INTRODUCED SPECIES IN KANSAS: FLORISTIC CHANGES AND PATTERNS OF COLLECTION BASED ON AN HISTORICAL HERBARIUM

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ABSTRACT

Herbaria with significant historical collections are critical to tracking floristic changes such as the introduction and spread of non-native plant species. To explore the importance of herbarium specimen data for understanding floristic changes in the central Great Plains, we utilized the Kansas State University Herbarium (KSC), known for its rich historical collections dating from the late 1800s. A list of all angiosperm plant taxa introduced to Kansas was obtained, and collection data (collector, number, year and county) were recorded for all in-state specimens (excluding cultivated material). A total of 6,565 specimens were recorded, comprising 314 species, 201 genera and 50 families, and dating from 1869. Of the recognized introduced species, 153 are represented by KSC collections made in Kansas prior to 1900, and 243 prior to 1940. All Kansas counties are well-represented by the early KSC material (1890s), bolstering our ability to infer floristic changes since that time. While 988 different collectors are represented, 14 collectors account for 52% of the specimens of introduced species. Peak collecting at KSC occurred in the 1890s and 1930s, and assessment of biases suggest that our data are a reasonably accurate representation of the presence and distribution of introduced species in Kansas at those times. Species not represented by pre-1900 KSC material were likely not established or even introduced in the state at the time; if a species was not documented prior to 1940 it was likely still not well established by then. This study demonstrates the utility of data housed at KSC, and by extension in other historical collections, for the study of regional floristic changes.

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RESUMEN

Los herbarios con colecciones históricas significativas son críticos para rastrear los cambios florísticos tales como la introducción y la extensión de las especies de plantas que no son nativas. Para explorar la importancia de datos de especímenes de herbario para entender los cambios florísticos en las llanuras centrales de Norteamérica, nosotros utilizamos el Herbario de Kansas State University (KSC), conocido por sus colecciones históricas ricas en datos desde el final de los 1800. Se obtuvo una lista de todas las angiospermas introducidas en Kansas, y los datos de la colección (el coleccionista, número, año y condado) fueron registrados para todos los especímenes del estado (excluyendo el material cultivado). Se registró un total de 6565 especímenes, que se incluyen en 314 especies, 201 géneros y 50 familias, que datan desde 1869. De las especies introducidas que se reconocieron, 153 son representadas por colecciones de KSC hechas en Kansas antes de 1900, y 243 antes de 1940. Todos los condados de Kansas están bien representados por el material inicial de KSC (1890s), reforzando nuestra habilidad de inferir los cambios florísticos desde ese tiempo. De los 988 colectores diferentes existentes, 14 de ellos son responsables del 52% de los especímenes de especies introducidas. Los puntos máximos de recolección en KSC ocurrieron en los 1890 y los 1930, y la evaluación de los sesgos sugiere que nuestros datos son una representación razonablemente precisa de la presencia y la distribución de las especies introducidas en Kansas en esos tiempos. Las especies no representadas en el material de KSC antes de 1900 probablemente no estaban establecidas ni habían sido introducidas aún en el estado en ese tiempo; si una especie no se documentó antes de 1940, es probable que todavía no estuviese bien establecida. Este estudio demuestra la utilidad de los datos de KSC, y por extensión de otras colecciones históricas, para el estudio de cambios florísticos regionales.

INTRODUCTION

Many non-native plants in North America were introduced decades and even centuries ago through agriculture, horticulture, shipping, and tainted seed imports, among other avenues (Mack & Lonsdale 2001; Reichard & White 2001; Costello & McAusland 2003; Cox 2004). After initial colonization, some introduced species became established and even spread in their new environments, at times altering the landscape profoundly (D'Antonio & Vitousek 1992; Gordon 1998; Callaway & Aschehoug 2000; Lavoie et al. 2003). The necessity of understanding the biological processes of establishment, spread, and invasion of introduced species has come into acute focus in recent decades as introduced species have caused immense economic and environmental damage (Pimentel et al. 2000; Naylor 2000; Zavaleta 2000). New associations with seed dispersers, pollinators, microorganisms, herbivores, pathogens, and other plants sometimes inhibit the spread of alien plant species, and sometimes foster their proliferation (Richardson et al. 2000a; Klironomos 2002; Siemann & Rogers 2003; Parker & Haubensak 2002; Callaway et al. 2004; Cox 2004; Kellogg & Bridgham 2004). As the number of introduced species has grown, so has the complexity of their ecological interactions in their adventive environments (Daehler 1994; Daehler & Strong 1997; Gordon 1998; Simberloff & Von Holle 1999; Callaway & Aschehoug 2000; Vilá et al. 2000; Daehler 2003; Brooks et al. 2004).

Given that many introductions into North America occurred well over a century ago, studies of the distributional history of non-native species can provide us with the knowledge of temporal and spatial data (e.g. earliest locations,

patterns of colonization, rates of spread, etc.) to understand past introductions more completely (Mack 2000; Meekins et al. 2001; Novak & Mack 2001). A better understanding of the establishment, distributional changes, and community associations of introduced taxa over time is vital to making informed decisions in managing existing introductions and in predicting future invasions (Ricciardi et al. 2000; Kolar & Lodge 2001; Lambrinos 2001; Lavoie et al. 2003; Dybos 2004; Simpson 2004).

The most reliable resources for historical research of biological distributions are natural history collections (Soberón et al. 2000; Ter Steege et al. 2000; Prather et al. 2004a, 2004b). As repositories of well-preserved plant specimens complete with spatial and temporal data, herbaria provide indisputable documentation of plant species occurrence, and form the very basis of floristic and plant taxonomic science as well as biodiversity studies (Prather et al. 2004b; Suarez & Tsutsui 2004). Herbarium specimens have been used effectively to document plant distributional changes such as species declines (Laughlin 2003; Lavoie et al. 2003) and spread of introduced plant species (Sheeley & Raynal 1996; Pyšek et al. 1998; Weber 1998; Lambrinos 2001; Novak & Mack 2001; Mihulka & Pyšek 2001; Pyšek et al. 2001; Delisle et al. 2003; Lavoie et al. 2003). Given that natural history collections contain inherent temporal and spatial inconsistencies, floristic analyses based on herbarium data must take into account collection biases (Soberón et al. 1996; Mack 2000; Mihulka & Pyšek 2001; Delisle et al. 2003). For instance, the date of first record of a species in an herbarium may accurately represent its approximate time of arrival in the region; alternatively, the date of first record may occur long after a particular species first appeared in the flora due to sparse collecting prior to documentation.

The Kansas State University Herbarium (KSC), founded in 1877, holds an extensive collection of significant historical specimens from the Great Plains of central North America. Indeed, an estimated 40% of its ca. 180,000 specimens of vascular plants were collected prior to 1900 (Barnard 2003), largely in association with the efforts of the distinguished botanist, A. S. Hitchcock, an early KSC curator who directed the herbarium from 1890 to 1901. Hitchcock promoted extensive collecting among his students and colleagues, and as a result, he and his protégés deposited a rich record of Kansas plant specimens at KSC prior to 1900 (Barkley 1965). Since then, KSC has been maintained and enhanced by numerous dedicated and productive curators (e.g., F.C. Gates, who directed KSC from 1919–1955; L.C. Hulbert, 1955–1961; and T.M. Barkley, 1961–1998). The result is an outstanding resource for researching historical floristic changes.

To explore the importance of herbarium specimen data for understanding floristic changes in the central Great Plains as represented by Kansas, we inventoried all specimens of non-native flowering plants collected in the state that are housed at KSC, identifying first records and subsequent temporal data for each species. Earliest date of collection for each species was also cross-referenced with

data at the R.L. McGregor Herbarium of the University of Kansas (KANU). To enable more robust floristic inferences, we determined collecting biases based on the KSC material, ascertaining collecting activity levels across time periods, spatial collecting patterns and effects of major collectors. These patterns demonstrate the utility of the historical component of the collections within the KSC herbarium and, moreover, the general importance of natural history collections as tools for understanding the dynamics of biological history.

METHODS

An initial list of introduced flowering plant species occurring in Kansas was obtained from the PLANTS Database (USDA National Resources Conservation Service; plants.usda.gov). *Introduced* or *non-native* species (also synonymous with *alien*, *exotic* and *nonindigenous* species) are here defined as those originating on other continents that are present in North America due to human activity. While there are certainly cases of native North American taxa that have been introduced into Kansas from other regions, our definition enabled us to analyze data for the vast majority of species not native to Kansas and it minimized ambiguity regarding geographic origins. We aimed to include in this analysis species recognized as *naturalized plants* (sensu Nesom 2000; Richardson et al. 2000b), and we also included species documented as *waifs* and *persisting* (Nesom 2000; the *casual alien plants* of Richardson et al. 2000b; when in doubt about persistence, we included material).

KSC was then inventoried for these species, and the following data were obtained for each specimen: species, year of collection, county, collector(s), and collection number. KSC material is generally filed following *Flora of the Great Plains* (FGP: Great Plains Flora Association 1986). Thus, when a PLANTS name was encountered that was updated or otherwise differentially recognized over FGP, the herbarium holdings were consulted for material potentially filed under the name recognized by PLANTS and the corresponding synonym(s) in FGP. Differences in taxonomy as represented by PLANTS relative to FGP were reconciled prior to analyses.

Because our goal was to count collections, we deleted duplicates when we knew of them (e.g., same collector with all other data present and matching). However, there may be early collection duplicates that are not deleted because they could not be identified as such (e.g., Hitchcock did not use collection numbers). Because of this ambiguity, we herein use the term *specimen* to refer to what was counted, i.e., each sheet representing—to the best of our knowledge—one collection. In addition, specimens were excluded if they lacked temporal data (year) or clearly represented cultivated material. The determination of whether or not a specimen represented cultivated material was occasionally difficult, particularly for historical collections with limited label data. With regard to taxon identification, we generally depended on the well-curated status

of the collection, only checking identifications when the investigators had questions or when preliminary analysis pointed to potential problems.

