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CYPERUS DIFFORMIS, AN INTRODUCED SPECIES NEW TO MISSOURI

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Cyperus difformis L. (Cyperaceae), smallflower umbrella sedge, is a widespread weed native to tropical and western Asia (Holm et al., 1977). In the United States it was first collected in California, in 1915 (Lipscomb 1980), and in Virginia, in 1934 (Tyndall, 1983). Since then, *C. difformis* has been reported throughout the Gulf states and in Tennessee, Kentucky, North Carolina, Pennsylvania, Arizona, New Mexico, and Nebraska (Bryson et al., 1996). This species is a troublesome weed of rice paddies, but can thrive in many damp habitats (Tyndall, 1983). It has a generation time of 4–6 weeks and is reported to be capable of producing 50,000 seeds per plant, with about 60 percent subsequent germination (Holm et al., 1977).

On 6 September 1998, while the author was sampling vegetation for the Missouri River post flood evaluation project (Galat et al., 1998), *C. difformis* was discovered growing in abundance at a study site south of Norborne, in Carroll County. Voucher specimens were collected and identified as *C. difformis* using the key in Gleason (1952). *Cyperus difformis* is not listed in the *Flora of Missouri* (Steyermark, 1963), the *Catalogue of the Flora of Missouri* (Yatskievich and Turner, 1990), or the *Flora of the Great Plains* (Kolstad, 1986). Identification was verified by Paul McKenzie of the U.S. Fish and Wildlife Service Missouri Field Office, in Columbia, and by George Yatskievych of the Flora of Missouri Project. The following collections voucher *C. difformis* in Missouri:

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Carroll County: ca. 200 clumps in a periodically farmed temporary wetland near a drainage ditch, ca. ½ mi E of County Road 509, ca. 2 mi SE of the junction of State Highway 10 and County Highway FF, near Norborne MO and near Missouri River mile 304.0 L; T51N, R25W S11 SW¼ SW¼; 6 Sep 1998, *Johnson 98-47,* (KANU, LSU, MO, UMO), 10 Oct 1998, *Johnson 98-68,* (BRIT, EIU, MICH, VSC, and personal herbarium of Charles T. Bryson).

This site was farmed in the past, but has received little cultivation in the last three years. The site was bordered on two sides by drainage ditches and was the last part of the surrounding farmland to be drained after high water. The proximity of the Missouri River made this site vulnerable to flooding, and in 1998 this area had shallow standing water throughout most of the growing season. *Cyperus difformis* appeared to be growing in rows parallel to the edge of the wetland basin.

Associated species at the site included: *Cyperus esculentus* L., *Cyperus acuminatus* Torr. & Hook., *Cyperus squarrosus* L. (*C. aristatus* Rottb.), *Echinochloa crusgalli* (L.) P. Beauv., *Eleocharis ovata* (Roth) Roem. & Schult. (*E. obtusa* (Willd.) Schultes), *Juncus torreyi* Cov., *Leersia oryzoides* (L.) Sw., *Lindernia dubia* (L.) Penn., and *Lipocarpha micrantha* (Vahl) G.C. Tucker. Additionally, *Schoenoplectus saximontanus* (Fernald) Raynal and *Bergia texana* (Hook.) Seub., both state listed species (Missouri Natural Heritage Program, 1998), were found in abundance at the same location.

Many of the above-mentioned species are important waterfowl foods (Fassett, 1940). This, combined with the standing water in the area, makes it reasonable that *C. difformis* achenes arrived at this location by way of migrating waterfowl or other birds, which is supported by Tyndall's account of the species occurring on the roof of a building in Lincoln, Nebraska (Tyndall 1983). The role of waterfowl in the dispersal of *Cyperus* spp. is supported by Dunn and Knauer (1975) in their account of the introduction of *Cyperus flavicomus* Michx. [*C.*

Fig. 1. Representative inflorescences of *Cyperus difformis* from Missouri. Note the ascending bracts. Photo by R. Johnson.

albomarginatus (Mart. & Schrad. ex Nees) Steud.] into the Mingo National Wildlife Refuge in southeastern Missouri (McKenzie et al. 1998). It is also conceivable that the species arrived in commercial seed or on farm equipment used in the area. A third possible means of its introduction to Missouri was the flood of 1993, which covered the site and may have brought achenes from Nebraska (Bryson et al. 1996).

Correll and Correll (1972) describe *C. difformis* as a cespitose annual with weak, slightly winged, trigonus culms 2–5 dm tall. The inflorescence consists of numerous, densely flowered, globose heads of spikelets (Fig. 1) that are sessile or on rays to 7 cm long. The spikelets are 4–8 mm long with roundish, obtuse scales 0.6–0.8 mm long. The achenes are trigonous, pale greenish brown and 0.5 mm long. Stem leaves are weak, 2–4 per culm, about equaling the culm. The inflorescence is subtended by 2 or 3 ascending to spreading bracts of unequal length (Fig. 1). For a detailed description and excellent illustration of this species see Correll and Correll (1972). Personal experience has shown this species to have reddish roots and often pinkish-tinged lower culms and leaf sheaths. Due to the combination of small achenes, globose heads, and short spikelets with rounded scales, this species is

easily distinguished from other Missouri *Cyperus*. The "bead-like" appearance of the scales is similar to those of *C. iria* L. of the Missouri Bootheel region, which is readily distinguished from *C. difformis* by its looser inflorescence and larger spikelets and achenes. The globose heads are somewhat similar to those of *C. echinatus* A.W. Wood (*C. ovularis* (Michx.) Torr.) and *Cyperus croceus* Vahl, which are both distinguished from *C. difformis* by their larger achenes, straight sided spikelets, and perennial habits (Correll and Correll, 1972).

