A. — 4876 Haypoint Landing Rd., Smyrna, DE 19977, 302-653-2880, wmcavoy@state.de.us
MCCOMBE, ROBERT — 106 Center St., Manahawkin, NJ 08050, 609-597-7107, rob.mccombe@worldnet.att.net
MCCOURT, RICHARD — Academy of Natural Sciences, 1900 Benj. Franklin Pkwy., Philadelphia, PA 19103, 215-299-1157, mccourt@acnatsci.org

McCREA, ESTHER J. — 70 Overhill Rd., Bala Cynwyd, PA 19004, 610-664-1642
McDADE, LUCINDA — Academy of Natural Sciences, 1900 Benj. Franklin Pkwy., Philadelphia, PA 19103, 215-405-5087, mcdade@acnatsci.org
McLAUGHLIN, WILLIAM — 5 Oak Dr., Tabernacle, NJ 08088, 609-268-1054, wmcl268@aol.com
MELENDEZ, MARISA — 1005 Lakewood Farmingdale Rd., Howell, NJ 07731, 732-961-1946, marisabel626@hotmail.com
MELLON, RICHARD — 200 Flint Ct. S., Yardley, PA 19067, 215-493-0697, rmellon@voicenet.com
MICHAEL, DAVID — 313 Green St., Philadelphia, PA, 215-923-6163, dmichael@pennhort.org
MICKLE, ANN — Dept. of Biology, Lasalle University, 1900 W. Olney Ave., Philadelphia, PA 19141, 215-951-1254, mickle@lasalle.edu
MILNER, NORMA — 1131 Harbour Dr., Palmyra, NJ 08065, 856-829-3142, normamartinmilner@juno.com
MONSHAW, HARRIET — 176B Lark Ln., Cherry Hill, NJ 08003, 856-428-2342, v.r.monshaw@ieee.org
MONTGOMERY, JAMES — Ecology III, 804 Salem Blvd, Berwick, PA 18603, 570-542-2191, jdm@sunlink.net
MOOBERRY, F.M. — 111 Spotswood Ln., Kennett Square, PA 19348, 610-444-5495
MOORE, JULIA — 91 Molyneaux Rd., Camden, ME 04843
MORRIS, MELISSA — 234 Broughton Ln., Villanova, PA 19085, 610-525-6659, mhmorris@umich.edu
MORSE, LARRY — The Nature Conservancy, 4245 N. Fairfax Dr., Ste. 100, Arlington, VA 22203, 703-841-5361, lmorse@tnc.org
MOSS, MIRIAM — 8120 Brookside Rd., Elkins Park, PA 19027, 215-635-0176
NACZI, ROBERT — Dept. of Agriculture & Natural Resources, Delaware State University, Dover, DE 19901, 302-857-6450, rnaczi@dsc.edu
NEWBOLD, ANN — 50 Renninger Rd., Bechtelsville, PA 19505, 610-754-7573
NEWSTEAD, CHARLOTTE — 270 Roseland Ave., Essex Fells, NJ 07021, 973-226-7651
NEWSTEAD, EDWIN — 20 Roseland Ave., Essex Fells, NJ 07021, 973-226-7651
NICHOLS, RAY — 412 Federal City Rd., Pennington, NJ 08534, 609-737-7442, nichols@nj1.aae.com
O'BRIEN, TERRY — Dept. of Biological Sciences, Rowan University, Glassboro, NJ 08028, 856-256-4500, obrien@rowan.edu
PALMER, MATTHEW — 1518 Millstone River Rd., Hillsborough, NJ 08844, 908-359-2073, mipalmer@eden.rutgers.edu
PARKS, JAMES — 103 Bender Mill Rd., Lancaster, PA 17603, 717-872-5206, james.parks@millersville.edu
PAYNE, ELISE — 643 Fernfield Circle, Wayne, PA 19087, 610-688-4377, erpayne@erols.com
PLYLER, D. — 18 Bridle Path, Chadds Ford, PA 19317, plylerd@aol.com
PREUCEL, RUTH — 1147 Norsam Rd., Gladwynne, PA
QUIGLEY, PATRICIA — 1080 Quarry Hall Rd., Norristown, PA 19403, 610-584-1829, paqinc@aol.com
RADIS, RICHARD — 69 Ogden Ave., Rockaway, NJ 07866, 973-586-0845, isotria@bellatlantic.net
RHOADS, ANN — 3 Blythewood Rd., Doylestown, PA 18901, 215-348-8139, rhoadsaf@pobox.upenn.edu
RHODES, CHARLES — 107 Stonycreek Ave., Lansdale, PA 19446, 215-368-9591, carhodes@earthlink.net
RISKA, MICHAEL — Delaware Nature Society, Box 700, Hockessin, DE 19707, 302-239-2334, mike@dnsashland.org
ROCHE, LESLIE — 73 Hull Ave., Freehold, NJ 07728, 732-780-0121
ROMANO, GABRIELLA — 4240 Fairview Ave., Newtown Square, PA 19073, 610-353-1550
ROSENBERG, ANN — 5 Westview Rd., Bryn Mawr, PA 19010, 610-525-8683
ROSENBERG, DICK — 5 Westview Rd., Bryn Mawr, PA 19010, 610-525-8683
ROWAN, JANE — Schnabel Engineering Associates, Inc., 510 E. Gay St., West Chester, PA 19380, 610-696-6066, jrowan@schnabel-eng.com

