Systematic Botany (2008), 33(4): pp. 685–694

Taxonomy, Morphology, and Geographic Distribution of *Juncus longii* (Juncaceae)

Wesley M. Knapp[1,2,3] and Robert F. C. Naczi[1]

[1]Claude E. Phillips Herbarium, Delaware State University, 1200 N. DuPont Highway, Dover, Delaware 19901 U.S.A
[2]Maryland Department of Natural Resources, Wildlife and Heritage Service, 909 Wye Mills Road (PO Box 68), Wye Mills, Maryland 21643 U.S.A.
[3]Author for correspondence (wknapp@dnr.state.md.us)

Communicating Editor: Mark P. Simmons

Abstract—Authors have debated the taxonomic status of *Juncus longii* almost since its description in 1937. Some authors treat the *J. marginatus* complex, to which *J. longii* belongs, as comprised of three species (*J. biflorus*, *J. longii* and, *J. marginatus*), whereas other authors recognize only one species (*J. marginatus*). Univariate and multivariate statistical analyses of measurements of twelve morphological characters suggest that *Juncus longii* is a species distinct from *J. marginatus* and *J. biflorus*. Ecological differences are also apparent. *Juncus longii* is restricted to early successional seepages with exposed soils. *Juncus marginatus* and *J. biflorus*, however, are found in less specialized habitats. Syntopic occurrences of *J. longii* with *J. marginatus* and *J. longii* with *J. biflorus* suggest the morphological differences used to identify these species are not a reflection of environmental conditions. *Juncus longii* is endemic to the southeastern United States, whereas *J. biflorus* and *J. marginatus* are more broadly distributed across eastern North America, Central America and central South America.

Keywords—cluster analysis, conservation concern, discriminant analysis, principal components analysis.

Juncus L. (Juncaceae) is a widely distributed genus of rushes with approximately 220 species worldwide (Balslev 1996; Kirschner 2002). Plants of this genus occupy a wide variety of habitats and are found on every continent except Antarctica. *Juncus marginatus* Rostk. s.l. (Sect. *Graminifolii* Buchenau) ranges throughout North America from southern Canada throughout every state in the eastern U.S., a small portion of the central U.S., and south to Central America and central South America. Members of the *J. marginatus* complex are identifiable by the combination of flat, unifacial, non-septate leaves; erect culms borne singly or in tufts, more than 2 glomerules per culm; each glomerule 2–12-flowered; and each flower with 3 stamens.

Juncus marginatus was described by Rostkov (1801). Since then, various workers have studied this species and its closest relatives, with little to no consensus. Consequently, 19 names apply to this complex. In the first revision of *J. marginatus,* Engelmann (1866, 1868) recognized three varieties, using a number of floral characters, particularly tepal shape. Coville (1893) used seed characters to recognize three varieties. However, he circumscribed them differently than Engelmann. Ten years later, Small (1903) raised two of Coville's three varieties to species. The most recently described species and the focus of this project is *J. longii* Fernald (1937).

Fernald (1937) named *Juncus longii* after one of its discoverers, Bayard Long (1885–1969). Fernald distinguished *J. longii* from the other members of the complex by its more slender culm; its flexuous, cord-like, scaly rhizomes up to 2 dm long; elliptic-oblong petals that are olive-brown with a broad white hyaline margin; short stamens that promptly shrivel; a compact cyme; and lance-fusiform, 8–12 ribbed seeds that are very slender, with definite white tails (Fernald 1937, 1950).

Many authors of floras do not recognize *J. longii* as distinct from the other members of the complex. There is also great disagreement concerning the number of taxa recognized in the *J. marginatus* complex. A sampling of recent floras shows little taxonomic agreement. Some works recognize only *J. marginatus* (Godfrey and Wooten 1979; Brooks and Clemants 2000; and Kirschner 2002), some recognize *J. marginatus* and *J. biflorus* Elliott (Hough 1983; Gleason and Cronquist 1991; Rhoads and Block 2000), while other recognize *J. marginatus, J. biflorus,* and *J. longii* (Fernald 1950; Radford et al. 1968; Brown and Brown 1984; Sorrie et al. 2007).

While conducting a survey of ecologically significant areas in Worcester County, Maryland, the first author was the co-discoverer of a population of *Juncus* that met the description of Fernald's *J. longii*. This population was growing with other plants that met the description of *J. marginatus*, and no apparent intermediates were present. Therefore, a reevaluation of *J. longii* seemed necessary.

Here we present the results of a morphological study of *J. longii* from throughout the geographic and ecologic range of the *J. marginatus* complex, based on multivariate and univariate statistical analyses. We then present a taxonomic revision of the complex including a key to species, description, and representative specimens. We recognize three species in the complex: *J. marginatus*, *J. biflorus*, and *J. longii*.

Material and Methods

We have studied the morphology, distribution, and habitats of *J. longii*, *J. marginatus*, and *J. biflorus* in the field from 2001–2007 at as many sites as possible throughout the entire known range of *J. longii*. We observed *J. longii* in the field in Alabama, Georgia, Maryland, North Carolina, Tennessee, and Virginia. In Alabama, Delaware, Georgia, Maryland, Massachusetts, Mississippi, New Hampshire, New Jersey, North Carolina, Pennsylvania, South Carolina, Tennessee, Vermont, and Virginia we observed the other members of the complex. We studied ca. 1,200 specimens from the following 14 herbaria: DOV, FLAS, FSU, GA, GH, MISS, MO, NCU, NY, PH, TENN, PENN, UC/JEPS, and US. Herbarium abbreviations follow Index Herbariorum (2007).

We created distribution maps from herbarium specimens. Thus, on our maps, every mapped symbol is based on at least one voucher specimen.

Previous authors vary in their use of terminology referring to the below-ground structures of *J. longii*. Fernald (1937) refers to both rhizomes and stolons in his description of *J. longii.* Fernald (1950) gives the following definitions in his glossary: *stolon* "A runner, or any basal branch that is inclined to root (p. 1583);" *rhizome* "Any prostrate or subterranean stem, usually rooting at the nodes and becoming upcurved at the apex (p. 1581)". Using these definitions, we elect to use the term *rhizome* over *stolon* in this manuscript.

We selected a representative subset of specimens, including our collections, for statistical analysis. We used only mature, complete specimens and our samples included the full range of morphologic variation from throughout the geographic ranges of the three species. Each specimen measured is denoted by an asterisk (*) after the herbarium acronym in the citations of representative specimens.

Statistical Analysis—A set of 118 complete specimens (45 *J. longii*, 39 *J. biflorus*, and 34 *J. marginatus*) from throughout the geographic and morphologic range of the complex was chosen for detailed morphologic analysis. After careful study of hundreds of specimens and a thorough literature review, a list of all characters putatively diagnostic for members of the complex was compiled, yielding a list of 24 characters (Table 1). We measured all of these characters on each of ten specimens of each of the three taxa recognized in most inclusive recent taxonomic and floristic treatments (e.g. Radford et al. 1968). We included those characters whose loadings were >0.5 on principal components analysis in future analysis. We then measured 12 of these characters (Table 1) on an additional 88 specimens. Summary statistics including means, standard deviation, and ranges are calculated for all 12 characters (Table 2).

When multiple individuals were present on a sheet, we measured all characters from a single mature individual. When measuring a character that was present more than once per specimen (e.g. stamen length), we measured the one with the greatest value. Similarly, when measuring the width of a particular structure we measured it at its widest point. Infructescence length was measured from the base of the infructescence bract to the tip of the infructescence. Infructescence width was measured at the widest point of the infructescence. Infructescence branch width was measured on the basal-most branch of the infructescence. Rhizome cataphyll distance was measured from cataphyll scale base to cataphyll scale base between the most widely separated but adjacent root cataphylls. Rhizome width was measured between the most separate but adjacent root cataphylls. Stem base width was measured at the junction of the stem and rhizome. Leaf sheath length was measured on the basal-most leaf sheath. Leaf width was measured at the widest point on the widest leaf, usually the basal-most leaf. Culm height was measured from the base of the culm to the first branch of the infructescence.

We submitted all characters measured to a Pearson Correlation Analysis. When two characters were highly correlated (r > 0.5), the character with the higher component loading (as determined by Principal Component Analysis) was retained. The other character was excluded from Principal Component Analysis in order to avoid weighting potentially redundant characters.

We conducted statistical tests on the measurements using Systat version 11 (SPSS 2004). An Analysis of Variance (ANOVA) was conducted to test the null hypothesis that there is no morphologic dissimilarity between *J. longii* and the other members of the complex. A Principal Component Analysis (PCA) determined the amount of morphological variation in the data set and the characters that are most diagnostic to *J. longii*.

Table 1. List of all characters examined with the component loadings and percent variance explained of the first two Principal Components.