ACKNOWLEDGMENTS

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ANOTHER APPLICANT FOR NATURALIZATION IN MISSOURI'S FLORA

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> "All nature is so full that that district produces the greatest variety which is the most examined."
>
> Gilbert White, 1768

For this field botany aficionado and hobbyist, it is encouraging to know that the number of known species of plants in the state is growing on average by nearly 10 per year (Summers, 1997). Such growth is based largely on discoveries by professional botanists, academics, land stewards, and ecologists, but also by amateurs. Collectively, the effort is helping to incrementally close the gap between the recorded data and the actual plant biota that exists in Missouri. This affords the opportunity for better strategic policy planning in natural resource management, and expands the horizons of wildflower watchers and nature lovers. That's the good news.

The bad news is that the rate of discovery of exotic species is growing faster than the rate of discovery of native species. This may be due to continued importation of different exotic species by the commercial nursery, agricultural, and gardening industries, or it may merely take time for certain escaped species to become naturalized and visible. For example, I recently discovered what I believe to be a naturalized population of *Ajuga reptans* (carpet bugle) in south St. Louis County, Missouri. Subsequently two other small populations of *A. reptans* were discovered by Pat Harris at a separate location also in St. Louis County. These discoveries led me to inquire as to the status of this plant species in the floristic records of Missouri. In communications with the George Yatskievych, Director of the Flora of Missouri Project, I was advised that this species had not been formally recognized as

occurring in Missouri in the literature, but that there were specimens that had been on file for some time that had been collected at two other locations (see below) in the state). The findings related in this report contribute to the evidence that the species may now be considered naturalized in the state. The slight uncertainty stems from the requirements that to be confirmed as naturalized, a species must be persistent through the seasons and be capable of reproducing or otherwise be self-sustaining over time.

Ajuga reptans L. is a member of the Lamiaceae (mint family, also known as the Labiatae). Globally the mint family has 258 genera and 6,970 species (Zomlefer 1998) and is particularly diverse in the Mediterranean region. *Ajuga* (bugle) comprises about 50 Old World species of which 10 (including *A. reptans*) are found in Europe (Mabberley, 1997) and 3 have been documented as escapes from cultivation in the United States (Gleason and Cronquist, 1991).

Carpet bugle has been around long enough to accumulate several common names (carpet bugle, bugle, bugleweed. The plant is also no newcomer to this continent. It had already been described as "locally naturalized" in North America nearly 100 years ago (Britton and Brown, 1913). At that time, the range was stated as: "In fields, Quebec and Maine to southern New York." Nearly 40 years later, distribution statements cited: "New Foundland to Wisconsin, south to Pennsylvania and Ohio." (Fernald, 1950), and a recent flora of more westerly scope (Brooks, 1986) merely concedes that *A. reptans*: "...occasionally escapes in the se GP [Great Plains]." This vaguely defined region may include western Missouri, Kansas, and Oklahoma. Across the continent in the Pacific Northwest, Hitchcock and Cronquist (1973) cited *A. reptans* as, "Escaped from cultivation west of the Cascade crest." In none of these citations is there a specific statement that the plant has been documented to reproduce and spread via seeds. Within our area of interest, perhaps one may speculate that the occurrence of *A. reptans* is

Fig. 1. *Ajuga reptans* inflorescences. Photo by Jahar.

likely where there is frequent gardening/landscaping activity that results in quantities of yard waste, and where someone looks for it. More populations will undoubtedly be discovered in the future.

The following description of *A. reptans* has been compiled from Fernald (1950) and Gleason and Cronquist (1991). The species is a copiously stoloniferous perennial. During most of the year, a colony of this plant is conspicuous for its glabrous leaves, which are initially dark purple changing to copper-colored and eventually dark green at maturity and are commonly crowded enough to appear to the casual observer as a loose, basal-leaved carpet of vegetation. The often persistent basal leaves are elliptic, sinuate-entire, mostly 3–7 × 1–3 cm with narrowly winged petioles 2–4 cm long. In late April to June, the 10–25 cm long erect flowering branches (Fig. 1) appear bearing verticels of usually 6 flowers axillary to sessile bracts, forming a predominantly bluish purple spike. The bracts diminish in size and take on a coppery color toward the top of the spike. The 5-toothed calyx has subequal lobes about as long as the tube. The bilabiate bluish-purple corolla is normally 12–20 mm long with the upper lip very short and the large lower lip deeply 2-cleft. The 5–8 mm long center lobe, which is spreading, may have obscure white markings in the center. The stamens are exserted from the a small cleft in the upper lip, with hairy

filaments. The ovary is lobed and matures into 4 nutlets that are laterally attached. The entire flowering spike is soon deciduous.

The recent discoveries that prompted the preparation of this report are both vouchered at MO. On 17 April 1998, I discovered a small colony of *A. reptans* (Fig. 1) in the flood plain of Gravois Creek in the City of Green Park, St. Louis County (T44N R6E, 38°31'33"N Lat., 90°19'13"W Long., elevation 452 ft; Webster Groves USGS quadrangle). Gravois Creek is a tributary of River Des Peres, which is in turn a tributary of the Mississippi River. The site is on the south side of an abandoned railroad right-of-way (which is now a part of the heavily trafficked, rails-to-trails Grant's Trail) ca. 40 m west of I-55 and a short distance along the trail from the northwest side of Green Park Road. It is on the north edge of a typical urban bottomland woods plant community. This particular population is in competition for space and sunlight with another exotic species, the more conspicuously aggressive *Lonicera mackii* (Rupr.) Maxim. (Amur honeysuckle). Recent trailside vegetation management by the park maintenance program (mowing, etc.) is suppressing competitors of *A. reptans* and inadvertently securing more open sunlit space, thus enhancing the low-lying bugle's chances of survival. Scattered litter and debris in the woods indicate that the area was used in past years for surreptitious disposal of yard and household waste, which is the likely source of the escaped plants.