RUCH, PAMELA — 542 Liberty St., Emmaus, PA 18049, 610-966-2635, pamruch@hotmail.com
RUDYJ, ERICH — 1021 Irwins Choice, Bel Air, MD 21014, 410-420-8973, erudyj@aol.com
RUE, MARGARET — 209 Arden Rd., Gulph Mills, PA 19428
RUSSELL, EMILY — P.O. Box 430, Mount Tabor, NJ 07878, 973-625-3382, erussell@nac.net
RYAN, JOEY — 521 S. Narberth Ave., Merion, PA 19066
SALGANICOFF, MATILDE — 556 N. 23rd St., Philadelphia, PA 19130
SCHAEFFER, ROBERT — 1940 W. Turner St., Allentown, PA 18104
SCHNEIDER, GEORGE W. — 345 Nursery Rd., Wellsville, PA 17365, 717-292-4035
SCHNEIDER, WILLIAM — 228 Canterbury Dr., West Chester, PA 19380, 610-431-2449, schndrw@aol.com
SCOTT, JOHN — 55 Hertzog School Rd., Mertztown, PA 19539, 610-682-2809, johndscott@mindspring.com
SCOTT, STELLA — 3316 Arch St., Philadelphia, PA 19104, 215-387-2698, stelsco@yahoo.com
SEAGER, KEITH — 278 Fishing Creek Rd., Cape May, NJ 08204
SEIFFERT, JUDITH — 1135 E. Oxford St., Philadelphia, PA 19125, 215-426-4201
SEIPLER, MARYJANE — 4200 Tamarack Ln., Murrysville, PA 15668, 724-325-3571, grosbeaker@aol.com
SETTLEMYER, KENNETH — 219 Maple St., Jersey Shore, PA 17740, 570-398-2546, ksettlem@uplink.net
SHANKER, MARSHA — 603 Acorn St., Philadelphia, PA 19128, 215-483-9971
SHERMAN, LYNN — P.O. Box 391, Ravena, NY 12143, 518-756-5028, shermanl@capital.net
SLANE, JOSEPH — 1207 Shackamaxon St., Philadelphia, PA 19125, 215-634-6332, jslane@avantgardens.net
SLATER, MIKE — R.R. 5, Box 5820, Mohnton, PA 19540, 610-775-3757
SMITH, CRAIG — 728 Seymour Rd., Bear, DE 19701, 302-324-9486, csmith6666@aol.com
ST. JOHN, MICHAEL — 4 Perry St., New York, NY 10014, misaintjon@aol.com
STAHL, STANLEY — 455 Garland Circle, Lancaster, PA 17602, 717-293-0292, joselyns@fine_hotels.com
STALTER, RICHARD — Dept. of Biology, St. John's University, Jamaica, NY 11439, 718-990-6269
STANDAERT, WILLIAM — 45 Maltbie Ave., Apt. 19B, Midland Park, NJ 07432, 201-612-9069, wfszzz@aol.com
STECKEL, CLAUDIA — 423 N. 27th St., Allentown, PA 18104, 610-740-0141
STECKEL, DAVID — 423 N. 27th St., Allentown, PA 18104, 610-740-0141
STUCKEY, RONALD — 1315 Kinnear Rd., Columbus, OH 43212, 614-292-6095
SWEENEY, BILL — Lockhouse, 393 Island Park Rd., Easton, PA 18042, 610-253-7053
SWEETMAN, HAROLD — Jenkins Arboretum, 631 Berwyn Baptist Rd., Devon, PA 19333, 610-647-8870
TEESE, PAUL — Bowmans Hill Wildflower Preserve, 1183 Apple Rd., Quakertown, PA 18951, 215-536-3719, teese@bhwp.org
TOFFEY, WILLIAM — 9001 Verree Rd., Philadelphia, PA 19115, 215-969-6789, wtoffey@prodigy.net
TREXLER, LARRY — 7501 Germantown Ave., Philadelphia, PA 19119, 215-242-1309
TREXLER, NANCY — 7501 Germantown Ave, Philadelphia, PA 19119, 215-242-1309
TUCKER, ARTHUR — Dept. of Agriculture & Natural Resources, Delaware State University, Dover, DE 19901, 302-857-6408, atucker@dsc.edu
TYNDALL, WAYNE — 15245 Oakland Rd., Goldsboro, MD 21636, wtyndall@intercom.net
UDELL, VAL — 2746 Yost Rd., Perkiomenville, PA 18074, 610-754-7163
VERLENDEN, DONALD — P.O. Box 116, Lansdowne, PA 19050
VOLLMER, JOHN — 42 Burrs Mill Rd., Southampton, NJ 08088, 609-859-2805
WHITING, GEORGE — 116 Spring Mount Rd., Schwenksville, PA 19473, 610-287-6397
WIEBOLDT, THOMAS — 155 Shady Grove Ln., Newport, VA 24128, 540-544-7967, wieboldt@vt.edu
WILEN, ELLEN — 143 Ridge Rd., Southampton, NJ 08088, 609-859-8685
WILLIAMS, CARL — Box 347, Hereford, PA 18056, 215-234-0545