Characters Examined	Loading 1	Loading 2
Culm height	0.696	0.541
Culm width at base		
Mid-Culm width	0.819	0.137
Stem base width	0.816	−0.091
Distance between adjacent rhizome cataphylls	0.021	0.912
Rhizome width between adjacent rhizome cataphylls	0.565	−0.573
Height of rhizome base		
Sheath length	0.736	0.414
Widest leaf width	0.834	0.09
Infructescence length	0.694	−0.445
Infructescence width	0.713	−0.137
Infructescence branch width	0.644	−0.3
Longest infructescence branch length		
Anther length	0.726	−0.109
Anther width	0.521	0.363
Filament length		
Tepal length		
Tepal margin width		
Tepal width		
Capsule length		
Capsule segment width		
Capsule width		
Seed length		
Seed width		
Percent of Total Variance Explained	46.5	17.6

A second PCA was conducted examining specimens of *J. longii* and the possibilities of infraspecific taxa being restricted to physiographic provinces. Measurements are grouped by the physiographic province in which the specimen originated. Before conducting PCA, we standardized the data so each variable would have a mean of 0 and a standard deviation of 1. A Cluster Analysis (CA) determined which specimens were the most morphologically similar by grouping each specimen by its overall phenetic similarity. The CA examined all 118 specimens using Euclidean distance and average linkage. A Discriminant Analysis (DA) assigned specimens to groups based upon overall morphologic similarities. The groups were assigned using the single most distinct morphologic character, the distance between adjacent cataphylls, as the grouping variable. Because cataphyll distance is used as the grouping variable, it could not be used in the DA and, thus, the other 11 characters were subjected to DA. Such methods have been quite useful in many similar studies (e.g. Chamberland 1997; Saarela and Ford, 2001; Janovec and Harrison 2002).

Micromorphology—We utilized Scanning Electron Microscopy (SEM) to study seeds using a Hitachi S-2600 N at an accelerating voltage of 15kV. A total of 18 seeds (6 *J. longii*, 6 *J. marginatus*, and 6 *J. biflorus*) were examined under SEM. Each specimen examined under SEM is denoted with a superscript S (^{S}) after the herbarium acronym in the citations of representative specimens.

Geographic Distribution—We obtained latitude and longitude coordinates for each specimen based on the specimen location label data, TopoZone (2006), and use of GPS in the field. Specimens were mapped by their location data using ArcView 3.2a (ESRI 2000).

Ecology—At every population studied in the field we compiled data on associated species, habitat information, and site condition. Notes on habitat include soil saturation, soil composition, exposure to direct sunlight, population size, and amount of disturbance. Our field surveys were conducted in the southeastern United States where all three species are sympatric. At sites where more than one species in the complex occurred, we diligently searched for intermediates by observing and collecting as many plants as time and population size warranted. We made a series of collections at each site showing the morphologic range of the species.

Results

Correlation Analysis—A Pearson Correlation Analysis showed six characters in the dataset as being highly correlated with a correlation coefficient of ≥0.7. Height of the stem base is highly correlated to width of the stem base (r = 0.772, $p < 0.0001$), length of the basal-most leaf is highly correlated to length of the basal most sheath (r = 0.835, $p < 0.0001$), and length of the longest infructescence branch is highly correlated with total infructescence length (r = 0.686, $p = 0.0003$). Height of stem base, length of basal-most leaf, and the length of longest infructescence branch are excluded from statistical analyses because their component loadings are less than the loadings for the characters with which they are highly correlated.

Univariate Analyses—The ANOVA (Table 2) revealed the characters accounting for the most morphologic dissimilarity among the taxa. These were cataphyll distance, stem base width, leaf width, culm height, and rhizome width. The two characters with the highest *F*-values are depicted graphically (Fig. 1), and reveal slight overlap in specimens of *J. biflorus* and *J. marginatus*, and no overlap with specimens of *J. longii*.

Multivariate Analyses—The scatter plot of the scores of components I and II from PCA shows three distinct groupings (Fig. 2). *Juncus longii* is the most morphologically distinct species in the complex. Though some individuals of *J. marginatus* and *J. biflorus* do approach one another, there is no overlap. The first two principal components account for 64.1% of the variation, with component I accounting for 46.5% and component II accounting for 17.6% (Table 1). The variables with the highest loadings on component I are widest leaf, mid-culm width, and stem base width, in descending order. On component II, distance between adjacent rhizome

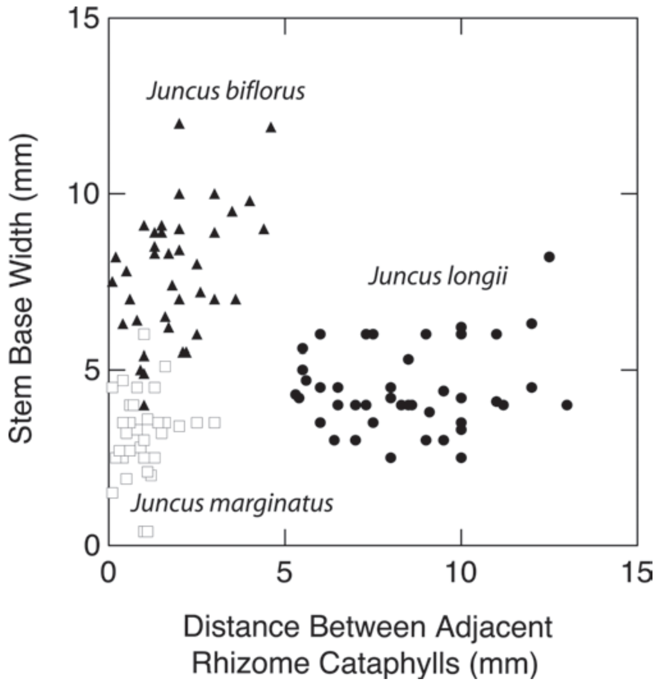

FIG. 1. Scatter plot of the two most important characters for distinguishing the members of the *J. marginatus* complex as revealed by ANOVA. Circles represent *J. longii* (N = 45), squares represent *J. marginatus* (N = 34) and triangles represent *J. biflorus* (N = 39).

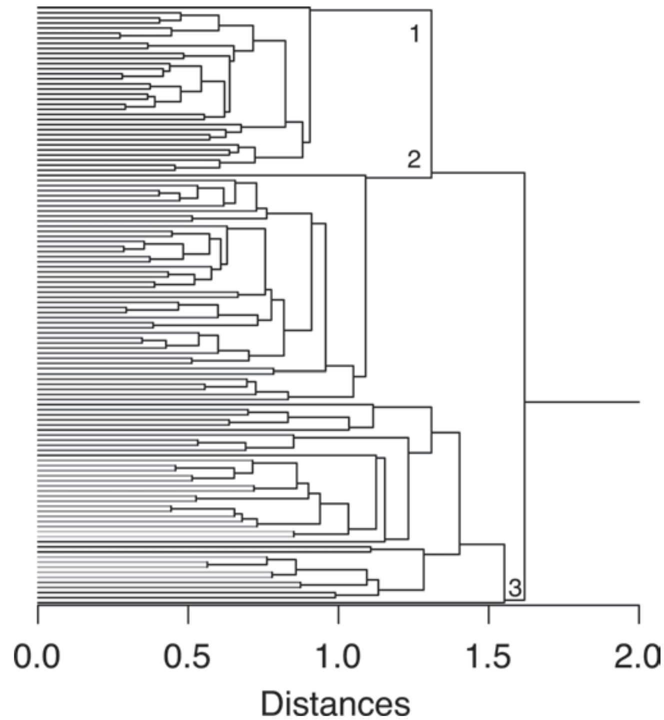

FIG. 3. Cluster Analysis of the 118 specimens measured in the *J. marginatus* complex. 1 = *J. marginatus* group, 2 = *J. longii* group, and 3 = *J. biflorus* group.

cataphylls, rhizome width, and culm height had the highest loadings.

A dendrogram resulting from the Cluster Analysis (CA) shows three groups with *J. marginatus* and *J. longii* being the most morphologically similar (Fig. 3). All specimens of *J. longii* clustered together in the CA. One specimen of *J. biflorus* clustered with the *J. marginatus* cluster, and two specimens of *J. marginatus* clustered with the *J. biflorus* cluster. Though resolving the relationship of *J. biflorus* and *J. marginatus* is beyond the scope of this project, the clustering of these specimens together shows the morphologic similarity between *J. marginatus* and *J. biflorus*.

A histogram of the canonical score from Discriminant Analysis (DA) of 11 morphological characters shows two peaks, one for *J. longii* and the other for both *J. biflorus* and *J. marginatus* (Fig. 4). The DA revealed the two groups had markedly different morphology (Wilks' Lambda = 0.239; F =

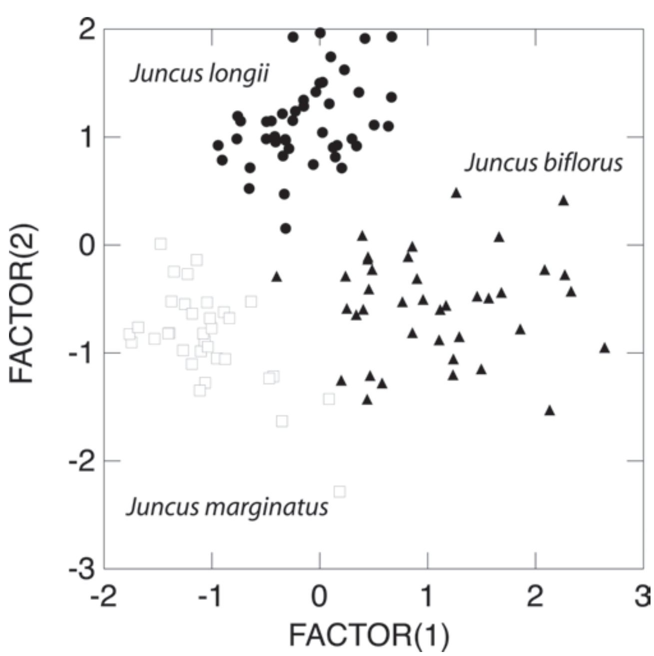

FIG. 2. Scatter plot of factor scores of PCA loadings I and II of 118 specimens from the *Juncus marginatus* complex. Circles represent *J. longii* (N = 45), squares represent *J. marginatus.* (N = 34) and triangles represent *J. biflorus* (N = 39).