On 12 August 1998, a second trailside colony along a nearby section of Grant's Trail was noted by Pat Harris (unvouchered). It is located about 120 m south of the intersection of the Trail and Green Park Road. Because of the carpet-like habit of the plant most of the year, this colony now benefits by its location on the shoulder of the trail that receives frequent mowing. This treatment suppresses vegetative competitors (grasses, forbs, and shrubs) that would otherwise grow tall and block access to sunlight. Mowing may pose a barrier to successful

flowering and fruiting. The colony currently appears to be robust and expanding via its copious stolons.

On 21 April 1998 a small colony of *A. reptans* was reported by Pat Harris. It was found in the upper reaches of a minor tributary to the Meramec River on the grounds of the Missouri Department of Conservation's Powder Valley Conservation Nature Center in Sunset Hills, St. Louis County (T44N R5E S14, 38°33'11"N Lat., 90°25'26"W Long., elevation 470 ft, Kirkwood USGS quadrangle]. The colony is under the canopy of a typical oak/hickory/sycamore woodland and is immediately downslope from residentially developed areas that are situated on the north and east uplands adjacent to the Nature Center grounds, ca. 150 m north of I-44. This colony is also likely an escape/yard waste disposal survivor from the surrounding residential properties.

The two records mentioned above that were on file previous to the findings of this report are as follows. On 6 May 1984, Michael Skinner discovered a colony at an old trailer site in Lake of the Ozarks State Park, Camden County (T38N R15W S4 SW¼, Toronto USGS quadrangle). The plants were in a "...shaded open area". A voucher specimen (*Skinner 861*) is on file at MODNR. On 12 May 1996, Stanton Hudson discovered a colony at 2610 Shady Lane, Popular Bluff, Butler County. The plants were growing as an escape in a back yard and are reported as "widespread in town and getting more so." A voucher specimen (*Hudson, 868*) is on file at MO.

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THE REINTRODUCTION OF RUNNING BUFFALO CLOVER (*TRIFOLIUM STOLONIFERUM* IN MISSOURI, 1989—1998

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Running buffalo clover, *Trifolium stoloniferum* Muhl. ex Eaton (Fabaceae), is native to eastern North America and has been documented from eastern Kansas to West Virginia (Brooks, 1983). This perennial legume was collected with some regularity from the late 1700s until the early 1900s, but very few reports occurred after 1910. In 1987, running buffalo clover was listed as an endangered species under the U.S. Endangered Species Act of 1973 (U.S. Fish and Wildlife Service, 1989). This action prompted surveys that led to the discovery of additional populations in several states within the species range.

Neither Missouri nor the adjacent states of Kansas, Arkansas, or Illinois had known extant sites for running buffalo clover when the Missouri Department of Conservation (MDC) began to consider reintroduction in 1989. Missouri has numerous tracts of public land in the southern two-thirds of the state, the region from which running buffalo clover was documented historically. These tracts provide stable ownership and long-term protection for experimental plantings. Another factor that encouraged the reintroduction was the fact that the Missouri Botanical Garden (MBG), as a participating institution in the Center for Plant Conservation (CPC), had collected cuttings and had begun propagation of clover plants from many of the extant populations in West Virginia, Kentucky, Ohio, and Indiana. Through the Department's use of federal funding, we were able to contract with MBG to increase propagation and to supply clover plants for Missouri reintroductions from 1990–1994.

A serendipitous discovery of running buffalo clover in Missouri happened in 1990, the year in which the planting began using out-of-state genetic stock. George Yatskievych, director of the Flora of Missouri Project, had a load of topsoil delivered to his residence in St. Louis for use in gardening. He procrastinated spreading the soil to the point that seeds in the topsoil germinated and grew into identifiable plants. To everyone's amazement, several plants of running buffalo clover were present. After some investigative work to track down the source of the topsoil, the source area was searched for more plants, but none were found. There were thus a few plants, and the opportunity to propagate more, of what was being considered, with some uncertainty, to be Missouri genetic stock. The Garden incorporated cuttings from these plants into their propagation program. Another independent occurrence of running buffalo clover in topsoil delivered in St. Louis came to light in 1996. A specimen sent to the Flora of Missouri Project for identification was confirmed.

EXPERIMENTAL PLANTINGS

Between 1990 and 1994, 27 experimental planting sites were established on MDC lands using plants propagated at MBG. Sites were selected that most closely matched available descriptions of historical sites as well as extant sites in other states. Most sites contained three 1 m^2 plots, each of which was planted with 16 plants. Sites typically contained plots from three different source states, but within a plot all plants originated from the same state. One half of each plot was caged with wire screen to protect the clover from rabbits, turkeys, or other herbivores. Additional plots were planted at some sites in 1993 and 1994 and some of the original plots that had failed were replanted. Plots were initially monitored for coverage of the clover, number of rooted crowns and number of flower heads produced. Coverage data was eliminated during later monitoring because the other variables were considered adequate for tracking populations. Wire cages were

removed from all plots at sites visited in 1998, because it was determined that the cages had become detrimental to the remaining plants due to shading from leaves that frequently accumulated on top of the cages.