WILLIAMS, DAVID — 61 Coppermine Rd., Princeton, NJ 08540, 732-297-0642, idwill@superlink.net
WILLIG, SARAH — 190 Sycamore Ln., Phoenixville, PA 19460, 610-933-3539, sallyhugh@msn.com
WILSON, RONALD — 3740 Ridge Rd., Snow Hill, MD 21863, 410-632-3892, rwilson@dmv.com
WINDISCH, ANDREW — P.O. Box 312, Chatsworth, NJ 08019, 609-726-9054, windisch2@erols.com
WITMAN, DEANNA — 214 3rd St., East Greenville, PA 18041, 215-541-1789
WOLFF, EMILY — 295 E. Rose Tree Rd., Media, PA 19063, 610-566-6385
WOOD, HOWARD — 3300 Darby Rd., C-802, Haverford, PA 19041, 610-642-9963, howardpagewood@aol.com
WOODFORD, JEANNE — Wildlife Advocate, 2 Sawmill Rd., Medford, NJ 08055, 856-983-1617, jeannewoodford@earthlink.net
ZAMPELLA, ROBERT — 12 Concord Dr., Shamong, NJ 08088, 609-268-3363, zampella@njpines.statenj.us
ZAREMBA, ROBERT — 143 Hoyt St., Apt. 6-J, Stamford, CT 06905
ZOLLER, HEINRICH — 50 Renninger Rd., Bechtelsville, PA 19505

# Instructions to Authors

## Types of Articles Published

Research papers communicate original research in plant ecology, plant conservation biology, plant systematics, and related topics. Other contributed papers convey the results of studies in floristics, distribution, methods, biography, bibliography, history of botanical exploration, and other topics of botanical interest. Short reports of one or two pages appear in "News and Notes." Other items include obituaries, book reviews, and field trip reports. The focus is on the mid-Atlantic region, but contributions of interest to *Bartonia* readers from farther afield are welcomed.

## Manuscript Style

Write in simple, clear sentences. Use the active voice where possible. Avoid redundancy. *Bartonia* generally conforms to the Council of Biology Editors, Committee on Form and Style, *CBE Style Manual*.

Consult recent issues of *Bartonia* for placement and style of main headings, subheadings, literature cited, table and figure captions, and tables.

Double-space *all* text, including tables.

Do not justify the right margin.

Arrange manuscript copy in this order:

- Name, address, e-mail address, and telephone number of corresponding author
- Running head (shortest intelligible version of title)
- Date of original manuscript submission
- Title of paper
- Name(s) of author(s)
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- Text of paper
    - Abstract
    - Introduction
    - Methods
    - Results
    - Discussion (may include Conclusions)
    - Literature Cited
    - Acknowledgments
- Tables (with captions)
- Figure captions
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## Manuscript Submission and Review

Authors should send *three, double-spaced, paper copies* of the manuscript, with all tables and figures (*copies only* of artwork with the first submission), to the Editor. Manuscripts with multiple authors should be accompanied by a clear designation of the corresponding author, to whom all communication from the Editor should be addressed. The Editor will select at least two reviewers for each manuscript and, on the basis of the reviews, decide on suitability for publication in *Bartonia*.

Submission of a manuscript implies that it is not under consideration in a similar form elsewhere.

The Editor will return manuscripts judged to require modification, along with suggestions for revision, to the authors. Manuscripts not accepted for publication will be returned to the authors.

Authors who have been asked to resubmit a revised manuscript should make the requested revisions and provide a brief rationale in a letter to the Editor for any reviewers' comments not complied with. Authors should send *one double-spaced paper copy and an electronic copy* (preferably as an e-mail attachment; a mailed diskette or CD-ROM is also acceptable) of the revised manuscript to the Editor, along with glossy prints or high-resolution scans in electronic form of any illustrations or photographs. Formatted tables and illustrations must be sent as separate files, not embedded in the text.

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