Temporal patterns were determined by conducting searches of the database for material corresponding to each decade. We defined a decade as beginning with the year ending in "0" and ending with the year ending in "9"; for example, the 1890s corresponds to material collected from 1 January 1890 to 31 December 1899. We also used a KSC data set from a related study (Prather et al. 2004a; on general temporal trends in collecting in the United States) to analyze temporal collecting patterns for a sample of Kansas specimens of native species relative to our data for introduced species. Additionally, we compared our data on timing of first collection for each species to the earliest records housed at KANU based on the KANU specimen database.

Spatial collecting patterns were mapped to the county level (ArcGIS version 9.0, ESRI) to explore numbers of species and specimens documented by the KSC collection by the end of major collecting peaks. Specimens lacking clear county information were excluded from spatial analysis. To assess spatial biases, we compared the spatial collecting patterns to population centers (defined as counties that have or have had a population of 30,000 or greater at any time since 1900, based on data from the Kansas Census Bureau; www.census.gov/population/cencounts/ks190090.text; www.census.gov/popest/counties/tables/CO-EST2003-01-20.pdf), and present locations of four year colleges and universities (Kansas on the Net; www.kotn.org/colleges.html).

To study biases due to particular collectors, we identified major collectors for this study (defined as individuals who contributed 100 or more of the Kansas specimens in our sample), and examined their collecting time frames, numbers of collections, and numbers of counties covered.

RESULTS

Specimens of non-native taxa in the KSC collection.—A total of 6,565 specimens of introduced flowering plants were recorded from KSC, comprising 314 species, 201 genera and 50 families (App. 1). Of the 412 species on the initial list obtained from PLANTS, 80 were excluded from our study because 1) they are in fact native species contrary to their listing in PLANTS as introduced, 2) we considered them to occur only under cultivation and not to persist in the Kansas flora as defined above, or 3) we found no vouchers at KSC or KANU (some of these were cited in previous literature but do not actually occur in Kansas; others may in fact occur or have occurred but are not vouchered at KSC or KANU and warrant further investigation). Twenty-four introduced species were added to the list because 1) they are in fact introduced species contrary to their listing in PLANTS as native, 2) they were discussed as additional taxa for Kansas by Freeman et al. (1998), 3) taxon recognition at the species level is favored over recognition at the subspecific level in PLANTS, or 4) we were aware of their

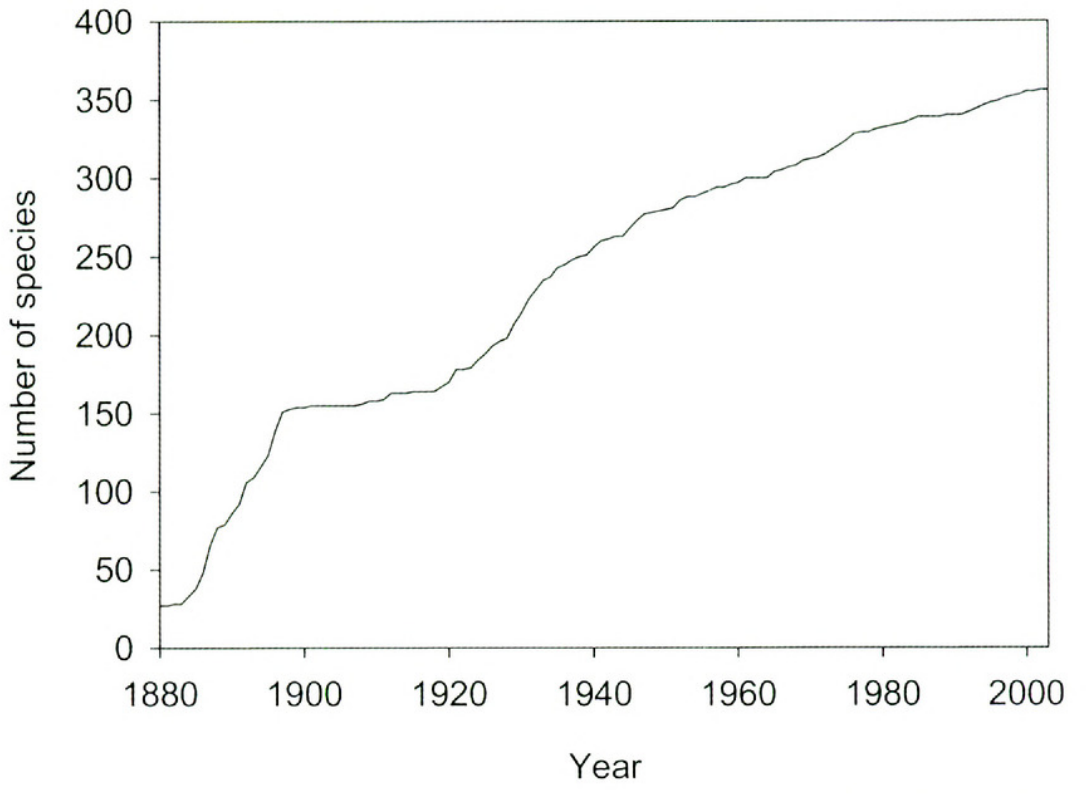

FIG. 1. Cumulative number of introduced species recorded at both KSC and KANU per year. The sharp rise shown in the number of species on record between 1880 and 1900 is what would be expected as a result of high collecting activity (Figs. 2, 4) and an initial documentation period during which time species that perhaps had long existed in the flora were initially collected. The low rate of increase from 1900 to 1930 corresponds with low collecting activity generally at both institutions (Prather et al., 2004a). The rate rose again in the early 1930s, only to slow later in the decade, despite it being a time of peak collecting activity at KSC, suggesting that most introduced species present in the flora at that time were, in fact, accounted for then. We expect that most introduced species present today are documented, because collecting activity in the latter half of the 20th century at KANU was relatively strong (Prather et al., 2004a).

presence in the Kansas flora. The changes made relative to the PLANTS list, with notes, are provided in Appendix 2.

Temporal collecting patterns.—A total of 1,994 Kansas KSC specimens representing 153 introduced species pre-date 1900. By 1940, 3,737 specimens and 243 species were represented (Figs. 1, 2a). Peaks in collection of introduced species in Kansas occurred in the 1890s and 1930s, with relatively reduced collecting activity in the 1900s, 1910s and 1970s (Fig. 2a). These results are highly congruent with collecting patterns for KSC inferred from a sample of native species (Fig. 2b; Prather et al. 2004a).

Of the 356 introduced species vouchered at KSC and/or KANU, the first or concurrent first records for 76% reside at KSC; for the time period prior to 1940 (251 species total), 94% of the earliest collections reside at KSC; and for the time period prior to 1900 (154 species), 95% of the earliest collections reside at KSC (App. 1). Based on both the KSC and KANU data of first records, 43% of the