The U.S. Forest Service's Mark Twain National Forest (USFS) planted running buffalo clover at several sites on national forest lands between 1991 and 1994 (Hickey, 1995). Plants were set out in different patterns to compare coverage success and effects of various management practices. Whereas MDC sites were planted with minimal cultivation and not managed other than in the context of the pre-existing natural community at the sites, various USFS plantings involved soil cultivation, soil amendment, weeding, mowing, grazing, and prescribed burning. We already knew that running buffalo clover could be successfully grown in cultivation. The question that MDC plantings were designed to address was: "Will the species survive and reestablish if returned to the Missouri landscape?" The only MDC planting that received cultural work was the Rockwoods Reservation site, which was established and maintained in a raised bed with an interpretive sign.

Table 1 includes a summary of data from the experimental planting sites on MDC and USFS lands. Number of rooted crowns and number of flower heads present is given for each year known. In recent years, monitoring efforts have focused on priority sites, i.e., those with greater numbers of rooted crowns and flower heads.

NATIVE POPULATIONS DISCOVERED

In the spring of 1994, a naturally-occurring population of running buffalo clover was discovered by Deborah Rowan on private land in southeastern Missouri's Madison County (Rowan, 1994). It was the first natural site known to have existed in the state since 1907, except for plants that sprouted in topsoil in St. Louis. Surveys in the vicinity of the Madison County site in 1994 (Hickey, 1994), 1996, and 1997 yielded no additional populations. In May of

1998, a second natural population was discovered by Ann Wakeman near the Gasconade River in Maries County on MDC property. This occurrence suggests that surveys in the Gasconade River basin, an area not previously searched for running buffalo clover, might result in the location of additional populations.

Genetic analysis has shown that the St. Louis plants and the Madison County plants are genetically similar to each other, and both differ from plants in other parts of the range (Crawford et al., 1996). These results help lay to rest any doubts that the St. Louis plants truly represent native Missouri genetic stock. The Madison and Maries counties' sites data are included at the bottom of Table 1.

RESULTS AND DISCUSSION

The rangewide condition of running buffalo clover is notably different today than it was in 1990 when the reintroduction effort began. Native populations have been discovered in two Missouri counties and the species has appeared twice in topsoil delivered commercially in St. Louis. The discovery of native Missouri plants provides encouragement that other populations may be discovered in the western portion of the range (i.e., Missouri, Arkansas, Illinois, Kansas). Many additional populations have been found in recent years in West Virginia, with one containing over 65,000 rooted crowns. Kentucky tracks more than 70 natural populations. Rangewide, more than 100,000 rooted crowns are known.

Had the occurrence of native Missouri genetic stock been known in 1989, we probably would not have decided to reintroduce plants from other parts of the species range. That decision was made at a time when running buffalo clover was considered extirpated from Missouri based on an unsuccessful survey in 1988 (Thurman, 1988) and no collections of the species in the previous 82 years. An advantage of planting different genetic stocks in close proximity to each other, however, is that cross-pollination can restore genetic diversity that may have been lost

through the previous isolation of populations. None of the plantings are near the natural populations, the closest being approximately 30 km distant.

Eight years after the first running buffalo clover plantings were made in Missouri, it is still not clear whether the restoration will be successful. Many of the reintroduction plots declined quickly after planting. This is not surprising because a number of factors could lead to decline at a given site, including herbivory, disease, drought, flooding, or inappropriate site conditions. The cause of the earlier decline of naturally-occurring populations, around the turn of the century, is still not known, although it has commonly been attributed to the disappearance of bison. Recent discovery of rather large populations on the Monongahela National Forest in West Virginia indicate that the bison association is not critical for the survival of running buffalo clover. Without a good theory to explain the species former decline, we can only hope that some of our multiple reintroductions will find conditions suitable to persist.

The plants at a particular planting site may take years to acclimate and reach population levels such that they can effectively spread. Several of the MDC plantings have a reasonable chance of surviving, the most notable being those at Flag Springs Conservation Area, Indian Trail Conservation Area, and Woodson K. Woods Conservation Area. Sites on USFS lands have received various cultural treatments that render them less instructive in determining whether the species will acclimate to local conditions.

Flowering heads have been produced at several sites and seedlings have been noted in some. The stoloniferous habit of the species has allowed it to grow beyond the bounds of the original planting plots, although this growth is not always associated with a net increase in number of rooted crowns. The reintroduction of running buffalo clover in Missouri will be considered a success if one or more of the plantings persist and become reestablished as part of the local flora in the years to come.

FUTURE ACTIVITIES AND RECOMMENDATIONS

No additional plantings of running buffalo clover are recommended. Existing plantings should be monitored periodically unless no living clover plants are found at the site. Natural History Regional Biologists will be enlisted to assist in periodic monitoring of planting sites in their regions. Present trends suggest that most plantings will not continue to have living plants. Management of the sites should continue to be that which would be conducted to benefit the natural community in which the plantings are located. The following activities are recommended for the next five years:

Those MDC sites that continue to persist should be monitored annually in May or June, if possible, to determine number of rooted crowns and number of flowering heads present. The number and condition of the clover at reintroduction sites will continue to be tracked using the Natural Heritage Database. As of August 1998, extant planting sites requiring future monitoring are: Caney Mountain, Davisdale North, Drury-Mincy North, Flag Spring, Huzzah, Indian Trail, Three Creeks South, White River Trace, Wilhelmina, and Woodson K. Woods.

Failed plantings will be designated as extirpated in the Missouri Natural Heritage Database. Based on 1998 or previous monitoring, the following sites are considered extirpated and are no longer a consideration in area management: Big Buffalo Creek, Clear Creek, Davisdale South, Drury Mincy-Bee Creek Ford, Drury Mincy-Bee Hive Rd., Eagle Bluffs-Bottom, Eagle Bluffs-Hill, Long Bald Natural Area, Osage Prairie, Peck Ranch, Prairie Home, Runge Conservation Nature Center, Sky Prairie, Stony Point Prairie, Three Creeks North, and Yokum Tract

Extant plantings should be protected from destruction by such activities as road, trail or fire line construction.