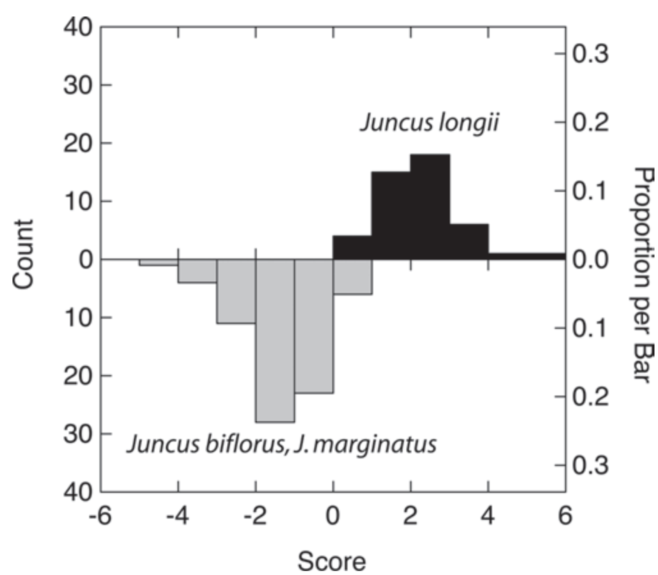

FIG. 4. Histogram of scores on canonical factor I from discriminant analysis of 118 specimens from the *J. marginatus* complex. Black bars represent *J. longii* and gray bars represent *J. marginatus* and *J. biflorus*.

30.423; df = 11, 105; $p < 0.0001$). Even with the most distinctive morphological character excluded from the analysis (because it was the grouping variable), 98% percent of all individuals were properly classified by the DA. Variables with the highest loadings on factor I are rhizome width (28.16), stem base width (23.02) and culm height (18.94). No specimens of *J. longii* were misclassified as being from the *J. biflorus/marginatus* group, while two specimens of *J. biflorus* were misclassified as being in the *J. longii* group. The specimens misclassified are from Brazil (*Koyama 13829* NY) and Marion County, Alabama (*Kral 31159* PH). The Koyama specimen from Brazil contains two plants on the same sheet. The Koyama specimen was scant, and thus probably did not express the full range of morphologic variation of an ample specimen, and was included in this analysis for the purpose of including as broad a geographic range of the complex as possible. The Kral specimen from Marion County Alabama is typical *J. biflorus*, with a large stem base, wide leaves, and long stamens. The measurements of cataphyll distance, culm height, and sheath length are all towards the low extreme for *J. biflorus* and are probably the reason this specimen was misclassified.

The possibilities of infraspecific taxa of *J. longii* were examined. A PCA examining 10 morphologic characters, grouped by physiographic province, showed no recognizable groupings of specimens (Fig. 5).

Morphological Characters—According to the PCA, 12 of the 23 morphologic characters measured can be used to identify species. *Juncus longii* is easily distinguished from *J. biflorus* and *J. marginatus* by the presence of long (up to 2 dm), narrow (0.8–1.9 mm wide), cord-like rhizomes with well spaced cataphylls (5.3–13.0 mm long) (Fig. 6; Table 2). The rhizome of *J. biflorus* is shorter, wider (0.4–4.5 mm), with very close and frequently overlapping rhizome cataphylls (0.1–4.6 mm) (Fig. 6; Table 2). The rhizome of *J. marginatus* is much shorter, generally wider (0.6–3.5 mm), with close to overlapping rhizome cataphyll scales (0.1–3.0 mm), that are easily overlooked (Fig. 6; Table 2).

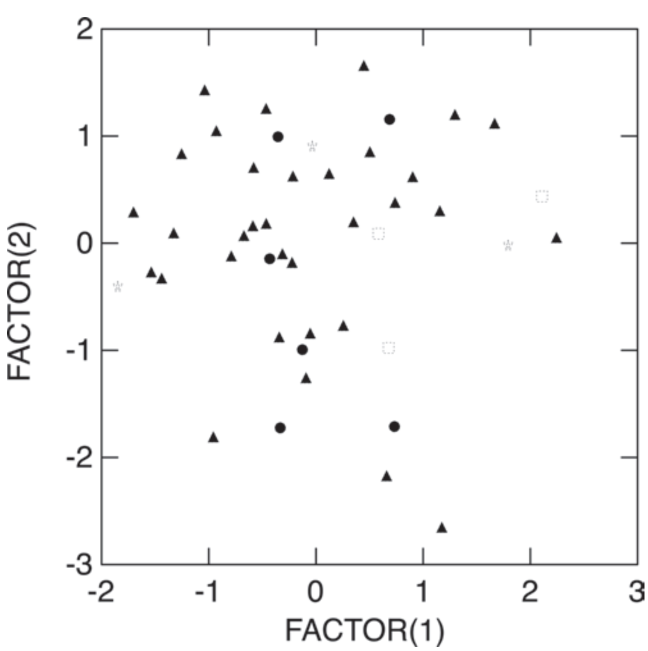

FIG. 5. Scatter plot of factor scores of PCA loadings by physiographic province of *Juncus longii*. Specimens are grouped by physiographic province with triangles = Coastal Plain, stars = Blue Ridge, circles = Piedmont, and open squares = Cumberland Plateau.

The relatively narrow (1.1–6.4 cm wide), and short (1.8–6.4 cm long), infructescence of *J. longii* gives a very congested and compact appearance (Fig. 7; Table 2). The infructescence of *J. biflorus* can be congested and in the range of *J. longii* but is more variable in width (2.0–8.3 cm), and length (2.7–14.5 cm), usually being more diffuse (Fig. 7; Table 2). The infructescence of *J. marginatus* is also more variable ranging from a width of 1.2–5.5 cm, and a length of 1.4–12.0 cm, but never appears as congested as *J. longii* (Fig. 7; Table 2).

Micromorphology—The seeds of the three species are different in shape and size (Fig. 8). The characters Fernald mentioned concerning the numbers of ridges per seed and the presence of white tails are too variable to be useful. Furthermore, many of the features vary with development, and thus are not useful because of the difficulty of comparing similar ontogenetic stages.

Geographic Distribution—*Juncus longii* is a species endemic to the United States and has a unique but overlapping range with that of *J. biflorus* and *J. marginatus. Juncus longii* (Fig. 9) has a much smaller and restricted range compared to the other species of the complex, being found only in freshwater seepages of the southeastern United States. Fernald (1950) described the range of *J. longii* as being chiefly coastal plain, southern New Jersey, and southeastern Pennsylvania to the District of Columbia, south to eastern Virginia, Louisiana to Missouri and Oklahoma. However, this range is not supported by known specimens of *J. longii*. No specimen of *J. longii* is currently known from Louisiana, Missouri, New Jersey, Oklahoma or Pennsylvania and specimens identified as *J. longii* by Fernald and/or Long from these states are actually *J. biflorus* (Orleans Parish., Louisiana, *Drummond 365* (GH); Saint Louis, Missouri, *Geyer s.n.* (GH); Bucks Co., Pennsylvania, *Long s.n.* (PH); Cumberland Co., New Jersey, *Long 44455* (PH); Philadelphia Co., Pennsylvania, *Long 58434* (GH, PH); Bucks Co., Pennsylvania, *Long 63567* (PH); Bucks Co., Pennsylvania, *Long 73831* (GH, PH); Ottawa Co. Oklahoma, *Stevens 2474* (GH)). The known range of *J. longii* (Fig. 9) is Maryland and the District of Columbia, throughout the southeastern Coastal Plain in Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi, on the Cumberland Plateau and Eastern Highland Rim of Tennessee, and in the Blue Ridge of North and South Carolina. Though *J. longii* is not currently known from Kentucky, Louisiana, or Texas, a well documented phytogeographic pattern exists suggesting the species could be expected to occur in these states (Sorrie and Weakley 2001).

Juncus biflorus and *J. marginatus* are far more wide-ranging than *J. longii*. *Juncus biflorus* ranges from the coasts of Massachusetts and New York, west to Kansas, with disjunct populations in Arizona, the West Indies, Bermuda, and south to Central and South America (Fig. 10). *Juncus marginatus* is even more wide-ranging, ranging farther north from southern Canada, throughout New England, west to Nebraska and south to Texas, with disjunct populations in South America (Fig. 11).