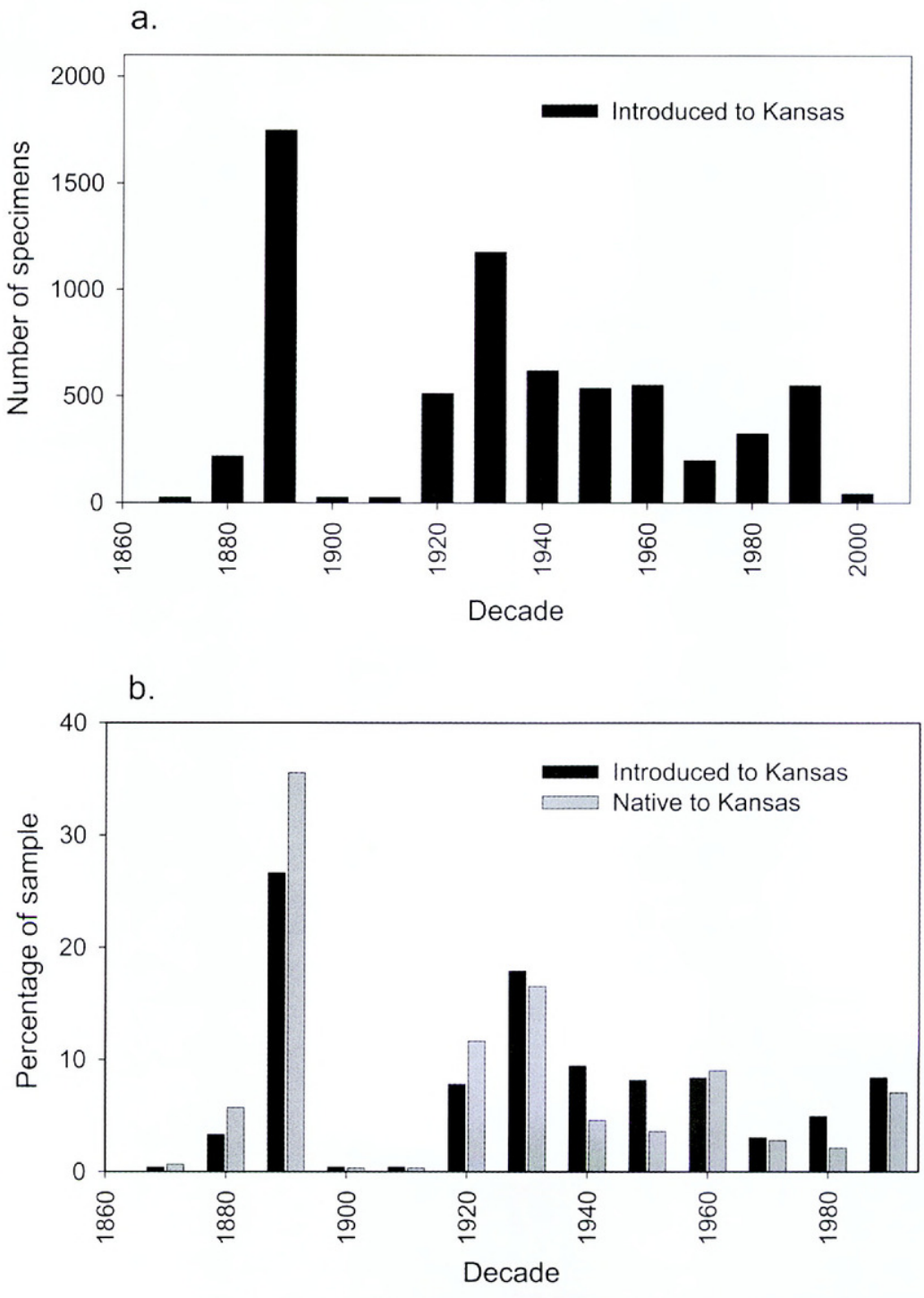

FIG. 2. Temporal patterns of plant collecting at KSC. **a)** The number of introduced specimens from Kansas collected in each decade of the herbarium's history. **b)** Comparison of collecting patterns based on introduced specimens at KSC (this study) and the overall KSC collecting pattern based on a sample of native taxa (Prather et al. 2004a); within each data set, we transformed numbers to percentages of each total sample (e.g., 27% of all Kansas KSC specimens of introduced plants were collected in the 1890s; 36% of the sample of KSC specimens studied by Prather et al. was collected in the 1890s). The results of both studies are highly congruent, suggesting they are generally representative of overall KSC collecting patterns. Minor differences suggest that the native collection was acquired prior to 1930 at a slightly higher rate than the introduced collection, whereas the trend was reversed after 1930.

currently recognized non-native species were collected in Kansas prior to 1900; and 71% were present by 1940. Moreover, examination of data for particular species shows that several problematic weeds and/or invasives (Stubbendieck et al. 1994; Division of Plant Health 2003) were established prior to 1900 (Fig. 3).

Spatial collecting patterns.—Kansas non-native flora prior to 1900 is well documented at KSC with representation from all 105 counties. Spatial mapping of species and specimens over time demonstrates a widely distributed collecting pattern at the level of counties prior to 1900 (Fig. 4a,b), with an increasing bias over time toward educational and population centers (Fig. 4c), although statewide collecting continued. The most thorough collecting over the course of the 20th century was from four counties in central and eastern Kansas: Cloud, Neosho, Riley and Saline. Not surprisingly, the county in which KSC resides, Riley County, is represented by the highest number of specimens of introduced plants: 1,025 (15.6% of the total).

Major collectors.—Fourteen collectors each contributed over 100 specimens of introduced plants to the KSC holdings, and together their activity accounts for 3,405 specimens (52% of the material studied). Figure 5a shows, for each major collector, the number of specimens deposited and the number of counties represented by those specimens; Figure 5b illustrates the time period in which each major collector actively contributed to KSC based on the material studied. Of the four major collectors who collected introduced species broadly (from over 33% of Kansas counties), Hitchcock and G.L. Clothier acquired most of their specimens prior to 1900, Gates in the early to mid 1900s, and Hulbert in the mid to late 1900s (Fig. 5). Of the ten most active collectors who collected from less than 10% of Kansas counties, only one of these collected prior to 1900, while four were active in the early to mid 1900s and five in the mid to late 1900s (Fig. 5). Three of the four counties best represented in this study correspond with the primary collecting area for particular major contributors: S.V. Fraser in Cloud County, J. Hancin in Saline County, and W.W. Holland in Neosho County.

DISCUSSION

The flora of the Great Plains has changed radically with the introduction of non-native species, and many of these floristic shifts are documented in the Kansas State University Herbarium. With 153 species of introduced flowering plants established in Kansas prior to 1900 based on KSC records (1,994 specimens), it is clear that the Great Plains had already undergone significant change by the turn of the last century. For example, Figure 3 shows many species currently considered noxious or agronomically important weeds and/or invasive species (Stubbendieck et al. 1994; Division of Plant Health, 2003) were well-established within the state by 1900: *Cirsium arvense* (Asteraceae); *Cardaria draba* (Brassicaceae); *Convolvulus arvensis* (Convolvulaceae); *Abutilon theophrasti*

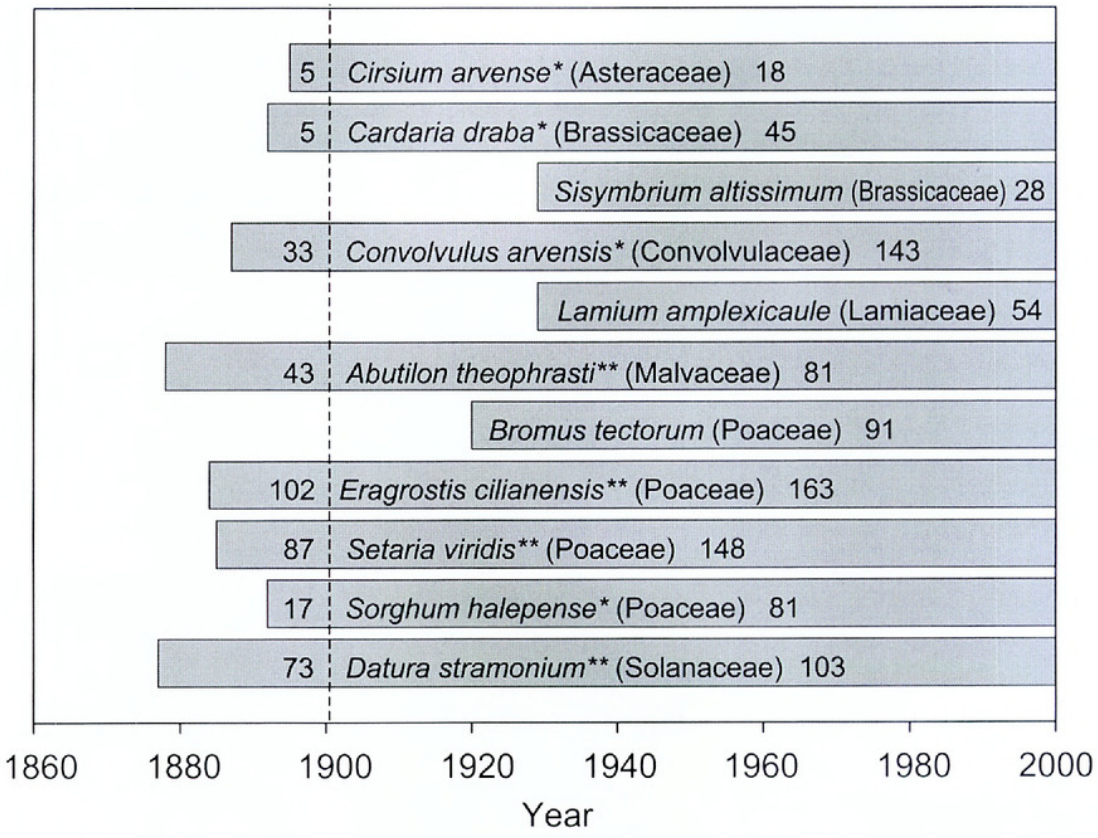

FIG. 3. Documentation of early arrival of some species of interest. Timelines begin with first records, whether housed at KSC or KANU (App. 1). Number of KSC specimens recorded prior to 1900 is shown just to the left of the vertical line, and total number of KSC specimens for each species is listed at the end of each line. Single asterisks indicate species included on the Kansas noxious weed list (Division of Plant Health 2003), and double asterisks denote Great Plains invasive species according to Stubbendieck et al. (1994). Other species are prevalent today yet not documented in Kansas until after the turn of the 20th century.

(Malvaceae); *Eragrostis cilianensis* (Poaceae); *Setaria viridis* (Poaceae); *Sorghum halepense* (Poaceae); *Datura stramonium* (Solanaceae). Equally intriguing is the fact that many notable introduced species prevalent in Kansas today are not documented until the 1920s or 1930s (Fig. 3), such as *Sisymbrium altissimum* (Brassicaceae), *Lamium amplexicaule* (Lamiaceae) and *Bromus tectorum* (Poaceae). Given that a lack of documentation via herbarium specimens does not necessarily indicate a species was absent from the flora at the time, inferences regarding the general timing of introduction of such species must be based on careful analysis of collecting patterns and biases for the herbaria examined, and eventually compared to introduction records for adjacent states.