Timber management is compatible with the growth of this clover as long as physical destruction of the plants is avoided.

Prescribed burning that may be conducted for natural community management needs should not excluded from the planting sites.

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Table 1. Summary data on experimental plantings and native occurrences of running buffalo clover, as the number of rooted crowns/number of flowering heads per site.* Additional plantings made and some failed plots replanted at many MDC sites during 1993 & 1994. Increases from 1992 due in part to new plants.

Site Name	1990	1991	1992	1993*	1994*	1995	1996	1997	1998
MDC Sites									
Big Buffalo Creek			47/0	87/?	54/78	30/0	0/0		0/0
Caney Mountain			48/0	128/25	81/35	124/3	26/1	19/0	6/0
Clear Creek				64/0	71/?	43/0			0/0
Davisdale North			37/0	18/1	36/38	22/7	20/6	11/3	4/0
Davisdale South			48/0	36/16	59/16	25/4	0/0		0/0
Drury Mincy - BCF		37/0	?/0	75/3	76/25	25/0			0/0
Drury Mincy - BHR		38/0	?/0	83/30	66/25	41/1	0/0		0/0
Drury Mincy North			48/0	71/76	82/54	98/4	21/0	6/0	1/0
Eagle Bluffs Bottom			48/0	66/12	32/17	0/0			0/0
Eagle Bluffs Hill	12/0	?/?	45/0	27/0	43/16	11/0			0/0
Flag Spring			47/0	64/48	100/216	111/8	41/0		21/0
Huzzah			48/0	43/24	40/7	25/0	4/0		1/0
Indian Trail			48/0	50/66	60/84	129/24	75/6	72/46	14/0
Long Bald N.A.				8/0	8/31	0/0	0/0		
Osage Prairie			48/0	61/0	47/76	44/3	4/0		0/0
Peck Ranch			48/0	48/28	62/59	76/21	11/2	1/0	0/0
Prairie Home				59/0	68/56	38/0			0/0
Rockwoods Reservation (display planting)			4/0	5/13	28/50	?/17			

Table 1 (continued).

Site Name	1990	1991	1992	1993*	1994*	1995	1996	1997	1998
MDC Sites (continued)									
Runge CNC				8/0	8/12	0/0			
Sky Prairie			48/0	71/?	67/23	4/1	1/0		0/0
Stony Point Prairie			48/0	74/?	65/11	25/6	0/0		0/0
Three Creeks North			36/0	75/2	56/0	3/0	1/0		0/0
Three Creeks South			34/0	53/11	34/5	18/1	10/2		6/0
White River Trace	8/0	?/?	50/0	46/38	39/82	35/8	15/2	7/8	7/0
Wilhelmina			48/0	33/12	53/39	8/0			6/0
Woodson K. Woods			48/0	42/3	25/1	56/0	?/?	6/0	21/0
Yokum Tract			48/0	37/24	38/14	2/0			0/0
USFS Sites									
Big Branch			25/0	?/?	?/0 remaining plants removed.				
Black River				36/0	?/?	?/?	?/?	35/3	
Bright Hollow			40/0	?/?	?/? remaining plants removed.				
Buttram Hollow			24/0	2/0	0/0				
Chicken Farm			24/0	1/0	0/0				
Johnson Bottoms			24/0	6/?	3/0 remaining plants removed.				
Lone Sycamore			40/0	0/0 plantings destroyed by flooding.					
Middle River			25/0	?/?	?/?	?/?	?/?	89/0	
Misty Valley Ridge					?/?	?/?	?/?	1294/195	

Table 1 (continued).

Site Name	1990	1991	1992	1993*	1994*	1995	1996	1997	1998
USFS Sites (continued)									
Tie Slide		50/0	?/?	?/?	?/143	?/?	?/?	439/1672	
Wrinkle Springs			24/0	?/?	?/? remaining plants removed.				
NATIVE OCCURRENCES									
Privately-owned									
Cedar Bottom Woodland					72/?	81/?	199/69	81/64	32/7
MDC-owned									
Bell Chute Access									8/4

TREASURES FROM THE GREAT NORTHERN MISSOURI DESERT

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Missouri has a rich history of botanical exploration. Early explorers like Lewis and Clark made keen observations about the native flora as they traveled through the new territories, but the specimens that Lewis collected in Missouri have not survived to the present. The first plant collectors in Missouri, such as John Bradbury in 1810–1811, found their specimens mainly along the Mississippi and Missouri rivers or in the St. Louis area. Later collectors branched off into the Ozarks, the Bootheel, southwestern Missouri, and the Kansas City area. Comparatively less botanizing has been done in the northern Missouri counties away from the big rivers, with few botanists concentrating in the northern counties or, for that matter, collecting statewide. The end result is that, according to Steyermark (1963), some of the least botanized counties include several from the northeastern part of the state, such as Schuyler, Scotland, and Sullivan.

One can speculate, perhaps endlessly, why so little botanizing has been done in northern Missouri. Some might say that there is nothing up there but agriculture. Others might say that it all looks the same; that there is not the glamor of the Ozarks. Still others might know of northern Missouri's reputation for deer and turkey and figure that all the vegetation has been browsed to the ground. Such speculation is merely a superficial impression. For example, the Missouri Department of Conservation's (MDC) Northeast Region encompasses sixteen counties ranging south from Clark County to the burgeoning suburbs of Lincoln County, northwestward to Randolph County

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and north to the Iowa border in Putnam County. This region is varied in landscapes and biological diversity as it sprawls across portions of three different Natural Sections of the Glaciated Plains Natural Division: the Grand River, Eastern, and the Lincoln Hills Section (Thom and Wilson, 1980). Prior to statehood and expanded Euro-American settlement, these counties were a complex of prairies, savannas, forests, wetlands, and even some glades in the Lincoln Hills. The landscape has obviously changed since 1821, and agriculture and other human machinations have vastly reduced the extent of natural communities in northeast Missouri. However, there are still pockets of prairies, wetlands, degraded savannas, and forests, and these pockets can hold treasures. This paper will highlight some of the finds that have recently come to light.