Ecology—In Worcester County Maryland, plants of *J. longii* (*Knapp 195-01* (DOV)) were growing syntopically with plants of *J. marginatus* (*Knapp 196-01* (DOV)). No intermediates were located at this site, suggesting the morphologic differences between the two species are genetic. In Talbot County, Georgia, plants of *J. longii* (*Knapp 733* (DOV)) were growing syn-

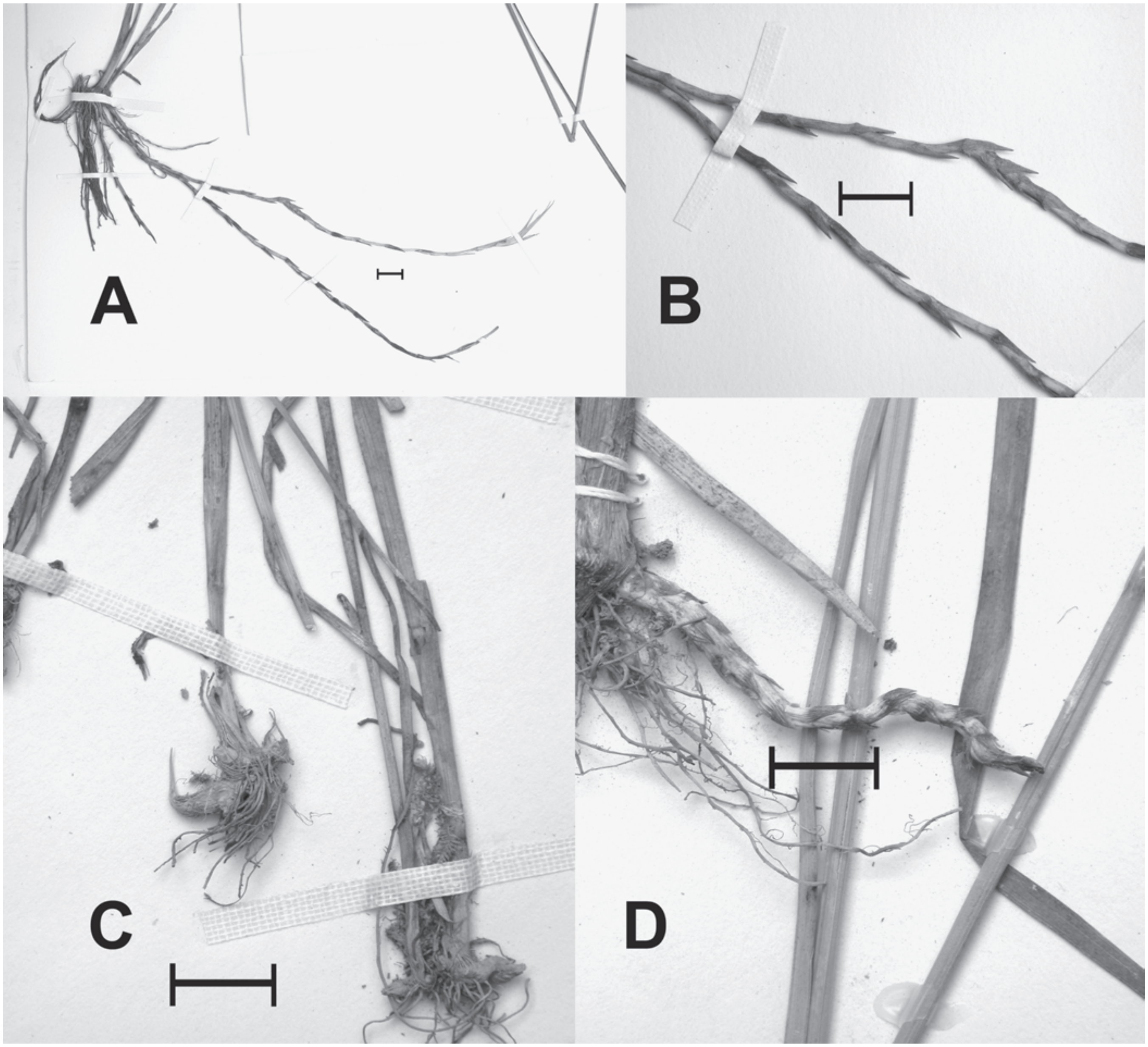

FIG. 6. Rhizome and cataphylls of A. *Juncus longii Schuyler 7925* (PH), B. Close-up of rhizome of *J. longii* showing cataphylls, C. *J. marginatus Stone 13942* (PH), D. *J. biflorus Batson 487* (NCU). Scale = 1.0 cm.

topically with *J. biflorus* (*Knapp 734* (DOV)). Again, no intermediates were located, which suggests that ecological conditions could not explain the morphologic differences. *Juncus longii* is restricted to early sucessional freshwater seepages of the southeastern United States that are either seasonal or persistent throughout the growing season. The soil conditions are typically sand-based (sandy loams or sandy clays); however in some habitats clay-dominated soils are present. Typically, high intervals of disturbance are necessary (i.e. powerline or roadside maintenance) but *J. longii* can persist and flowers only infrequently in shaded conditions.

DISCUSSION

Morphologic characters can easily distinguish *J. longii* from the other members of the *J. marginatus* complex. An examination of the PCA (Fig. 2) shows the morphologic variability in the complex, and reveals that *J. longii* is the least variable species, while *J. biflorus* and *J. marginatus* are far more morphologically variable. All specimens of *J. longii* (Fig. 2) are nested closely together whereas specimens of *J. marginatus* and *J. biflorus* are widely spaced and more broadly distributed. The morphologic dissimilarities of *J. longii* exhibited from the PCA are consistent with other studies that recognize taxa at the species level (e.g. Naczi et al. 1998; Henderson 2002; Saarela et al. 2003).

Since *J. longii* is the most morphologically distinct member, it is curious that this species was overlooked for so long. When Fernald (1950) first included *J. longii* in *Gray's Manual of Botany* he was uncharacteristic in using only two characters (rhizomes and culms) to distinguish this species from the other members of the complex. We can only hypothesize the reasons for this brevity, but suggest that perhaps Fernald himself was not clear on the boundaries of this species.

The geographic range of *J. longii* as first outlined by Fern-

TABLE 2. Morphological characters measured on *J. longii*, *J. biflorus*, and *J. marginatus* showing mean ± 1 standard deviation and range (in parentheses) for each character. N = sample size. Within a row, means with different superscripts differ significantly (ANOVA, $P < 0.05$).

Character (mm)	*J. longii* (N = 45)	*J. biflorus* (N = 39)	*J. marginatus* (N = 34)	ANOVA *F*
Distance between adjacent rhizome cataphylls	$8.4^{a} \pm 2.1$ (5.3–13.0)	$1.9^{b} \pm 1.1$ (0.1–4.6)	$1.0^{c} \pm 0.6$ (0.1–3.0)	313
Stem base width	$4.4^{a} \pm 1.2$ (2.5–8.2)	$7.7^{b} \pm 1.9$ (3.4–12.0)	$3.2^{c} \pm 1.2$ (0.4–6.0)	92
Widest leaf	$2.9^{a} \pm 0.5$ (2.0–4.4)	$3.8^{b} \pm 0.7$ (2.6–5.4)	$2.1^{c} \pm 0.5$ (1.3–3.5)	88
Culm height	$659^{a} \pm 132$ (385–968)	$660^{a} \pm 152$ (272–1007)	$350^{b} \pm 90$ (192–568)	70
Rhizome width	$1.2^{a} \pm 0.2$ (0.8–1.9)	$2.7^{b} \pm 0.8$ (0.4–4.5)	$1.8^{c} \pm 0.8$ (0.6–3.5)	57
Anther length	$0.5^{a} \pm 0.2$ (0.3–0.9)	$0.8^{a} \pm 0.2$ (0.5–1.3)	$0.4^{a} \pm 0.1$ (0.2–0.7)	56
Basal most sheath length	$56.7^{a} \pm 15.5$ (2.8–9.1 cm)	$60.6^{a} \pm 17.5$ (3.2–9.7 cm)	$29.8^{b} \pm 7.7$ (1.7–4.7 cm)	48
Mid-culm width	$1.7^{a} \pm 0.4$ (0.8–2.3)	$2.1^{b} \pm 0.7$ (0.8–3.7)	$1.0^{c} \pm 0.4$ (0.6–1.8)	40
Anther width	$0.2^{a} \pm 0.1$ (0.1–0.3)	$0.2^{a} \pm 0.1$ (0.1–0.3)	$0.1^{b} \pm 0.1$ (0.1–0.2)	35
Infructescence length	$35.6^{a} \pm 11.6$ (1.8–6.4 cm)	$75.0^{b} \pm 28.9$ (2.7–14.5 cm)	$44.6^{a} \pm 26.7$ (1.4–12.0 cm)	29
Infructescence branch width	$0.4^{a} \pm 0.1$ (0.2–0.8)	$0.6^{b} \pm 0.2$ (0.3–1.2)	$0.4^{a} \pm 0.1$ (0.2–0.7)	24
Infructescence width	$32.3^{a} \pm 11.1$ (1.1–6.4 cm)	$45.4^{b} \pm 16.7$ (2.0–8.3 cm)	$26.9^{a} \pm 10.8$ (1.2–5.5 cm)	19

ald is here clarified (Fig. 9). This range is similar to many species of plants with coastal affinities from the southeastern United States as outlined by Sorrie and Weakley (2001). This species is more frequent than previously believed. Currently, NatureServe (2005) ranks this species as G3, meaning between 26 and 100 populations may exist. During fieldwork in 2004 the first author discovered seven new populations in an array of seepage wetlands including roadsides and wet swales in frequently mowed fields, suggesting the actual rank for this species is most probably G4/G5. Although the species is probably globally secure, *J. longii* is rare in portions of its range. Currently, Maryland lists this species as Endangered, while North Carolina and Virginia list this species as Watch List. These ranks appear appropriate. This species should be considered Watch List in Tennessee based upon its apparently restricted range in the state. The species appears common in Alabama and Georgia given the number of populations discovered during limited field surveys. Though the species has not been recently vouchered in South Carolina we expect it to be frequent, given the ranks in adjacent states. Few specimens are known to exist from Mississippi and Florida. At this time it is premature to consider this species rare in these states given the ample amount of habitat present.