In the case of KSC, we found the collecting of introduced species prior to 1900 and during the 1930s remarkably extensive (Figs. 1, 2, 4), and the congruence we found in overall collecting pattern between our study and that of Prather et al. (2004a) corroborates these collecting "peaks." The historical na-

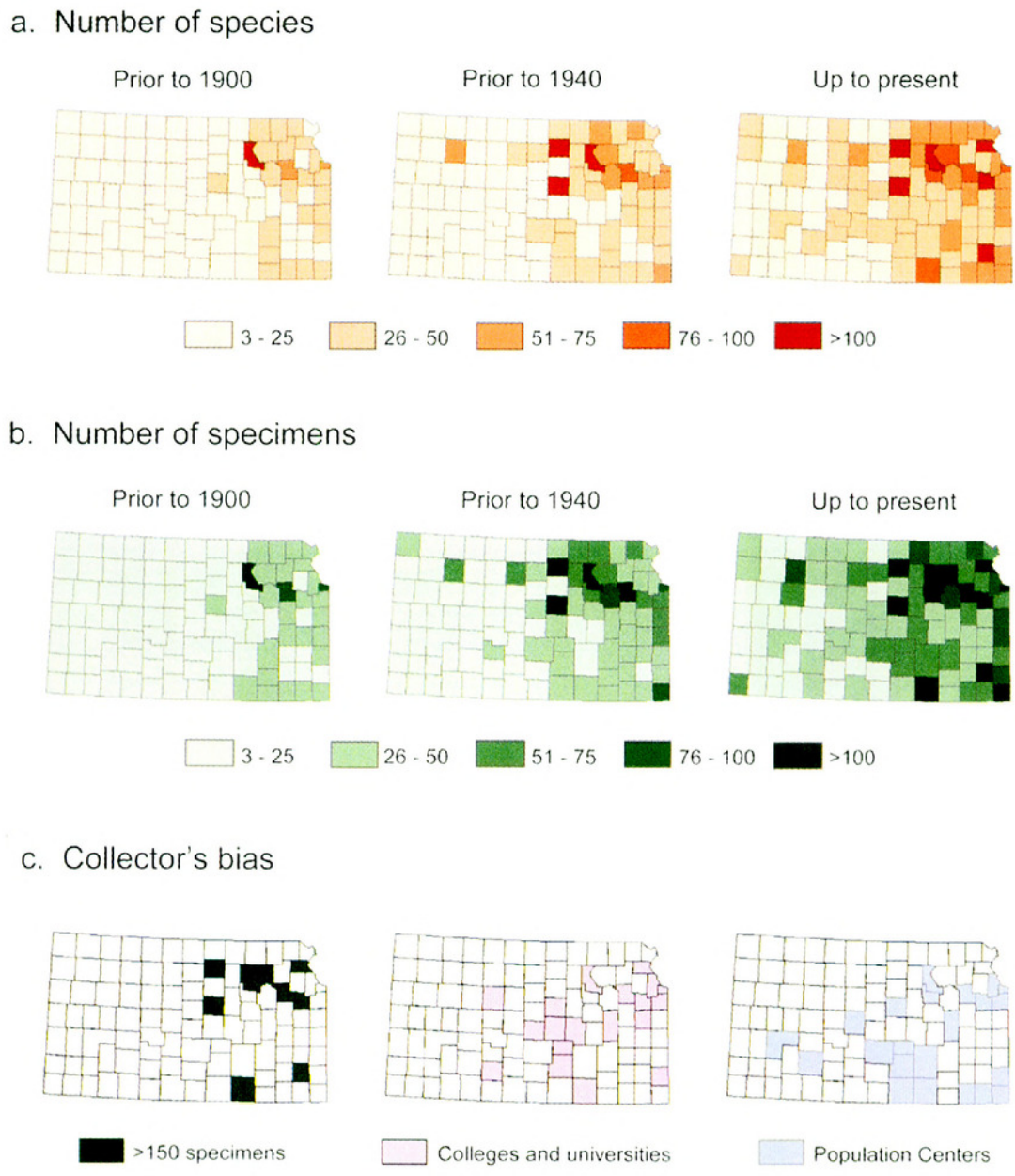

FIG. 4. Spatial patterns of collecting of introduced species at KSC. **a, b)** Number of species and specimens, respectively, collected in each county over time. The counties with higher numbers of species correspond closely with the counties from which higher numbers of specimens were recorded; thus, the greater number of species documented in these counties is likely a result of collecting bias rather than a demonstrated difference in actual species richness. **c)** Comparison of counties represented by over 150 specimens (left) to counties with four-year colleges or universities (middle) and to counties that have recorded a population greater than 30,000 at any census since 1900 (right). Six of the nine counties with large specimen counts correspond to educational or population centers, or both. Two of the others (Cloud and Neosho) had strong individual collectors sampling from those counties almost exclusively (see text), and the third (Pottawatomie) is adjacent to the home county of KSC.

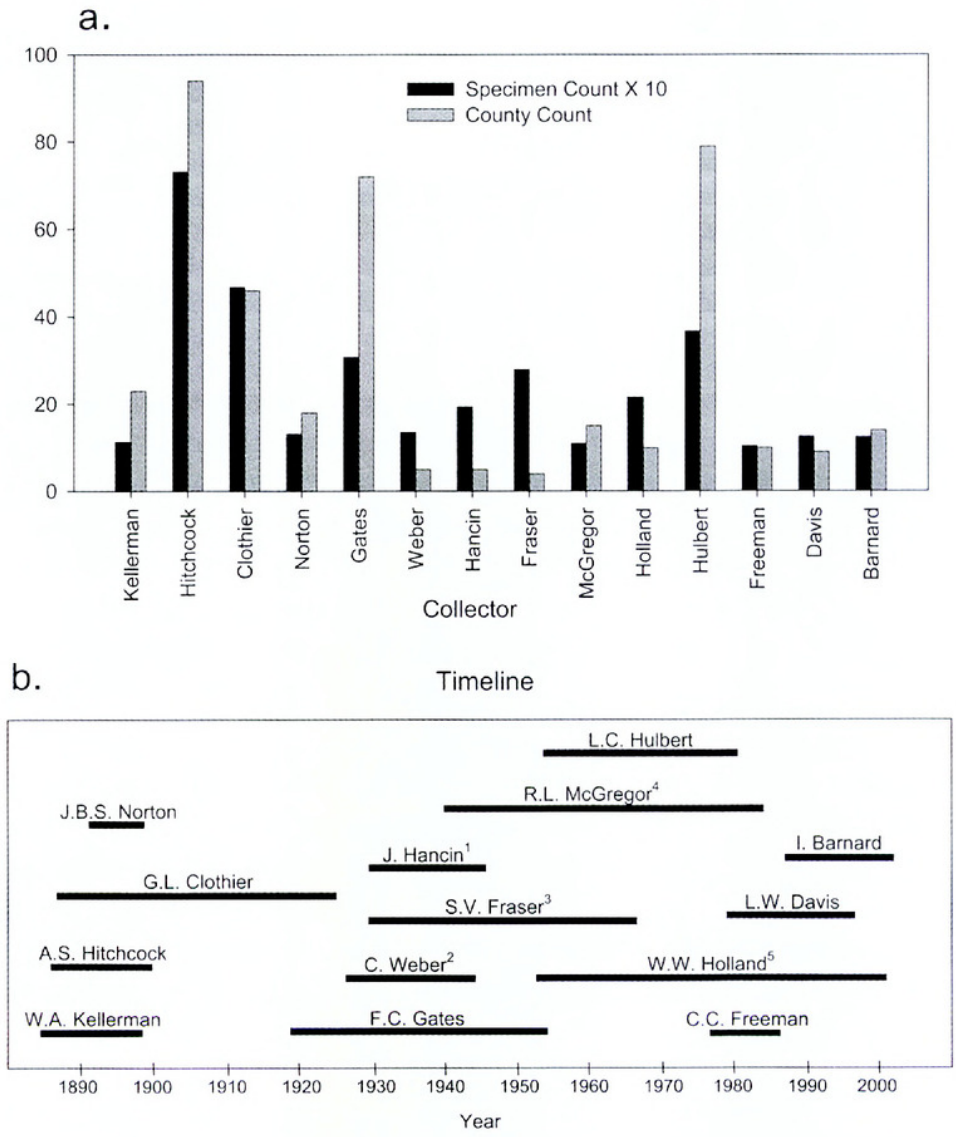

Fig. 5. Major collectors of introduced species at KSC. a) Specimen count and county count for each collector contributing more than 100 specimens of introduced plants. Collectors are in general chronological order, left to right, based on their activity at KSC. b) Timeline representing the active periods of collecting for each collector based on these data. Institutional affiliation for the time period indicated is KSC unless otherwise indicated in footnotes (note that some collectors have been and/or are active at other times elsewhere; e.g., Hitchcock moved to US; Freeman is currently at KANU). Hitchcock, Clothier, Gates and Hulbert stand out as the most prolific and even collectors based on species and county counts. While also prolific, Fraser and Hancin concentrated their activities in six and four counties, respectively. In total, the 14 major collectors contributed 52% of the material studied.

[1] A collector working in Saline County whose specimens were mainly deposited at Bethany College, Lindsborg, Kansas. The herbarium of Bethany College was incorporated into KSC in 1990.

[2] Affiliation presumed to be KSC (labels indicate Kansas State University, but we have little information about this collector).

[3] A reverend working in Cloud County whose collection was deposited at Marymount College, Salina, Kansas; the Marymount College Herbarium was incorporated into KCS in 1992.

[4] KANU Curator, 1954–present (1988–, Curator Emeritus).

[5] A doctor of veterinary medicine who works independently in Neosho County.

ture of the KSC collection in the region is underscored by the finding that KSC houses the overwhelming majority of earliest records of introduced species in relation to KANU.

Spatially, collecting at KSC was more evenly distributed across the state prior to 1900, and less so in more recent decades. Indeed, over time KSC shows an increasing bias (based on specimens of introduced plants) toward counties with four-year colleges and universities, and/or population centers (Fig. 4c), suggesting that many collectors focus their collecting efforts in areas that are easily accessed (e.g., near home and work). Other researchers have noted similar biases (in Mexico, Soberón 1996; in Texas, B. Lipscomb, Botanical Research Institute of Texas, pers. comm.), emphasizing a need for increased collecting in remote areas. Eastern and central Kansas, which include most of the population and educational centers, show far greater representation in our study than western Kansas, especially after 1940.

This study does not address the question of differences in species richness of introduced plants across Kansas, an interesting avenue for future research. The observed patterns in this study document collecting bias at the county level as indicated by the correlation of higher species numbers with higher numbers of collections (Fig. 2a, 2b). A demonstration that the number of species for particular unit areas is fairly stable regardless of increased collecting activity (over some moderate level) could enable exploration of geographical differences in species richness. We suggest that an intriguing investigation of species richness of native and introduced taxa could be accomplished within the region by drawing on the data housed within the network of Great Plains herbaria, provided that collecting biases were carefully taken into account.