A BOATING ADVENTURE

In late July 1998, scattered small populations of water smartweed, *Polygonum amphibium* L. var. *stipulaceum* N. Coleman, were found on Hazel Creek Lake, north of Kirksville, by John Richardson and Mike Bohon of the Fisheries Division, Missouri Department of Conservation. They did not recognize the plants and brought specimens to the author for identification. It turned out that this was a new record for a species listed as state extirpated. A second visit by the author and John Richardson in late August resulted in location of another small population, for a total of six locations with two to four plants per site. All the plants were only vegetative on both dates. Hazel Creek Lake is a water supply lake for Kirksville and was built in the early 1980s. At all locations, plants were growing in about 0.5–1.5 m of water 1.5–2.5 m from shore.

Voucher collection—**Adair County:** Hazel Creek Lake, ca. 2.5 mi N and 2 mi W of Kirksville on a county road, City of Kirksville, T63N R15W S7 SW¼ NW¼, elev. ca. 850 ft, 28 July 1998, *Anderson MO514* (MO); same locality, but T63N R16W S12 NE¼ SE¼, *Anderson MO515* (MO).

Water smartweed is in the section *Persicaria* of the widespread, mainly temperate genus *Polygonum* (Gleason and Cronquist, 1991). *Polygonum amphibium* is a rhizomatous perennial and is functionally dioecious. Flowers are arranged in 1 or 2 terminal racemes on the branches. The perianth is 4–5 mm long, with pink sepals. There are 8 stamens that are included or exserted, but are always different in length from the styles. The 2 styles are united to about the middle and are included or exserted. The fruit is a dark, glossy, lenticular achene about 2.5 mm in length (Gleason and Cronquist, 1991). Worldwide, the species is represented by three varieties: var. *amphibium*, var. *emersum* Michx., and var. *stipulaceum*. The typical var. *amphibium* is circumboreal, and in North America, occurs far to the north of Missouri. The var. *emersum* includes all of the varieties and forms that Steyermark (1963) recognized as *P. coccineum* Muhl. ex Willd. and is widespread in the state. Of the two varieties in Missouri, this is the terrestrially adapted extreme.

The third variety, var. *stipulaceum*, is the aquatically adapted extreme and had only been collected from Missouri once before, from a pond in Greene County in the 1890s. Because the variety had not been collected for about a century, it was listed as state extirpated by the Missouri Natural Heritage Program (1998). This variety has cordate leaves with the upper stems and leaves floating on the water surface, flowering only when in deeper water. The stems are up to 1(2) m in length and are rooted at the nodes. The leaves are 2–15 cm long and 1–5 cm wide. They are glabrous and long-petiolate (Gleason and Cronquist, 1991). The racemes are spiciform, cylindrical, 1.5–3 cm long, and 0.5–1.5 cm thick. Rangewide, this taxon grows from Labrador west to Alaska, south to New Jersey and west through Colorado, with additional populations in California (Steyermark, 1963).

AN OLD FRIEND REVISITED, OR STUCK IN MUCK

In July, 1998, a trip was made to a known ditchgrass (*Ruppia maritima* L. var. *rostrata* J. Agardh) site at the privately owned Spalding (Lake) Spring, Ralls County. The Spalding Spring

complex consists of one main spring and about four minor springs within a basin of less than five acres. The minor springs are visible during dry periods of the year. Two large patches of ditchgrass were found growing in a pool of shallow water supplied by a complex of saline springs. The pool was bounded on three sides by narrow-leaved cattail (*Typha angustifolia* L.), the rare introduced sheep fescue (*Festuca ovina* L.), the state-listed small spike rush (*Eleocharis parvula* (Roem. & Schult.) Link), and open mudflats. Footing was precarious, and a careless step quickly resulted in that sinking feeling.

Voucher of *Ruppia maritima*—**Ralls County:** Spalding, Spalding Spring, T56N R6W S25 NW¼ SW¼, elev. ca. 525 ft, 20 July 1998, *Anderson MO501* (MO).

Ruppia maritima L. is a cosmopolitan species in the only genus of the family Ruppiaceae. Missouri material has been determined as *Ruppia maritima* var. *rostrata* (Steyermark, 1963), although some sources do not recognize varietal or subspecies taxa for *Ruppia* (e.g., Gleason and Cronquist, 1991). Ditch grass is a submerged aquatic herb that grows in saline or brackish water. In the United States, the species commonly grows along both the Atlantic and Pacific the coasts and is scattered in the interior of the country (Gleason and Cronquist, 1991). The stems are slender and up to 8 dm in length, with either long or short internodes. The leaves are mostly alternate, but may appear opposite or tufted, and are linear, 3–10 cm long and ca. 0.5 mm. The inflorescences are small, 2-flowered, axillary spikes. The flowers are perfect, regular, hypogynous, and are without a perianth. There are 2 stamens and usually 4 pistils, although the number may vary from 2–8.An interesting feature is that the stalks of the ovaries eventually elongate as the fruits develop and the peduncle of the inflorescence commonly becomes elongated and spirally twisted (Gleason and Cronquist, 1991; Great Plains Flora Association, 1986).