We found no evidence to support the recognition of infraspecific taxa restricted to a given physiographic province. If infraspecific taxa were restricted to a physiographic province, plants from these provinces should cluster together in the PCA. This is not the case as specimens from the Blue Ridge Escarpment, Coastal Plain, Cumberland Plateau, and Piedmont are imbedded within one another. Intraspecific taxa independent of physiographic province may be present within *J. longii* but these possibilities were not considered in this project.

Study within the *J. marginatus* complex is far from complete. There are still questions regarding the species boundary between *J. marginatus* and *J. biflorus*. The PCA shows that these two taxa are very morphologically variable, but individuals do not overlap. Further analysis (preferably molecular) of the relationship between *J. marginatus* and *J. biflorus* is needed before the proper rank of these two taxa may be definitively determined. At this time we recognize both *J. marginatus* and *J. biflorus* because of the results of the morphologic analysis. This analysis included specimens from throughout the ranges of both species; however, more specimens from, and fieldwork in, Central and South American are needed to completely examine these morphologically similar species.

TAXONOMIC TREATMENT

JUNCUS LONGII Fernald. Rhodora 39: 397, Table 477, Fig. 1–4. 1937.—TYPE: USA. Virginia, [Sussex Co.], Coddyshore, 20 July 1936, *Fernald* and *Long 6144* (holotype: GH!; isotypes: NY!, PH!, US!).

Perennial, rhizomatous, glabrous, herb. Culms erect, solitary 38.5–96.8 cm long, from a narrow base 2.5–8.2 mm wide. Rhizome elongate, up to 2 dm long, and slender, 0.8–1.9 mm wide, with well spaced root cataphylls 5.3–13.0 mm, often with purple-red coloration. Foliar leaves basal and cauline; leaves unifacial, alternate, 12.5–21.5 cm long. Sheaths to 3.1–9.1 cm with the margins terminating in two 0.5–1.1 mm rounded auricles. Blade linear 2.8–9.1 cm, 3–5 veined, 1.5–4.4 mm wide, canaliculate, flat. Inflorescence congested, hemispheric, compound, composed of 9–37 glomerules, of 1–12 flowers per glomerule. Flowers bisexual, ebracteolate. Inflorescence bracts decreasing in size from base of inflorescence upwards. Tepals subequal, 2.2–2.6 mm long, 1.1–1.8 mm wide, entire, obtuse to lance-obtuse, persistent, occasionally with mucronate tips, green to castaneous, with hyaline margin 0.2–0.4 mm wide. Stamens 3; filaments filiform, 1.1–1.4 mm long, anthers 0.1–0.3 mm long, purple to light brown, quickly shriveling after anthesis, concealed by tepals. Cap-

FIG. 7. Infructescence habit of A. *Juncus longii Schuyler 7925* (PH), B. *J. marginatus Stone 13942* (PH), C. *J. biflorus Lakela 23553* (NCU), D. *J. biflorus Batson 487* (NCU), E. *J. biflorus Stone 12958* (PH). Scale = 1.0 cm.

sule about as long as tepals, broadly ellipsoid, round in cross section, dark brown and glossy, 2.2–2.7 mm high, 1.3–1.8 mm wide, unilocular. Seeds many, ellipsoid to oblong, with 8–12 longitudinal lines, yellow or yellow-orange or orange, 0.5–0.7 mm long, 0.1–0.2 mm wide, with white-hyaline narrow wing longitudinal on seed.

KEY TO SPECIES OF THE *JUNCUS MARGINATUS* COMPLEX

1 Infructescence usually congested, (1.8–)2.4–4.7(–6.4) cm long; greatest distance between adjacent rhizome cataphylls (5.3–)6.3–10.5(–13.0) mm; rhizome width (measured between adjacent cataphylls) (0.8–)1.0–1.4(–1.9) mm . . . . *Juncus longii*

1 Infructescence usually loose, (1.4–)17.9–103.9(–145) cm long; greatest distance between adjacent rhizome cataphylls (0.1–)0.4–3.0(–4.6) mm; rhizome width (measured between adjacent cataphylls) (0.4–)1.0–3.5(–4.5) mm 2

2. Widest leaf blade (2.6–)3.1–4.5(–5.4) mm wide; sheath of lowest leaf (3.2–)4.3–7.8(–9.7) cm long; tallest culm (27.2–)50.8–81.2(–100.7) cm; anthers (0.5–)0.6–1.0(–1.3) mm long, exserted; stem base (3.4–)5.8–9.6(–12.0) mm wide . . . . *Juncus biflorus*

2. Widest leaf blade (1.3–)1.6–2.6(–3.5) mm wide; sheath of lowest leaf (1.7–)2.2–3.8(–4.7) cm long; tallest culm (19.2–)26.0–44.0(–56.8) cm; anthers (0.2–)0.3–0.5(–0.7) mm long, concealed by tepals; stem base (0.4–)2.0–4.4(–6.0) mm wide . . . . *Juncus marginatus*

REPRESENTATIVE SPECIMENS EXAMINED

1. Juncus longii Fernald—(* = specimen measured for statistical analysis; [s] = specimen examined under SEM). USA. **Alabama**: Autauga Co., meadow below Walker's Lake, ca. 9 mi due N of mouth of Mulberry Creek on Alabama River, 31 May 1980, *J.H. Wiersema 1895* (NY*). Chambers Co., 5.1 miles N on AL 147, from jct. with US 280, 11 Jul 2000, *Hansen 2000–37 and Nims* (TENN); Cullman Co., wet places, 18 Jun 1897, *Eggert s.n.* (MO); Coffee Co., heavily disturbed seepage N of Glainsburg, 14 Jul 2004, *Knapp 873* (DOV*). Lee Co., Auburn, 3 Jul 1897, *F.S. Earle and C.F.*

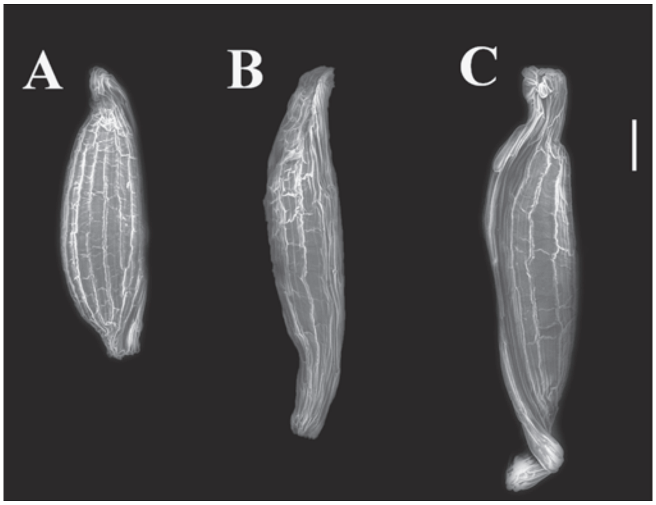

FIG. 8. SEM images of seeds from A. *Juncus marginatus* B. *Juncus biflorus* and C. *Juncus longii*. Scale = 0.1 mm.