The role of individual collectors is highlighted by this study. Those who collected widely provided KSC with a broad, spatially distributed collection. For example, the prolific and broad collecting in the 1890s suggests that Hitchcock and his protégés worked systematically to obtain, at a minimum, a specimen of each species present in each county. Collecting patterns during the 1930s also indicate relatively thorough and even collecting, accomplished largely through the efforts of Gates and numerous less prolific collectors (many cited as County Agricultural Extension Agents). Alternatively, those individuals who collected abundantly in limited regions (e.g., Fraser, Hancin, Holland) provided KSC with a very thorough sampling of particular counties. Although collecting continued throughout the state, the most active collecting after 1925 was concentrated in four counties: Cloud, Neosho, Riley and Saline, due in large part to specific individuals. This results in KSC having excellent documentation over an extended time within these areas.

It should be noted that the major collectors as determined by this study likely do not correspond entirely with major collectors overall for KSC, as many botanists and taxonomists focus on certain groups of plants and, in many cases,

native species. Undoubtedly, some of the major collectors discussed here were generalists in their collecting (e.g., Hitchcock collected both native and introduced species widely). On the other hand, some workers, perhaps especially at agricultural universities such as Kansas State University, are particularly interested in weeds [e.g., L.W. Davis' collecting (Fig. 5) took place while she was researching weeds of the region, culminating in *Weed Seeds of the Great Plains* (1993)]. Broader comparisons of KSC collector data will be feasible once the entire herbarium holdings are databased.

Based on our analyses of the strengths and biases of the KSC material, we are confident that the records from the 1890s and the 1930s represent a reasonably accurate account of the presence and distribution in Kansas of introduced species at those times (although we acknowledge that some species and areas may have been missed by collectors). If an introduced species is not represented by pre-1900 KSC material, it most likely was not established in Kansas by then, and probably not even introduced to Kansas. If a species was not documented prior to 1940, it likely was still not well-established in Kansas by that time. Appropriate floristic inferences for Kansas made in reference to periods post-1940 must utilize complementary herbaria such as KANU.

We encourage researchers to utilize the KSC collection more extensively, incorporating the collection biases identified here to form accurate floristic inferences. Although the temporal data for particular plant species presented in Appendix 1 are a primary result of this study, we hope that others will improve the taxonomic and distributional data to a more refined level. Looking to the future, increased collecting activity is fundamental to the goal of better understanding and managing plant introductions.

This study underscores the critical importance of natural history collections as resources for investigations in distributional changes of species—in this case, of introduced plants. Given the understanding of collecting biases and strengths of a particular collection, floristic changes can be rigorously studied. The increased use of information technology such as databasing and georeferencing, as well as analytical techniques that account for biases (Weber 1998; Soberón et al. 2000; Ter Steege et al. 2000; Mihulka & Pyšek 2001; Delisle et al. 2003) will continue to highlight the value of herbaria in accurately tracking the establishment and spread of introduced plant species, and changes in community associations. Ironically, just at a point when natural history collections are becoming more widely recognized as critical research infrastructure, drastic funding cuts threaten the very existence and curation of some collections (Dalton 2003; Gropp 2003; Suarez & Tsutsui 2004). Despite these setbacks, the increasing accessibility of herbarium specimen data online and the linking of these databases (via Distributed Generic Information Retrieval, DiGIR, sourceforge.net/projects/digir; e.g., the National Biological Information Infrastructure of the Global Biodiversity Information Facility, gbif.nbii.gov/search/

search.html) are beginning to enable inter-collection data-mining with great opportunities for tracking floristic patterns on a large scale. As new technologies emerge, we expect to see the wealth of data in natural history collections yielding exciting new information for different geographical regions. Indeed, as the Natural Science Collections Alliance (2004) states, "... we are just embarking on the Golden Age of collections research."

APPENDIX 1

Species included in analyses, with general historical temporal information on specimens (see text). Taxonomy is alphabetical, with family recognition following the APG system (Angiosperm Phylogeny Group 2003) and taxa listed to species following the PLANTS Database (USDA NRCS, see text)[1, 2, 3]. Additional information is provided below the name only when necessary to reference the taxon in *Flora of the Great Plains* (FGP; Great Plains Flora Association 1986; i.e., when the species is treated under a different name there and the currently accepted name is not mentioned as a synonym or otherwise discussed, or, in some cases, where additional information is necessary to clarify treatment here relative to FGP). Note that some of the species here were mentioned but not described in FGP (usually because they were considered waifs, cultivated taxa not considered to escape or persist long, or uncommon species very similar to described taxa). A single asterisk denotes a species that was added to the FGP in the supplement accompanying the second printing (Brooks 1991), and is therefore not referenced in the regular index of that treatment. A double asterisk denotes a species that was not referenced at all in FGP.

Family/Species[1, 4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Amaranthaceae						
Atriplex hortensis L.	1928	0	4	5		—
Atriplex rosea L.	1932	0	1	2		—
Atriplex prostrata Bouchér ex DC.	—	0	0	0	X	1971
Chenopodium album L.	1885	29	3	47		1952
Chenopodium ambrosioides L.	1890	16	16	38		1915
Chenopodium botrys L.	1888	3	1	5		—
Chenopodium glaucum L.	1897	1	1	3		1912
Chenopodium murale L.**	1897	1	0	3		—
Chenopodium pumilio R. Br.	—	0	0	0	X	1992
Kochia scoparia (L.) Schrad.	1912	0	43	83	same	1912
Salsola collina Pall.	1923	0	2	3		1972
Salsola tragus L. FGP: *S. iberica* Sennen & Pau	1894	21	21	51		1900

Family/Species[1,4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Apiaceae						
Bupleurum rotundifolium L.	1890	1	0	8		1969
Conium maculatum L.	1927	0	11	38	same	1927
Daucus carota L.	1891	12	7	35		1929
Falcaria vulgaris Bernh. FGP: *F. sioides* (Wibel) Aschers.	1936	0	1	2	X	1932
Foeniculum vulgare Mill.	—	0	0	0	X	1965
Pastinaca sativa L.	1896	6	1	10		1930
Torilis arvensis (Huds.) Link	1926	0	1	21		1929
Apocynaceae						
Cynanchum louiseae Kartesz & Gandhi FGP: *C. nigrum* (L.) Pers.	1941	0	0	4		1979
Vinca minor L.	1925	0	1	1		1969
Asteraceae						
Achillea millefolium L. var. *millefolium*[1]	1876	64	25	131		1918
Acroptilon repens (L.) DC.	1921	0	16	31		1976
Anthemis cotula L.	1885	27	5	38	X	1880
Arctium minus Bernh.	1879	34	6	50		1913
Artemisia abrotanum L.	1931	0	1	2		—
Artemisia annua L.	1897	1	2	5		1995
Artemisia biennis Willd.	1886	8	8	19		1956
Carduus acanthoides L.	2001	0	0	1	X	1940
Carduus nutans L.	1932	0	1	24		1940
Centaurea biebersteinii DC. FGP: *C. maculosa* auct. non Lam.	1951	0	0	4	X	1940
Centaurea cyanus L.	1888	1	4	9		1952
Centaurea solstitialis L.	1919	0	5	10		1961
Cichorium intybus L.	1888	2	8	22		1929
Cirsium arvense (L.) Scop.	1895	5	2	18		1975
Cirsium vulgare (Savi) Ten.	1894	17	4	36		1929
Cosmos bipinnatus Cav.**	1929	0	1	3		1995
Crepis capillaris (L.) Wallr.	1947	0	0	1		—
Galinsoga parviflora Cav.	1921	0	1	3		1968
Galinsoga quadriradiata Cav.	1896	1	4	13		1932
Gnaphalium uliginosum L.	1892	1	0	1		—
Guizotia abyssinica (L. f.) Cass.**	—	0	0	0	X	1976
Lactuca saligna L.	1941	0	0	15		1949
Lactuca serriola L.	1895	25	17	72		1913
Leontodon hispidus L.	—	0	0	0	X	1952
Leucanthemum vulgare Lam.	1887	10	8	31		1929
Matricaria discoidea DC. FGP: *M. matricarioides* auct. non (Less.) Porter	1931	0	1	12		1964

Family/Species[1, 4]	KSC: earliest	prior to 1900	1900–1940	total records	KANU: earlier than KSC?[5]	earliest
Matricaria recutita L. FGP: *M. chamomilla* L. 1755 & 1763, non 1753	1929	0	3	5		—
Onopordum acanthium L.	1933	0	1	1		1975
Parthenium hysterophorus L.	1932	0	2	9		1950
Scorzonera laciniata L.	1976	0	0	2	same	1976
Senecio vulgaris L.	1992	0	0	1	X	1976
Sonchus arvensis L.	1984	0	0	1	X	1959
Sonchus asper (L.) Hill	1878	26	13	59		1915
Sonchus oleraceus L.	1896	1	3	7		1918
Tanacetum vulgare L.	1897	3	1	5		—
Taraxacum laevigatum (Willd.) DC.	1890	2	8	18		1929
Taraxacum officinale G.H. Weber ex Wiggers	1884	10	14	48		1887
Tragopogon dubius Scop.	1926	0	19	59		1932
Tragopogon porrifolius L.	1920	0	10	16		1933
Xanthium spinosum L.	1938	0	1	18		1975
Berberidaceae						
Berberis thunbergii DC.**	—	0	0	0	X	1976
Betulaceae						
Alnus glutinosa (L.) Gaertn.*	1939	0	1	2		1987
Boraginaceae						
Asperugo procumbens L.	1952	0	0	2		1959
Buglossoides arvensis (L.) I.M. Johnston FGP: *Lithospermum arvense* L.	1896	5	5	38		1913
Cynoglossum officinale L.	1887	15	2	19		1946
Echium vulgare L.	1891	1	2	7		1938
Heliotropium indicum L.	1995	0	0	1	X	1947
Lappula squarrosa (Retz.) Dumort. FGP: *Lappula echinata* Gilib.	1878	8	2	16		1884
Brassicaceae						
Alliaria petiolata (M. Bieb.) Cavara & Grande	1895	1	4	17		1947
Alyssum alyssoides (L.) L.	1984	0	0	1	X	1975
Alyssum desertorum Stapf	—	0	0	0	X	1996
Alyssum minus *(L.) Rothm.*	—	0	0	0	X	1973
Arabidopsis thaliana (L.) Heynh.	—	0	0	0	X	1984
Barbarea vulgaris Ait. f.	1898	1	1	20		1933
Berteroa incana (L.) DC.	1897	1	1	4		1975
Brassica juncea (L.) Czern.	1898	1	8	15		1933
Brassica napus L.	2000	0	0	1		—