Given the habitat requirements of this species, one might expect to find ditch grass in the saline springs and seeps known across the state. However, this species has only been collected

from two locations in Missouri. Once was in 1920 from a slightly sulphury lake formed by an artesian spring in Clinton, Henry County. That site has not been relocated. The second site is Spalding Spring, and specimens were collected there in 1937, 1979, and, now in 1998. *Ruppia maritima* var. *rostrata* is listed as S1, critically imperilled in the state, by the Missouri Natural Heritage Program (1998).

The Spalding site has an interesting history, but one that is probably not vastly different than a lot of the other saline springs in Missouri. Saline springs in the vicinity of Spalding were identified early in the 19th century, with salt-making at an adjacent saline spring around 1800. Salt works at Spalding springs were active later during that century. The development of a health spa based on the mineral rich spring complex was begun in 1883. A levee was built around the springs to impound the water, and a hotel and guest cabins were built nearby. Attempts were made to regulate the main spring with pipes. Eventually, the spa faded away and all that remains are foundations of a few buildings, one cabin, and some pipes around the main spring (Roland et al., 1990).

According to the current owner, a "seaweed" was introduced to the pond at some point in time. Many years later, the "seaweed" apparently became a nuisance and the levee was breached to eliminate the pest. The levee has never been repaired, and the spring complex now consists of small pools, some flowing water, mud flats, and bands of vegetation. The identity of the seaweed is not known, but it is plausible that it might have been the *Ruppia*, in which case the Spalding population might be introduced rather than a native occurrence.

WE SEEK IT HERE, WE SEEK IT THERE

Auriculate false foxglove, *Agalinis auriculata* (Michx.) S.F. Blake, is a most variable species, both in habitat and in the synonymy that it has been given. *Agalinis auriculata* is the name followed by Gleason and Cronquist (1991) but the taxon formerly was called many names, including *Gerardia auriculata* Michx. (Steyermark, 1963) and *Tomanthera auriculata* (Michx.)

Raf. (Great Plains Flora Association, 1986; Yatskievych and Turner, 1990). At any rate, auriculate false foxglove is an annual, hemiparasitic herb in the figwort family, Scrophulariaceae.

Voucher collection—**Putnam County:** Mineral Hills Conservation Area, T65N R18W S1925 W½ SW¼, elev. ca. 1030 ft, 8 Sep 1995, *Anderson MO432* (MO).

The stems of *Agalinis auriculata* are simple to sparsely branched, range from about 30–80 cm tall, and are rough-hairy with retrorse hairs and some longer spreading ones. The leaves are sessile, lanceolate, entire or basally 1- or 2-lobed, and about 2–6 cm long and 0.5–1.5 cm wide; the upper leaves are auriculate at the base. Flowers are sessile in the upper axils. The calyx is campanulate, about 10–16 mm long, and the lobes are lanceolate and longer than the tube. The lobes are usually unequal in width but equal in length. The corolla is tubular-campanulate with spreading lobes and is 20–27 mm long. It is pinkish with purple spots inside the throat. The species usually flowers from August into September (Steyermark, 1963; Great Plains Flora Association, 1986; Gleason and Cronquist, 1991). The range of auriculate false foxglove is from Kansas east to Pennsylvania, south to South Carolina and west to Arkansas. There are also populations in Iowa and Mississippi. It has also been reported from New Jersey, West Virginia, and Texas.

The remainder of this section will review the general status of the species in Missouri and discuss new populations that have been found in northeastern Missouri beginning in 1995. There are about 33 records dating from the 1860s of *Agalinis auriculata* in the state, of which 19 have been found in the past 20 years. Most of the 33 specimens have been collected in ten counties north of the Missouri River, four counties in southwest Missouri, the St. Louis metro area, and Jackson County. All of the recent records have been found in 13 counties, most of those again north of the Missouri River. Because of the small number of recent records of auriculate false foxglove, it has been listed as S2, imperiled in the state, by the Missouri Natural Heritage

Program (1998). The species was formerly a candidate for listing under the Federal Endangered Species Act. Habitat in which *A. auriculata* has been found in Missouri is very diverse, varying the floodplains of streams to eroded places in prairies, old fields, post oak thickets, and rocky slopes. The most common element in the plant's habitat seems to be some degree of disturbance.

Beginning in 1995, five new sites for auriculate false foxglove were discovered in three counties. One population consisting of 40–50 individuals was found in 1995 in the Mineral Hills Conservation Area, Putnam County, along a field road. Further investigations in 1997 resulted in the location of two additional subpopulations along the same field road, for a total of more than 80 plants between the three subpopulations. At each location, all of the plants were growing in full sunlight, with most of the plants along the edge of the road and a few directly in the road. A field check in 1998 yielded only about 20 plants at all of the sites, most of them concentrated at one location. At least a third of the plants were only vegetative. The stems seemed to be associated with groups of *Helianthus hirsutus*. Disturbance is probably provided by the annual mowing of the road.

In addition to the subpopulations of auriculate false foxglove at Mineral Hills, new populations were found at two other sites during 1997. One site was located south of Atlanta, Macon County, in a prairie remnant along an abandoned railroad right of way at the junction of Highways 63 and M. At least 53 plants were found, of which 2 were in flower and the rest in fruit. In 1998, no plants were found. At least part of the area in which the plants were originally discovered was severely disturbed this summer by salvage operations on the railroad bed.

The other population found in 1997 was at Rebels Cove Conservation Area, Putnam County, on the lower slope of an old field that had sustained a prescribed burn that spring. Well over 100 plants were counted, all in fruit or flower. In 1998, there were again more than 100 plants but spread over less area. The prescribed fire appears to have reduced competition from other plants in 1997, and the additional growth of other species

may have reduced the amount of area available for successful growth in 1998.