Baker s.n. (NY). Montgomery Co., roadside seepage in front of house number 2937 off Rt. 724, 14 Jul 2004, *Knapp 834* (DOV*). Pike Co., small seepage in dry sandy soil N of Rd. 46, 14 Jul 2004, *Knapp 857* (DOV*). **Florida**: Escambia Co., edges of woods along Rt. 29, ca. 3 mi N of Cantonment, 2 May 1982, *D.S. 53849 and H.B. Correll* (NY). **Georgia**: Clarke Co., by margin of Dixie Lake 2 mi E of Athens, 21 Jun 1934, *L.M. Perry 805* (NY). DeKalb Co., Stone Mountain, 23 Jul 1897, *H. Eggert s.n.* (NY), Gwinnett Co., Thompsons Mills and vicinity, 10 May 1908, *Allard 80* (US). Talbot Co., N side of Sidling Road in freshwater seepage, 15 Jul 2004, *Knapp 897* (DOV*). Taylor Co., sandy disturbed soil along roadside of Thomas Road, 15 Jul 2004, *Knapp 733* (DOV*^{S}). **Maryland**: Montgomery Co., near Sligo N of Takoma Park, 10 Jul 1895, *Pollard 488* (US*); Prince George's Co., E boundary of U.S. Naval Ordinance Lab, 0.15 mi W of Powder Mill Run, 1 Nov 1998, *Strong et al. 1804*, (NY*); E side of I-95, ca 0.7 miles SW of jct. 95 and SR 212, 1.6 miles due W of Beltsville, 12 Jul 1999, *Strong 1972 and Simmons* (NY*); Suitland, open sphagnum bog, 20 Jul 1958, *Sargent 7673* (FSU, US*); remnant Magnolia Bog, Suitland Bog, 24 Sep 1997, *Meininger 970924* (Maryland Natural Heritage Program Herbarium); Suitland Bog, 22 Aug 1920, *E.C. Leonard 1732* (NY). Worcester Co., low drainage channel across logging road W of power-line cut, W of Rt. 12, 24 Jul 2001, *McAvoy 5193* (DOV*). **Mississippi**: Harrison Co., just S of Pass Road along Debuys Road, Biloxi, 6 Jun 1971, *Lasseigne 2636* (NCU*); mixed woods along footpath, DeSoto National Forest Trail, 10 Jul 1971, *Lasseigne 2750* (MO*); Pearl River Co., grassy, open, acid savannah 1 mi. N of Picayune, coastal flatwoods, 3 May 1967, *Reynolds 11946 and Jones* (MISS). Wayne Co., 5.3 mi W of Whistler on I-84, 9 Aug 1985, *R. Brooks 17655 and C. Kuhn* (NY^{S}). **North Carolina**: Buncombe Co., moist sandy places, Biltmore, 1 Aug 1897, *no collector 552a* (MO, PENN* and US). Cumberland Co., Fort Bragg Military Base, NE training area, W of Kates Rd., at junction of firebreak 7 and 8, E. of Rt. 210, 3 Oct 2003, *Knapp 143–03* and *B. Sorrie* (DOV*^{S}). Graham Co., peat-sedge bog, 1 mile s.w. of Robbinsville, 19 Jul 1956, *Radford 14161* (FSU). Hoke Co., pocosin border, 4.2 miles SSW of Ashley Heights, 26 Jun 1957, *Ahles 29469 and Haesloop* (NCU*). Jackson Co., sphagnous boggy meadow, vicinity of Mulkey Gap, 23 Jun 1960, *Godfrey 59996and Triplet Jr.* (FSU, NCU, US). Lee Co., along railroad 0.3 miles E of SR 1179 on SR 1162/1116, S. of Lemon Spring, 10 Aug 1993, *Sorrie 7532 and Van Eerden* (NCU). **South Carolina**: Greenville Co., bog 1/eighth mile E of Mt. Lebanon Church, 3 Aug 1952, *Rodgers 2015* (NCU*). **Tennessee:** Fentress Co., large seepage 3.4 miles NNW of Fentress, 18 Jul 2004, *Knapp 664* and *D. Estes* (DOV*^{S}); in bog 2–3 miles E of Clark Range on State Hwy 62, 19 Aug 1966, *Sohmer 6, 9* (TENN); bog, Clark Range, 7 Jul 1935, *Underhill 2871 and Sharp* (TENN); bog, Clark Range, 7 Jul 1935, *Underwood 3930* (TENN); wet area around and below pond 2 miles E of Clark Range, 7 Oct 1958, *Underwood et al. 26063* (TENN); 2.8 miles SE the intersection of Rt. 28, roadside seepage, 12 Jul 2004, *Knapp 664 and Estes* (DOV*^{S}). Grundy Co., swampy area near Gruetli-Laager, Hwy 108, 6 Jul 1969, *Rogers 43786* (TENN). Marion Co., roadside bog near Foster Falls, 17 Jun 1948, *Fairchild et al. 48–176* (NY). VanBuren Co., seepage wetland ¾ mi E of Old Rt. 111, 18 Jul 2004, *Knapp 671 and Estes* (DOV*^{S}). White Co., pasture swale with creek present S. of Road, 28 Jul 2004, *Bailey s.n.* (TENN). **Virginia**: Accomac Co., SW of Simoneaston Bay

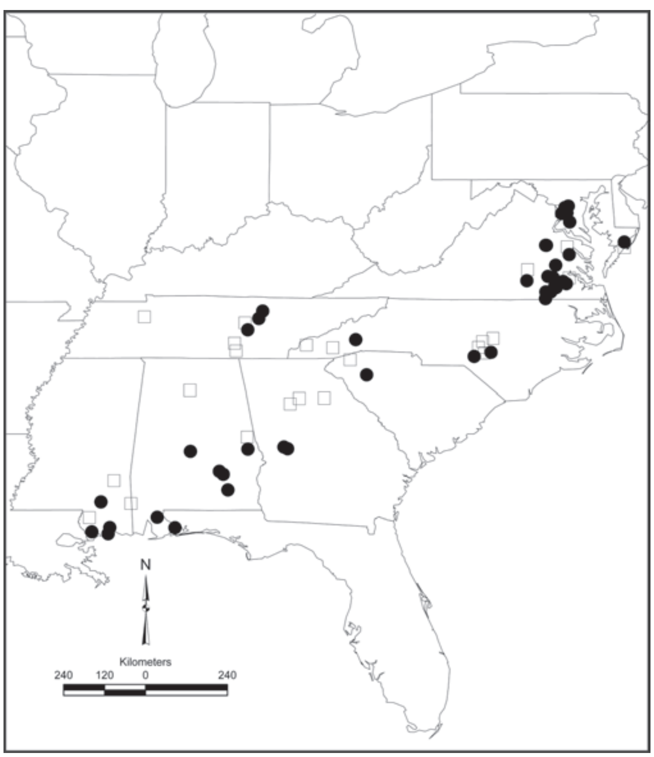

FIG. 9. Known geographic range of *Juncus longii*. Circles represent the locations of specimens measured for analysis, squares represent specimens not measured.

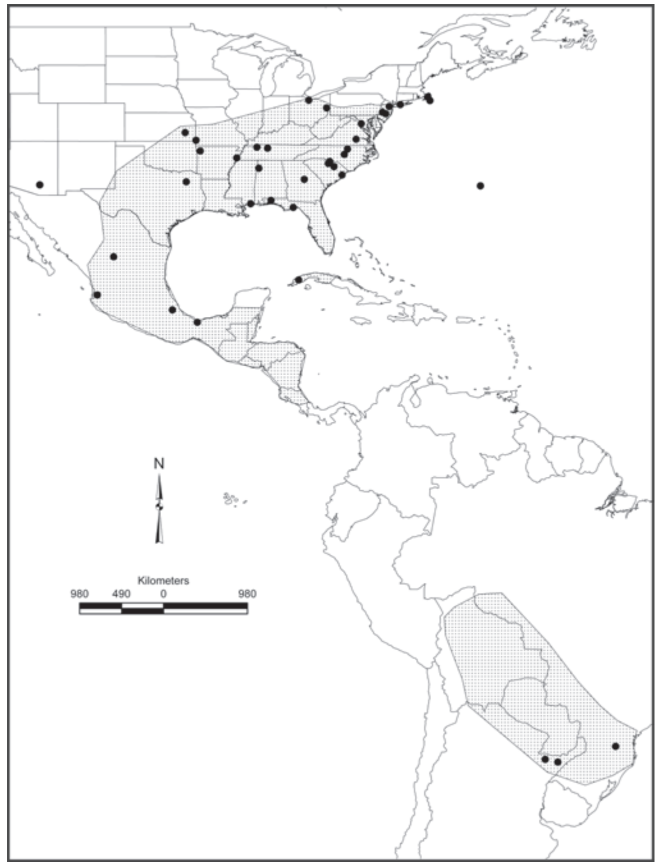

FIG. 10. Geographic Range of *Juncus biflorus*. Circles represent specimens measured for analysis.

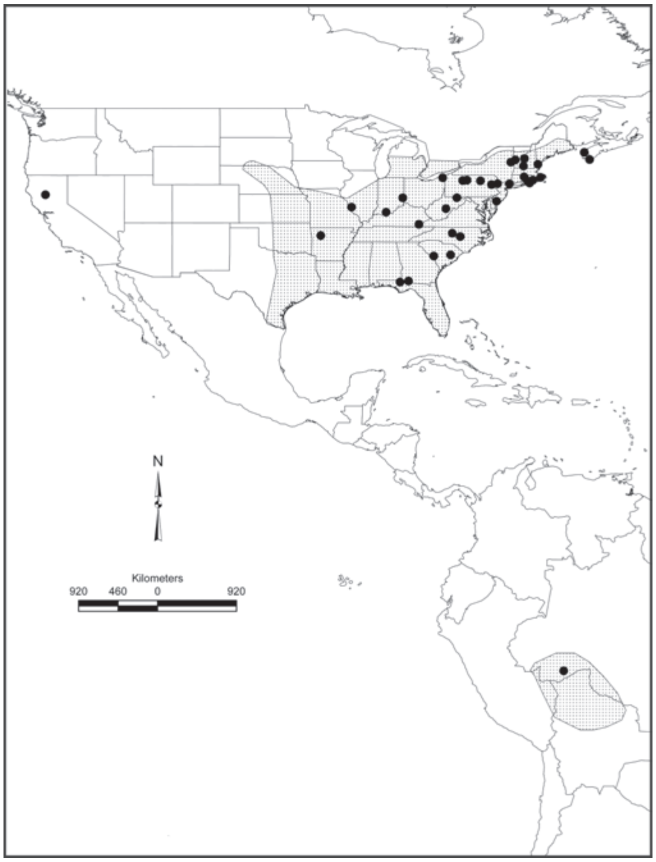

FIG. 11. Geographic range of *Juncus marginatus.* Circles represent specimens measured for analysis.