Family/Species[1,4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Brassica nigra (L.) W.D.J. Koch	1887	29	6	37		1929
Brassica rapa L.	1894	15	3	23		1937
Camelina microcarpa DC.	1887	5	13	49		1929
Camelina rumelica Velen.*	1947	0	0	4		1970
Capsella bursa-pastoris (L.) Medik.	1879	22	20	64		1911
Cardaria chalapensis (L.) Hand.-Mazz.	1932	0	3	4	X	1929
Cardaria draba (L.) Desv.	1892	5	16	45		1935
Chorispora tenella (Pall.) DC.	1956	0	0	23		1957
Cleome hassleriana Chod.	1896	1	0	2		—
Conringia orientalis (L.) Dumort.	1886	1	10	18		1923
Descurainia sophia (L.) Webb ex Prantl	1930	0	2	16		1931
Diplotaxis muralis (L.) DC.	—	0	0	0	X	1972
Eruca vesicaria (L.) Cav.	1908	0	1	1		2001
Erucastrum gallicum (Willd.) O.E. Schulz	1945	0	0	1		1967
Erysimum repandum L.	1896	1	9	53		1940
Hesperis matronalis L.	1932	0	6	22		1956
Lepidium campestre (L.) Ait. f.	1896	1	0	4		1952
Lepidium latifolium L.	—	0	0	0	X	1985
Lepidium perfoliatum L.	1919	0	7	10		1957
Malcolmia africana (L.) Ait. f.	1956	0	0	23		1975
Microthlaspi perfoliatum (L.) F.K. Mey. FGP: *Thlaspi perfoliatum* L.	1993	0	0	4	X	1969
Raphanus sativus L.	1885	5	2	7		1971
Rorippa sylvestris (L.) Besser	1978	0	0	1	X	1972
Sinapis alba L.	1935	0	1	1		—
Sinapis arvensis L.	1892	20	8	39		1933
Sisymbrium altissimum L.	1930	0	14	28	X	1929
Sisymbrium loeselii L.	1945	0	0	1		1976
Sisymbrium officinale (L.) Scop.	1879	27	2	37		1911
Thlaspi arvense L.	1870	4	27	76		1931
Campanulaceae						
Campanula rapunculoides L.	1977	0	0	1		—
Cannabaceae						
Cannabis sativa L.	1884	16	14	49		1913
Humulus japonicus Siebold & Zucc.	1930	0	1	7		1947
Caprifoliaceae						
Dipsacus fullonum L.	1945	0	0	6		1947
Dipsacus laciniatus L.	1979	0	0	4	X	1966
Lonicera japonica Thunb.	1893	1	2	12		1928

Family/Species[1,4]	KSC: earliest	prior to 1900	1900–1940	total records	KANU: earlier than KSC?[5]	earliest
Lonicera maackii (Rupr.) Herder	1935	0	1	7		1981
Lonicera tatarica L.	1892	1	1	4		1899
Scabiosa atropurpurea L.**	1928	0	2	4		1995
Caryophyllaceae						
Agrostemma githago L.	1873	3	6	14		1930
Arenaria serpyllifolia L.	1930	0	4	23		1946
Cerastium brachypetalum Desp. in Pers.	1892	3	9	20		1930
Cerastium fontanum Baumg.	1891	5	6	19		1941
Cerastium glomeratum Thuill.	1971	0	0	2	X	1946
Cerastium pumilum W. Curtis	—	0	0	0	X	1965
Dianthus armeria L.	1940	0	0	16	X	1937
Holosteum umbellatum L.	1946	0	0	22		1955
Myosoton aquaticum (L.) Moench	—	0	0	0	X	1970
Saponaria officinalis L.	1879	18	11	42		1929
Scleranthus annuus L.	—	0	0	0	X	1967
Silene latifolia Poir.	1921	0	2	3		1932
Silene noctiflora L.	1909	0	4	7		1975
Silene vulgaris (Moench) Garcke	1888	2	1	5		—
Stellaria graminea L.	—	0	0	0	X	1947
Stellaria media (L.) Vill.[1]	1892	1	26	47		1940
Stellaria pallida (Dumort.) Crép.[1]	1931	0	4	8		1974
Vaccaria hispanica (Mill.) Rauschert FGP: *V. pyramidata* Medik.	1888	4	3	13		1932
Celastraceae						
Euonymus fortunei (Turcz.) Hand.-Mazz.**	—	0	0	0	X	1995
Clusiaceae						
Hypericum perforatum L.	1889	5	2	29		1929
Commelinaceae						
Commelina communis L.	1937	0	1	7	X	1911
Convolvulaceae						
Calystegia pellita (Ledeb.) G. Don	1894	1	2	6		1932
Convolvulus arvensis L.	1887	33	85	143		1912
Ipomoea coccinea L.	1894	2	3	14		1929
Ipomoea hederacea Jacq.	1878	39	8	66	X	1866
Ipomoea purpurea (L.) Roth	1892	39	10	59	X	1866
Crassulaceae						
Hylotelephium telephium (L.) H. Ohba**	1897	1	0	1		—
Diascoreaceae						
Dioscorea oppositifolia L. FGP: *D. batatas* Decne.	1993	0	0	1	X	1981

Family/Species[1,4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Elaeagnaceae						
Elaeagnus angustifolia L.	1891	1	2	10		1944
Elaeagnus umbellata Thunb.**	1993	0	0	1		1995
Euphorbiaceae						
Euphorbia cyparissias L.	1887	7	6	14		1897
Euphorbia esula L.	1933	0	4	12		1967
Ricinus communis L.**	1924	0	3	6		1977
Fabaceae						
Coronilla varia L.	1946	0	0	14		1956
Kummerowia stipulacea (Maxim.) Makino FGP: *Lespedeza stipulacea* Maxim.	1933	0	3	23		1937
Kummerowia striata (Thunb.) Schindl. FGP: *Lespedeza striata* (Thunb.) Hook. & Arn.	1897	3	2	5		1976
Lathyrus latifolius L.	—	0	0	0	X	1965
Lespedeza bicolor Turcz.**	1996	0	0	2	same	1996
Lespedeza cuneata (Dum.-Cours.) G. Don	1950	0	0	31		1960
Lotus corniculatus L.	1953	0	0	7		1966
Lotus tenuis Waldst. & Kit. ex Willd.	—	0	0	0	X	1973
Medicago lupulina L.	1892	4	20	54		1911
Medicago minima (L.) L.	1940	0	0	6		1973
Medicago sativa L.	1886	44	17	70		1912
Melilotus alba Medik.	1879	40	14	71		1911
Melilotus officinalis (L.) Lam.	1887	14	21	55		1913
Pueraria montana (Lour.) Merr.**	—	0	0	0	X	1975
Senna occidentalis (L.) Link FGP: *Cassia occidentalis* L.	1896	1	0	1		1988
Sphaerophysa salsula (Pall.) DC.	—	0	0	0	X	1979
Trifolium campestre Schreb.	1888	2	2	10		1929
Trifolium dubium Sibthorp	1938	0	1	4		1972
Trifolium fragiferum L.	—	0	0	0	X	1985
Trifolium hybridum L.	1890	4	3	11		1974
Trifolium incarnatum L.	1885	1	1	2		1998
Trifolium pratense L.	1889	29	14	52	X	1882
Trifolium repens L.	1884	29	10	52		1887
Trifolium resupinatum L.	1932	0	4	6		—
Vicia sativa L.	1895	1	0	2		2001
Vicia villosa Roth	1891	1	5	18		1933
Geraniaceae						
Erodium cicutarium (L.) L'Hér. ex Ait.	1935	0	2	14		1957

Family/Species[1,4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Geranium pusillum L.	1933	0	2	9	X	1929
Haloragidaceae						
Myriophyllum aquaticum (Vell.) Verdc. FGP: *M. brasiliense* Camb.	1935	0	1	1		—
Hydrocharitaceae						
Egeria densa Planch. FGP: *Elodea densa* (Planch.) Caspary	1934	0	1	1		1973
Iridaceae						
Belamcanda chinensis (L.) DC.	1897	5	13	22		1929
Iris germanica L.**	1895	1	2	6		1999
Iris pseudacorus L.	1992	0	0	2	X	1959
Lamiaceae						
Ajuga reptans L.	1957	0	0	2		1958
Chaiturus marrubiastrum (L.) Rchb. FGP: *Leonurus marrubiastrum* L.	1940	0	0	1		—
Glechoma hederacea L.	1892	7	5	17		1897
Lamium amplexicaule L.	1929	0	20	54		1933
Lamium purpureum L.	1940	0	0	10	same	1940
Leonurus cardiaca L.	1876	8	8	25		1929
Marrubium vulgare L.	1890	29	15	59		1912
Mentha x *gracilis* Sole (pro sp.) FGP: *Mentha cardiaca* (Gray) Gerarde ex Baker	1961	0	0	2	X	1912
Mentha x *piperita* L. (pro sp.)	1899	1	2	4		1983
Mentha spicata L.	1930	0	2	2		1975
Nepeta cataria L.	1880	24	11	44		1912
Perilla frutescens (L.) Britton	1924	0	7	10	same	1924
Salvia nemorosa L.	1935	0	1	4		1995
Salvia pratensis L.	1930	0	1	1		1955
Salvia sclarea L.	1945	0	0	2		1992
Stachys annua (L.) L.	1896	1	0	1		—
Liliaceae						
Allium porrum L.	1930	0	2	4		—
Allium sativum L.	1943	0	0	4		1957
Allium vineale L.	1931	0	3	9	same	1931
Asparagus officinalis L.	1884	16	4	25		1911
Hemerocallis fulva (L.) L.	1940	0	0	8	X	1929
Muscari botryoides (L.) Mill.	1967	0	0	1	X	1949
Ornithogalum umbellatum L.	1888	1	2	7		1937
Linaceae						
Linum perenne L.	1897	1	1	6		—
Linum usitatissimum L.	1887	21	2	26		1913