and N of Watts Bay, *McAvoy 1772* (DOV); Arlington Co., weedy partially drained bog Virginia Highlands, 24 Aug 1939, *Fosberg 16638* (PENN). Caroline Co., ca. 0.8 km NW of Golansville, along base of earth dam forming Lake Caroline, 17 Aug 1994, *Schuyler 7925* (PH*); swale ("Ham's Meadow") by railroad, NW of Guinea, 22 Aug 1938, *Fernald 9024 and Long* (GH*); bushy swale N of Golansville, 22 Aug 1938, *Fernald 9023 and Long* (PH*); E side of Rt. 1 under roadside powerline, between Golansville and Rt. 657, 2 Oct 2003, *Knapp 124–03* (DOV*). Dinwiddie Co., sphagnous boggy margin of spring-fed pond, Century House, NE of Burgess, 13 and 14 Sep 1937, *Fernald 7378 and Long* (GH*); damp bushy pasture SW of Petersburg, 22 Jul 1936, *Fernald 6146 and Long* (GH*); boggy woods near head of Old Town Creek SW of Petersburg, 22 Jul 1936, *Fernald 6145 and Long* (GH*, MO). Fairfax Co., bog, 13 Jun 1922, *Newbold 1163* (MO); edge of Turkeycock Run, 5.8 miles bearing 285 degrees from Alexandria, 8 Sep 1945, *Walker 9968* (US*). Greensville Co., ca. 3 km WNW of Jarratt, Foxtail Bogs, 16 Aug 1994, *Larkin 7915, 7918 and Schuyler*(PH*^{S}); sphagnous bog ca. 1 mile NW of Dahlia, 17 Jul 1938, *Fernald 8662 and Long* (MO and PH*); ca. 3.5 km WNW of Jarratt, Foxtail Bogs, 16 Aug 1994, *Larkin 7913 and Schuyler* (PH). Henrico Co., sphagnous springy swales bordering White-Oak Swamp, W of Elko Station, 23 Jul 1938, *Fernald Long 8663 and* (GH*). King and Queen Co., border of magnolia swamp ca. 2 miles E of St. Stephen's Church, 31 Jul 1941, *Fernald 13299 and Long* (GH*). Nottoway Co., ca. 3.7 km SE of Blackstone, Fort Pickett, 16 Aug 1994, *Larkin 7922 and Schuyler* (PH*). Prince George Co., exsiccated argillaceous swale ca. 3 miles SE of New Bohemia, 28 Jul 1936, *Fernald 6148 and Long* (GH*); argillaceous and siliceous boggy depression about 3 miles SE of Petersburg, 25 Jun 1936, *Fernald et al. 5711* (GH); argillaceous and siliceous boggy depression N of Gary Church, 25 Jun 1936, *Fernald et al. 5712* (GH*). Surry Co., sphagnous swale SE of Spring Grove, 15 Jun 1958, *Fernald 8196 and Long* (PENN). Sussex Co., argillaceous swale SW of Grizzard, 14 Jun 1939, *Fernald 10196 and Long* (PH*); depressions in argillaceous field N of Littleton, 22 Jul 1936, *Fernald 6147 and Long* (NY*); sphagnous argillaceous boggy depression just NW of Wakefield, 13 Jul 1938, *Fernald 8661 and Long* (GH*); peaty and argillaceous swale N of Littleton, 10 Jun 1938, *Fernald 8195 and Long* (GH*); clay depression in wet woods, Coppahaunk Swamp S of Waverly, 19 Jun 1939, *Fernald 10197 and Long* (GH); spring-fed wooded argillaceous sphagnous bog, headwaters of Jones Hole Swamp, N of Coddyshore, 20 Jul 1936, *Fernald 6144 and Long* (MO). **Washington D.C.** In vicinis, 5 August 1877, *Ward s.n.*; Aug 11, 1896, *Steele s.n.* (GH, MO).

2. *Juncus biflorus* Elliott—(* = specimen measured for statistical analysis; ^{s} = specimen examined under SEM). USA**.** **Alabama**: Marion Co., sandy clay of marshy area at E side Hamilton on US 278, 5 Jun 1968, *Kral 31159* (PH*). **Arkansas**: Crittenden Co., wet bottomland, 7 Jun 1937, *Demaree 15183* (GH*). **Arizona:** [county not indicated], Santa Catalina Mountains, 4 Jun 1882, *Pringle s.n.* (PH*). **Florida**: Okaloosa Co., in wet peat or in shallow standing water at margin of cypress pond, 4 miles NNW of Baker, 20 Jul 1956, *Kral 2907* (NCU*^{S}). Wakulla Co., moist, broad, shallow, sandy-peaty ditch near Panacea, 14 May 1955, *Godfrey 53295* (NCU*). **Georgia**: Baldwin Co., Central State Hospital pond 1.0 mile from Wilkinson Co line on Georgia highway 441, 7 Jul 1971, *Cowart 46* (NCU*). **Kansas**: Woodson Co., in moist soil of prairie pasture gully, 6 Jul 1965, *Lathrop 1133* (GH*). **Maryland:** Somerset Co., large clear-cut S of Charles Cannon Rd, N of Rt 413, 12 Aug 2004, *Knapp 974* (DOV^{S}). **Massachusetts**: Barnstable Co., dry upper sandy and peaty beach of Saul's Pond, Brewster, 7 Sep 1919, *Fernald 350* (PH*); dry sandy upper beach of No Bottom Pond, Brewster, 7 Sep 1928 *Fernald 16571 and Long* (PH). Nantucket Co., Nantucket, 18 Sep 1899, *Bicknell s.n.* (GH*). **Mississippi**: Jackson Co., gravel pits in pine barrens 3 miles E of Ocean Springs, 29 Jul 1954, *Demaree 35869* (GH*). **Missouri:** Jasper Co., flat prairies near Joplin, 27 Aug 1920, *Palmer 3224* (GH*). **New Jersey**: Burlington Co., ca. 2 km SSE of Atsion, 10 Jul 1994, *Schuyler 7889 and Schuyler* (PH*). Union Co., Watching Spring Bog, Plainfield, 22 Jul 1920, *Miller 1717* (NY*). **New York**: Suffolk Co., Flanders, 4 Aug 1929, *Ferguson 7911* (NY*). **North Carolina**: Catham Co., 1.5 miles SE of Haywood between Deep and Haw Rivers, 16 May 1955, *L.S. Beard 487* (NCU*). Granville Co., alongside Seaboard Airline RR, 1 mi E of US 15, 9 Jul 1963, *Dayton 597* (NCU*). Union Co., eroded field, 6.5 miles S of Monroe on NC 207, 14 Jun 1957, *Ahles 31445 and Haesloop* (NCU*). **Ohio**: Erie Co., Berlin, 1 Sep 1896, *Moreley s.n.* (GH*). Jefferson Co., bank of St. Rt. 164, 0.5 mi N, Bergholz, 8 Aug 1965, *Cusick 1149* (NCU*). Richmond Co., savannah in Sand Hills Game Land, 6 Jul 2005, *Knapp 1482 and Sorrie* (DOV^{S}). **Pennsylvania**: Philadelphia Co., meadow-swale near mouth of Pennypack Creek, 12 Jul 1942, *Long 58434* (GH*). **South Carolina**: Lancaster Co., ca. 8 mi. NE of Kershaw, NE of Flat Creek, 15 Jul 1961, *Williamson 1315* (NCU*). Georgetown Co., peaty excavated area in savannah at side of road 12 miles N of Georgetown, 23 Jun 1939, *Godfrey 2 and Tryon* (PENN*). **Tennessee**: Cheatham Co., E facing shaley bank off I-40, 5 mi. E jct. Tenn 96 on seepage, 6 Aug 1968, *Kral 32217* (NCU*). Coffee Co., N and S of Hwy 41, abundant, 2 mi NW of Hillsboro, 18 Jul 2004, *Knapp 676 and Estes* (DOV*^{S}). Henry Co., E of Paris, bottoms along Tennessee River, 21 Jun 1948, *Sharp et al. 7647* (NY*). **Texas**: Wood Co., W of Mineola, 12 Jun 1940, *Lundell 9432 and Lundell* (GH*). **Virginia**: Amelia Co., argillaceous swale in old plowed field, about 1 mile SE of Ammon, 18 Aug 1938, *Fernald 9020 and Long* (PH*^{S}). Fairfax Co., wet ground near roadside near Merrifield, 5 Aug 1937, *Allard 3460* (NCU*).

ARGENTINA. Corrientes, Estancia Santa Teresa, 10 February1980, *Jansen 736 and Sarandon* (NY*); Gob, Nisasoro, 3 Nov 1944, *Hanola 1192* (NY*).

BERMUDA. Pembroke Marsh, 22 May – 2 Jun 1909, *Brown 724* (NY*).

BRAZIL. Parana, Restinga, Rio Pereleue, 121 km from Curitiba, 4 Mar 1970, *Koyama et al. 13829* (NY*).

MEXICO. Veracruz, swamps near Jalapa, 17 Apr 1899, *Pringle 8123* (PH*^{S}); Coatzacoalcos, isthmus of Tehauntepec, 8 Mar 1895, *Smith 1121* (GH*). Huichol, Sierra du Nayarit, [No collector or date given] (NY*); Jalisco, Rio Blanco, Jun-Oct 1886, *Palmer 13* (PH*).

3. *Juncus marginatus* Rostk—(* = specimen measured for statistical analysis; ^{s} = specimen examined under SEM). USA. **Alabama:** Sumter Co., E of Rt 17 S of York, 21 Jul 2004, *Knapp 714* (DOV^{S}). **Arkansas**: [County not indicated], low ground NW AR, May 1882, *Harvey 22* (GH*). **California:** Tehama Co., seepage on gentle slope on volcanic substrate, 20 Jul 2003, *Ertter 18256* (JEPS*^{S}). **Connecticut**: Mansfield Co., shore of Duck Pond, Storrs, 6 Jul 1939, *Torrey 3322* (PENN*). **Delaware:** Kent Co., 0.5 mi NNW of Dinahs Corner, 20 Jul 2002, *Naczi 9380* (DOV*^{S}). **Florida**: Jackson Co., in marshes of Blue Powder River, Mariana Red Hills, 5 Aug 1927, *Kelley 580* (PENN*). **Georgia**. Grady Co., in moist flats near small slow stream, about 7 mi. N. of Whigham, 7 Jul 1948, *Cronquist 5453* (PH*). Taylor Co., 0.1 mi NW of trib of Little Rocky Creek, 23 Jul 2004, *Knapp 736* (DOV^{S}). **Indiana**: Perry Co., barren wooded slope in sec. 32 of Union Tp., 24 Jul 1919, *Deam 28561* (PH*). **Kentucky**: Harlan Co., near Harlan Court House, 1893, *Kearney, Jr. 22* (GH*). **Maine**: York Co., springy spot in open soil, Gerrish Island, Kittery, 11 Aug 1916, *Fernald 13230 and Long* (PH*). **Maryland**: Garrett Co., the Glades, 4 mi. SW of Bittinger, 12 Aug 1911, *Stone 13942* (PENN*). **Massachusetts**: Barnstable Co., boggy swale bordering maple swamp, Spring Hill, Sandwich, 30 Jul 1919, *Fernald 18229* *and Long* (PH*). **New Hampshire**: Cheshire Co., Keene, 19 Aug 1920, *Knowlton s.n.* (PH*). Gafton Co., in wet open swale, Route 60, S. of Lyme, 27 Jul 1932, *R.H. True 40* (PENN*). **New Jersey**: Camden Co., Clementon, 12 Aug 1911, *Bartman 1668* (PH). Cumberland Co., Bear Swamp, 23 Aug 1910, *Long 4940* (PH). **New York**: Warren Co., old meadows near Lake George, Brayton, 22 Jul 1942, *House 28806* (PENN*). Westchester Co., Collaberg Pond town of Cortland, 28 Jul 1916, *Pennell 7699* (PH*). **North Carolina**: Guilford Co., low pasture and wooded lake margins N of NC 62, 8 Aug 1958, *Bell and Batson s.n.* (NCU*). Harnett Co., abundant in a boggy meadow, ½ mile E of Duncan, 8 Jul 1949, *Godfrey 49416 and Fox* (PENN*). **Pennsylvania**: Bradford Co., 4 mi SSE of Franklin, 28 Jul 2007, *R.F.C. Naczi 11990 and A.T. Gibson* (DOV*). Elk Co., roadside, borough of Ridgway, Montmorency, 22 Aug 1943, *Reed 202* (PENN*). Lycoming Co., shore of Loyalsock Creek at Barbours, 20 Jul 1952, *Wahl 13626* (PENN*). Pike Co., Bushkill, Old State Road, 23 Jul 1917, *Bartram s.n.* (PENN*). **Rhode Island**: Newport Co., dune-hollows back of Crescent Beach, Block Island, 20 Aug 1943, *Fernald 9228 and Long* (PH*). Washington Co., sandy border of marsh, Westerly R.I., 21 Aug 1913, *Bissell s.n.* (GH). **South Carolina**: Aiken Co., wet places Aiken, 15 June 1866, *Ravenel 36* (PENN*). Williamsburg Co., 5 miles S of Kingstree, 23 Aug 1939, *Godfrey 393 and Tryon, Jr.* (PENN*). **Vermont**: Rutland Co., swamp Castleton, 24 Aug 1937, *Knowlton s.n.* (GH*). **West Virginia**: Webster Co., Camp Caesar, 26 June 1929, W.V.U Botanical Expedition *s.n.* (PENN*).

CANADA. **Nova Scotia**: Digby Co., roadside ditch Weymouth, 4 Aug 1928, *Fernald* 23638 *and Long* (PH*S). Shelburne Co., damp sandy roadside near Welentown (Birchtown) Lake, 8 Aug 1921, *Fernald 23639 and Long* (PENN). Yarmouth Co., wet clayey brook side, Argyle Head, 4 Aug 1920, *Long 20725 and Linder* (PH*).

BRAZIL. Famenda B. Velho, 1 June 1947, *Rambo 34623* (NY*).

ACKNOWLEDGMENTS. A litany of botanists from the eastern United States aided us in the location of plants in the field, including Robert Bertin, Dwayne Estes, Chris Frye, Arthur Haines, Frank Hirst, Linda Kelly, Robert Kral, Richard LeBlond, Bill McAvoy, Kathy McCartney, Autumn Sabo, Paul Somers, Bruce Sorrie, Mark Strong, John Townsend, and Ron Wilson. The Maryland Department of Natural Resources, Wildlife and Heritage Service, namely Scott A. Smith, Tim Larney, and Glenn Therres, did a great service supporting work toward the completion of this project. A number of herbaria were gracious enough to loan material for study at DOV. These herbaria are FLAS, FSU, GA, GH, JEPS, MISS, MO, NCU, NY, PH, TENN, PENN, and US. This publication is based upon a M.S. thesis from Delaware State University. The thorough reviews by Mark P. Simmons, Lenka Drabkova, Alan Whittemore, and an anonymous reviewer are greatly appreciated. The first author thanks the members of his thesis committee, Robert Naczi, Hazel Reed, Ernie Schuyler, Art Tucker, and Susan Yost. Funding for portions of this project was supplied by the Claude E. Phillips Herbarium of Delaware State University.

LITERATURE CITED

Balslev, H. 1996. Juncaceae. *Flora Neotropica Monograph* 68: 1–168.

Brooks, R. E. and S. E. Clemants. 2000. Juncaceae. Pp 225–255 in *Flora of North America* vol. 22, ed. Flora of North America Editorial Committee. New York: Oxford University Press.

Brown, M. L. and R. G. Brown. 1984. *Herbaceous plants of Maryland*. Baltimore, Maryland: Port City Press.

Chamberland, M. 1997. Systematics of the *Echinocactus polycephalus* Complex (Cactaceae). *Systematic Botany* 22: 303–313.

Coville, F. V. 1893. *Juncus marginatus* and its varieties. *Proceedings. Biological Society of Washington* 8: 121–128.

Engelmann, G. 1866, 1868. A revision of the North American species of the genus Juncus, with a description of new and imperfectly known species. *Transactions of the Academy of Sciences of St. Louis* 2: 424–499 (424–458 publ. 1866; 459–499 publ. 1868).

ESRI. 2000. ArcView 3.2a Software. Redlands, California: Environmental Systems Research Institute.

Fernald, M. L. 1937. Plants of the inner coastal plain of Virginia. *Rhodora* 39: 397–399.

Fernald, M. L. 1950. *Gray's manual of botany*, 8th ed. New York: American Book Co.

Gleason, H. A. and A. Cronquist. 1991. *Manual of vascular plants of northeastern United States and adjacent Canada*, 2nd ed. New York, New York: New York Botanical Garden Press.

Godfrey, R. K. and J. W. Wooten. 1979. *Aquatic and wetland plants of southeastern United States*. Atlanta: University of Georgia Press.

Henderson, J. A. 2002. Phenetic and phylogenetic analysis of *Reinhardtia* (Palmae). *American Journal of Botany* 89: 1491–1502.

Hough, M. Y. 1983. New Jersey wild plants. Harmony, New Jersey: Harmony Press.

Index Herbariorum. 2007. http://sciweb.nybg.org/science2/IndexHerbariorum.asp. Accessed 1 August 2007

Janovec, J. P. and J. S. Harrison. 2002. A morphological analysis of the *Compsoneura sprucei* Complex (Myristicaceae), with a new combination for the Central American species *Compsoneura mexicana. Systematic Botany* 27: 662–673.

Kirschner, J. 2002. Juncaceae 2: *Juncus* subg. *Juncus* Pp.27–57 in *Species plantarum: flora of the world* vol. 7, ed. A. E. Orchard, J. Bleyerveen, A. J. G. Wilson, and B. Kuchlmayr. Canberra: Australian Biological Resources Study.

Naczi, R. F., A. A. Reznicek, and B. A. Ford. 1998. Morphological, geographical and ecological differentiation in the *Carex willdenowii* complex (Cyperaceae). *American Journal of Botany* 85: 434–447.

NatureServe. 2005. NaturesServe Explorer: an online encyclopedia of life. http://www.natureserve.org/explorer/servlet/NatureServe?init=Species. Accessed 22 March. 2005.

Radford, A. E., H. E. Ahles, and C. R. Bell. 1968. *Manual of the vascular flora of the Carolinas*. Chapel Hill: The University of North Carolina Press.

Rhoads, A. F. and T. A. Block. 2000. *The plants of Pennsylvania*. Philadelphia: University of Pennsylvania Press.

Rostkov, G. T. 1801. *Dissertatio botanica inaguralis de Iunco*. Halle: F. A. Grunnerti.

Saarela, J. M. and B. A. Ford. 2001. Taxonomy of the *Carex backii* complex (Section Phyllostachyae, Cyperaceae). *Systematic Botany* 26: 704–721.

Saarela, J. M., P. Peterson, R. J. Soreng, and R. E. Chapman. 2003. A taxonomic revision of the eastern North American and eastern Asian disjunct genus *Brachyelytrum* (Poaceae): evidence from morphology, phytogeography and AFLPs. *Systematic Botany* 28: 674–692.

Small, J. K. 1903. *Flora of the southeastern United States*. New York: Published by the Author.

Sorrie, B. A. and A. S. Weakley. 2001. Coastal Plain vascular plant endemics: phytogeographic patterns. *Castanea* 66: 50–82.

Sorrie, B. A., B. Van Eerden, and W. Knapp. 2007. *Juncus.* Pp. 799–805 in *A. Weakley, ed. Flora of the Carolinas, Virginia, Georgia and surrounding areas* (Working Draft 11 Jan. 2007). Unpublished. University of North Carolina Herbarium (NCU), North Carolina Botanical Gardens.

SPSS. 2004. SYSTAT 11. Chicago: SPSS.

TopoZone 2006. www.topozone.com. Accessed 1 August 2007