Family/Species[1,4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Lythraceae						
Lythrum salicaria L.	1995	0	0	4	X	1989
Malvaceae						
Abutilon theophrasti Medik.	1878	43	11	81		1911
Alcea rosea L.	1932	0	1	4		1941
FGP: *Althaea rosea* (L.) Cav.						
Hibiscus trionum L.	1878	46	23	98		1911
Malva neglecta Wallr.	1892	8	11	33		1911
Malva parviflora L.	1919	0	2	6		—
Malva pusilla Sm.[3]	1895	3	8	14		1929
Malva sylvestris L.	1931	0	2	2		—
Molluginaceae						
Glinus lotoides L.	1980	0	0	3	X	1952
Moraceae						
Broussonetia papyrifera (L.) L'Hér. ex Vent.	—	0	0	0	X	1965
Morus alba L.	1887	2	20	43		1915
Papaveraceae						
Fumaria officinalis L.	—	0	0	0	X	1961
Glaucium corniculatum (L.) J.H. Rudolph	—	0	0	0	X	1979
Papaver dubium L.	1983	0	0	1	X	1975
Papaver rhoeas L.	1927	0	2	4		1948
Plantaginaceae						
Plantago lanceolata L.	1999	0	0	1	X	1912
Poaceae						
Aegilops cylindrica Host	1924	0	30	55		1926
×*Aegilotriticum sancti-andreae* (Degen) Soó**	1924	0	4	11		—
Agropyron cristatum (L.) Gaertn.	1960	0	0	1	same	1960
Agrostis gigantea Roth	1886	39	10	61	same	1886
FGP: *A. stolonifera* L., in part						
Agrostis stolonifera L.[6]	—	0	0	0	X	1930
Arthraxon hispidus (Thunb.) Makino**	1999	0	0	2	X	1984
Arundo donax L.**	1984	0	0	1	X	1974
Avena fatua L.	1947	0	0	1		1966
Avena sativa L.	1896	1	3	7		1967
FGP: *Avena fatua* L., in part						
Bothriochloa bladhii (Retz.) S.T. Blake	1952	0	0	12	same	1952
Bothriochloa ischaemum (L.) Keng	1935	0	4	23		1973
Bromus catharticus Vahl	1921	0	10	23		1949
FGP: *Bromus unioloides* Kunth						

Family/Species[1,4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Bromus commutatus Schrad.	1894	1	12	52		1929
Bromus hordeaceus L. FGP: *B. mollis* L.; *B. racemosus* auct. non. L.	1888	1	1	2		1975
Bromus inermis Leyss.	1894	1	12	47		1935
Bromus japonicus Murray	1889	5	35	111		1917
Bromus secalinus L.	1869	23	24	57		1887
Bromus tectorum L.	1920	0	26	91		1936
Cynodon dactylon (L.) Pers.	1897	1	13	28		1935
Dactylis glomerata L.	1879	14	13	39		1903
Digitaria ischaemum (Schreb.) Schreb. ex Muhl.	1892	6	1	11		1948
Echinochloa colona (L.) Link	—	0	0	0	X	1974
Echinochloa crus-galli (L.) P. Beauv.	1893	2	9	37		1913
Echinochloa crus-pavonis (Kunth) J.A. Schultes	1895	5	1	7		1929
Echinochloa muricata (P. Beauv.) Fern.	1879	112	43	187		1902
Eleusine indica (L.) Gaertn.	1895	5	3	16	X	1886
Elymus repens (L.) Gould FGP: *Agropyron repens* (L.) P. Beauv.	1921	0	2	16		1972
Eragrostis barrelieri Daveau	1933	0	2	2		1937
Eragrostis cilianensis (All.) Vignolo ex Janch.	1886	102	37	163	X	1884
Eragrostis curvula (Schrad.) Nees	—	0	0	0	X	1967
Eragrostis minor Host	1933	0	2	5		1935
Holcus lanatus L.	1921	0	1	1		1953
Hordeum vulgare L.	1941	0	0	1	same	1941
Lolium arundinaceum (Schreb.) S.J. Darbyshire FGP: *Festuca arundinacea* Schreb.	1952	0	0	5	same	1952
Lolium perenne L.	1887	2	17	32		1888
Lolium pratense (Huds.) S.J. Darbyshire FGP: *Festuca pratensis* Huds.	1886	15	14	39		1902
Lolium temulentum L.	1948	0	0	1		—
Panicum miliaceum L.	1896	1	2	11		1976
Paspalum urvillei Steud.**	—	0	0	0	X	1936
Phalaris canariensis L.	1896	1	12	16		1969
Phleum pratense L.	1879	25	10	42		1913
Poa annua L.	1886	7	6	18		1936
Poa bulbosa L.	1936	0	2	11		1976

Family/Species[1,4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Poa compressa L.	1888	12	5	29		1938
Poa trivialis L.**	1937	0	1	1		—
Polypogon monspeliensis (L.) Desf.	1931	0	3	8	X	1912
Saccharum ravennae (L.) L. FGP: *Erianthus ravennae* (L.) P. Beauv.	1925	0	1	3		1975
Sclerochloa dura (L.) P. Beauv.	1975	0	0	16	X	1961
Secale cereale L.	1920	0	3	5		1974
Setaria faberi Herrm.	1942	0	0	21	X	1929
Setaria italica (L.) P. Beauv.	1886	15	12	31		1912
Setaria pumila (Poir.) Roemer & Schult.**	1886	62	12	100		1902
Setaria verticillata (L.) P. Beauv.	1921	0	3	8		1975
Setaria viridis (L.) P. Beauv.	1885	87	27	148		1900
Sorghum halepense (L.) Pers.	1892	17	22	81		1902
Themeda quadrivalvis (L.) Kuntze**	1998	0	0	2		—
Thinopyrum ponticum (Podp.) Z.-W. Liu & R.-C. Wang FGP: *Agropyron elongatum* (Host) P. Beauv.	1921	0	3	10		1964
Vulpia myuros (L.) K.C. Gmel. FGP: *Festuca myuros* L.	—	0	0	0	X	1973
Polygonaceae						
Fagopyrum esculentum Moench	1892	6	2	10		1940
Polygonum arenastrum Boreau	1938	0	1	5	X	1929
Polygonum aviculare L.	1879	33	17	76		1995
Polygonum bellardii All. FGP: *Polygonum aviculare* L.	1897	1	4	6		—
Polygonum caespitosum Blume var. *longisetum* (Bruijn) Steward	—	0	0	0	X	1995
Polygonum convolvulus L.	1887	57	4	70	same	1887
Polygonum cuspidatum Siebold & Zucc.	1951	0	0	6		1965
Polygonum hydropiper L.	1897	1	0	2		1964
Polygonum orientale L.	1886	4	1	7		—
Polygonum persicaria L.	1887	41	8	65		1911
Rumex acetosella L.	1874	12	10	31		1930
Rumex crispus L.	1879	35	12	65		1912
Rumex cristatus DC.	—	0	0	0	X	1980
Rumex obtusifolius L.	1892	10	1	17		1932
Rumex patientia L.	1888	8	9	21		1913
Rumex stenophyllus Ledeb.	1945	0	0	10		1948

Family/Species[1, 4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Portulacaceae						
Portulaca grandiflora Hook.	1925	0	3	5		2002
Potamogetonaceae						
Potamogeton crispus L.	1955	0	0	6	same	1955
Primulaceae						
Anagallis arvensis L.	1887	5	2	11	same	1887
Lysimachia nummularia L.	1901	0	1	2		1931
Ranunculaceae						
Ceratocephala testiculatus (Crantz) Roth	1961	0	0	11		1975
Clematis terniflora DC.	1955	0	0	5	same	1955
Consolida ajacis (L.) Schur FGP: *Delphinium ajacis* L.	1896	2	8	19		1932
Ranunculus acris L.	1890	2	0	2		—
Ranunculus arvensis L.	—	0	0	0	X	1969
Ranunculus sardous Crantz	1993	0	0	7	X	1974
Rhamnaceae						
Rhamnus cathartica L.	—	0	0	0	X	1998
Rosaceae						
Malus floribunda Siebold ex Van Houtte**	—	0	0	0	X	1995
Potentilla recta L.	1887	3	2	19		1948
Prunus armeniaca L.	1925	0	2	3		—
Prunus cerasus L.	1933	0	1	1		1969
Prunus mahaleb L.	1897	1	3	9		1930
Prunus persica (L.) Batsch	1893	1	1	9		1941
Pyrus communis L.	1999	0	0	2	same	1999
Rosa eglanteria L.	1887	5	0	5		—
Rosa multiflora Thunb.	1958	0	0	8	X	1957
Rosa spinosissima L.	1897	2	0	2		—
Rubiaceae						
Cruciata pedemontana (Bellardi) Ehrend.**	—	0	0	0	X	1982
Galium verum L.	1926	0	1	1		—
Sherardia arvensis L.	1931	0	1	1		1991
Salicaceae						
Populus alba L.	1915	0	9	12	X	1913
Populus nigra L.	1926	0	7	9		2002
Salix alba L.	1927	0	1	4		1972
Salix fragilis L.	1896	4	2	8		1913
Sapindaceae						
Koelreuteria paniculata Laxm.**	1934	0	1	1		1996
Scrophulariaceae						
Chaenorhinum minus (L.) Lange	1984	0	0	2	X	1968
Digitalis lanata Ehrh.**	—	0	0	0	X	1994

Family/Species[1,4]	KSC:					KANU:
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Kickxia elatine (L.) Dumort.	1941	0	0	1		1949
Linaria dalmatica (L.) Mill.	1986	0	0	1	X	1967
Linaria vulgaris Mill.	1896	3	5	15		1913
Verbascum blattaria L.	1888	8	6	46		1929
Verbascum thapsus L.	1885	22	13	52		1929
Veronica arvensis L.	1890	3	10	35		1929
Veronica biloba L.	—	0	0	0	X	1997
Veronica hederifolia L.	—	0	0	0	X	1993
Veronica persica Poir.	—	0	0	0	X	1975
Veronica polita Fr.	1931	0	11	29		1943
FGP: *Veronica agrestis* L.						
Veronica serpyllifolia L.	1942	0	0	1	same	1942
Veronica triphyllos L.	1943	0	0	4	same	1943
Simaroubaceae						
Ailanthus altissima (Mill.) Swingle	1874	9	11	27		1936
Solanaceae						
Datura stramonium L.	1878	73	13	103	X	1877
Lycium barbarum L.	1891	6	14	35		1913
FGP: *Lycium halimifolium* Mill.						
Nicandra physalodes (L.) Gaertn.	1896	1	2	3		—
Petunia axillaris (Lam.)	—	0	0	0	X	2002
Britton, Sterns, & Poggenb.**						
Solanum dulcamara L.	1887	3	3	8		1929
Tamaricaceae						
Tamarix parviflora DC.	—	0	0	0	X	1892
Tamarix ramosissima Ledeb.	1877	1	8	32		1929
Thymelaeaceae						
Thymelaea passerina (L.) Lange	—	0	0	0	X	1970
Typhaceae						
Typha angustifolia L.	1946	0	0	7	same	1946
Ulmaceae						
Ulmus pumila L.	1926	0	7	18		1927
Violaceae						
Viola arvensis Murray	1931	0	3	4		—
Viola patrini DC.	1953	0	0	2		—
Viola tricolor L.**	1937	0	2	4		—
Zygophyllaceae						
Tribulus terrestris L.	1909	0	55	99		1912
Zygophyllum fabago L.**	1924	0	1	2		—

[1]Taxa were recognized only to the species level, with one exception: when infraspecfic taxa of a species differ with respect to nativity (native versus introduced) and the introduced taxon occurs in Kansas, the infraspecific name was included in the list (we had only one such case, *Achillea millefolium* var. *millefolium*).

[2]Changes relative to the PLANTS list are outlined in Appendix 2.

APPENDIX 2

Revisions to the list generated by PLANTS for angiosperms introduced to Kansas.

Excluded names:

Native species listed erroneously in PLANTS as introduced:

Amaranthus blitoides S. Watson [see Mosyakin and Robertson 2003], *Amaranthus retroflexus* L. [see Mosyakin and Robertson 2003], *Datura quercifolia* Kunth, *Euphorbia davidii* R. Subils [see Mayfield 1997]

Cultivated species, not persisting in the Kansas flora:

Allium cepa L., *Alopecurus myosuroides* Huds., *Alopecurus pratensis* L., *Amaranthus caudatus* L., *Anethum graveolens* L., *Arachis hypogaea* L., *Armoracia rusticana* P. G. Gaertn., B. Mey. & Scherb., *Arrhenatherum elatius* (L.) P. Beauv. ex J. Presl & C. Presl, *Berberis vulgaris* L., *Calamagrostis epigeios* (L.) Roth, *Canavalia ensiformis* (L.) DC., *Carthamus tinctorius* L., *Celosia cristata* L., *Centaurea iberica* Trevir. ex Spreng., *Cicer arietinum* L., *Citrullus lanatus* (Thunb.) Matsumura & Nakai, *Convallaria majalis* L., *Cucumis melo* L., *Cucumis sativus* L., *Cucurbita pepo* L., *Forsythia suspensa* (Thunb.) Vahl, *Forsythia viridissima* Lindl., *Gypsophila elegans* M. Bieb., *Gypsophila paniculata* L., *Ipomoea batatas* (L.) Lam., *Ipomoea quamoclit* L., *Lobularia maritima* (L.) Desv., *Lycium chinense* Mill., *Malus pumila* Mill., *Melissa officinalis* L., *Nicotiana tabacum* L., *Pennisetum glaucum* (L.) R. Br.[1], *Periploca graeca* L., *Petroselinum crispum* (Mill.) Nyman, *Petunia atkinsiana* D. Don ex Loud., *Physalis philadelphica* Lam., *Pisum sativum* L., *Potentilla argentea* L., *Prunus domestica* L., *Reseda lutea* L., *Rheum rhabarbarum* L., *Solanum lycopersicum* L., *Sorghum bicolor* (L.) Moench, *Spergula arvensis* L., *Spinacia oleracea* L., *Triticum aestivum* L., *Ulmus glabra* Huds., *Ulmus procera* Salisb., *Zea mays* L.

Species for which we found no vouchers of non-cultivated material at KSC or in the KANU database (some do not occur in Kansas; some may occur and may be naturalized, but require further study and documentation; cultivated species are indicated):

Agropyron desertorum (Fisch. ex Link) Schult. [cult./crop], *Arctium vulgare* (Hill) A. H. Evans, *Artemisia absinthium* L., *Artemisia vulgaris* L., *Balsamita major* Desf., *Berteroa mutabilis* (Vent.) DC., *Bromus arvensis* L., *Bromus racemosus* L., *Bromus squarrosus* L., *Camelina sativa* (L). Crantz[2], *Cardaria pubescens* (C.A. Mey.) Jarm. [voucher was misidentified], *Consolida orientalis* (J. Gay) R. Schrödinger [cult.], *Dianthus deltoides* L., *Eriochloa villosa* (Thunb.) Kunth, *Euphorbia agraria* M. Bieb., *Euphorbia helioscopia* L., *Geranium rotundifolium* L., *Matthiola longipetala* (Vent.) DC. [cult.], *Nigella damascena* L., *Raphanus raphanistrum* L., *Rosa canina* L. [cult.], *Syringa vulgaris* L. [cult.], *Tragopogon pratensis* L., *Trifolium arvense* L., *Tripleurospermum perforata* (Merat) M. M. Laínz, *Trisetum flavescens* (L.) P. Beauv., *Veronica agrestis* L.

Additions (authorities listed in App. 1):

Introduced species listed erroneously in PLANTS as native:

Continued from page 1719.

[3]The name *Malva pusilla* here replaces *M. rotundifolia* L., nom. rej. (Greuter et al. 2000).

[4]Assessment of the impact of each species (e.g., relatively benign, agricultural weed, ecological invasive, etc.) and determination of particular geographical origin was beyond the scope of the present study, and the reader is referred to other sources (e.g., the PLANTS database; Great Plains Flora Association 1986) for this information.

[5]For the 20 cases for which simultaneous first records (by year) are present at both KSC and KANU ("same"), 10 are apparent cases of duplicate collections between the two institutions, with the biggest contributor to the duplicate set being McGregor (KANU) with three records.

[6]KSC material of *Agrostis gigantea* (considered a synonym of *A. stolonifera* in FGP) has not been recently studied and annotated, and it is possible some of the KSC specimens counted here as *A. gigantea* may truly represent *A. stolonifera*.

Agrostis stolonifera, *Camelina rumelica* [see Brooks 1991]

Additional taxa for Kansas discussed by Freeman et al. (1998):

Alyssum desertorum, *Atriplex prostrata*, *Chenopodium pumilio*, *Digitalis lanata*, *Elaeagnus umbellata*, *Euonymus fortunei*, *Lespedeza bicolor*, *Malus floribunda*, *Polygonum caespitosum*, *Rhamnus cathartica*, *Trifolium incarnatum*, *Veronica biloba*, *Veronica hederifolia*, *Veronica persica*

Taxa recognized at the species level, rather than the infraspecific level:

Stellaria pallida[3]

Additional taxa for Kansas recognized here[4]:

×*Aegilotriticum sancti-andreae*, *Crepis capillaris*, *Leontodon hispidus*, *Melilotus alba* [Great Plains Flora Association 1986], *Setaria pumila*[1], *Themeda quadrivalvis* [see Towne and Barnard 2000], *Viola patrini*

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[1] *Setaria pumila* ssp. *pumila* is the correct name for plants treated as *S. glauca* (L.) P. Beauv. in FGP, and later as *Pennisetum glaucum* in PLANTS (see draft treatment of *Setaria* by J. M. Rominger for *Flora of North America North of Mexico*; herbarium.usu.edu/treatments/Setaria.htm).

[2] There is actually one KANU specimen of *Camelina sativa* that is equivocal with regard to cultivated status; however, the specimen apparently lacks temporal data (no year; and no locality data, in addition) and therefore was not included in this study (see Methods).

[3] In one case, a taxon recognized at the subspecific level in PLANTS is here recognized at the specific level, following the preference of regional floristics workers: *Stellaria media* ssp. *pallida* (Dumort.) Asch. & Graebn. = *S. pallida* (Freeman et al. 1998; App. 1).

[4] In some cases inclusion is based on small numbers of KSC specimens examined (App. 1), and may well be refined by future workers; in the case of *Melilotus alba*, a different taxonomic concept is favored. Relevant references are provided where available.

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