Two new populations were also found in 1998. The first was found on private land about 11 miles west-southwest of Kirkville, Adair County, on bare ground near a pond that was built about two years ago. There were at least 20 plants, all in fruit or flower. All of the plants were growing in a former hay field that had been planted to native species this past spring. There is a strong possibility that this might be an introduced population, because the seed mix did include a small amount of auriculate false foxglove seeds collected from the Atlanta railroad site in 1997.

The second 1998 location was near the edge of a ditch along a county gravel road about 12 miles southwest of Kirksville, Adair County. Only one plant was found at this site.

Most of the populations of *Agalinis auriculata* found in north-central Missouri in 1995 and 1997 have fluctuated in size and in location. The Mineral Hills populations have increased and decreased in numbers, the Atlanta railroad site has apparently crashed, and the Rebels Cove site has about the same abundance of stems, but the amount of area covered has decreased somewhat. Patterns like this are common with annual plants, because such species often survive adverse conditions as dormant seeds. Such adaptations allow annuals to escape in time and then rapidly exploit newly favorable conditions.

Due to the status of this species, S2, some basic questions still need to be answered to help maintain populations in Missouri. Some of the questions include: what species are suitable hosts for the hemiparasitic *Agalinis auriculata*; how long do seeds remain viable in the seed bank once they've dispersed from the parent plant; and what type and frequency of disturbance is needed to maintain populations of this species at a site.

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PANICUM VERRUCOSUM (POACEAE), NEW TO MISSOURI

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Godfrey and Wooten (1979) listed the range of *Panicum verrucosum* Muhl. (warty panicum) as Massachusetts south to Florida, west to southern Ohio, Kentucky, southern Ontario, southwestern Michigan, northwestern Indiana, Arkansas, and Texas. Gould (1975) included Oklahoma within the range of the species. Habitats given for warty panicum include wet or moist sand (Gould, 1975; Swink and Wilhelm, 1994); marshy soil (Gould, 1975); ditches (Radford et al., 1964; Godfrey and Wooten, 1979); depressions in pine savannahs or flatwoods (Radford et al., 1964; Godfrey and Wooten, 1979); as well as dried up cypress-gum ponds, spoil banks, temporary pools, borrow pits, and sloughs (Godfrey and Wooten, 1979). The species was not recorded for Missouri by Steyermark (1963), Yatskievych and Turner (1990), or Kucera (1998).

On 3 September 1998, while monitoring plant species within the sand prairies of Scott County, Missouri, a group of botanists (see specimen citation and acknowledgments) discovered a large population of this grass within a sandy depression about 6.4 kilometers (4 miles) north northeast of Blodgett, or about 6.4 kilometers southeast of Benton. The population covered an area of about 100×50 m and contained several thousand plants. *Panicum verrucosum* was associated with *Carex* spp., *Lechea mucronata* Raf., *Ludwigia alternifolia* L., *Rhexia mariana* L., *Rhus copallina* L., *Sporobolus clandestinus* (Biehler) A. Hitchc., and *Viola lanceolata* L. Interestingly, Swink and Wilhelm (1994) listed some of the same associates for populations of the species in northwestern Indiana. The following voucher information provides the first documented occurrence of this grass in Missouri:

Scott County: Unity Baptist Church Camp, ca. 4 mi NNE of Blodgett, ca. 4 mi SE of Benton; T28N R14E S27 SW¼ of NE¼ of SW¼; Thebes SW 7.5' Quad., 3 Sep 1998, *McKenzie 1838 with Jacobs, Laatsch, Smith, Summers & Yatskievych* (BRIT, LSU, MICH, MO, NCU, SEMO, UMO).

DESCRIPTION AND APPEARANCE

Godfrey and Wooten (1979) provided the following description for *Panicum verrucosum*: "Annual, generally wiry-stemmed, very variable in stature, relatively unbranched and erect growing amidst dense vegetation, much branched, sprawling and intertwining with other plants of its kind when in pure stands; slender prop roots forming on lower nodes sometimes, lower stems often decumbent and rooting at the nodes, midstem nodes well off the substrate sometimes with aerial roots. Leaf sheaths loose, commonly detached from around the stems, blades flat, variable in length from 5-20 cm long, mostly 4-8 mm wide, finely scabrous marginally; ligule fimbriate-ciliate, very short. Panicles very open and diffuse, varying a very great deal in overall dimensions, commonly very wide-spreading, the branches capillary and bearing but a few distant spikelets distally on the branchlets. Spikelets obovate, about 2 mm long; first glume short-ovate, less than 1 mm long, not nerved, obtuse apically; second glume and sterile lemma equal, obovate, obtuse apically, their outer surfaces dotted with wartlike tubercles."

The open, diffuse panicles, wiry culms, and often sprawling, decumbent habit of this species is somewhat suggestive of *P. hians* Ell., which also occurs in identical or similar habitats in the Missouri Bootheel. *Panicum verrucosum* can be distinguished easily from *P. hians*, however, by its wider leaf blades, by its verrucose (warty) spikelets, and by its annual habit. The only other North American species of *Panicum* that potentially could be confused with this species is *P. brachyanthum* Steud. (pimple panicum), which has spikelets that are tuberculate-hispid (hairy with expanded blisterlike bases on the hairs) rather than

verrucose. Missouri botanists and grass enthusiasts should be aware that *P. brachyanthum* has been documented in Arkansas and Oklahoma (Gould, 1975) and might possibly be discovered in Missouri in the future.

ECOLOGICAL REQUIREMENTS

Panicum verrucosum is a native species that apparently is adapted to various types and levels of disturbance. In commenting on the habitat requirements of the species, Godfrey and Wooten (1979) stated, "commonly pioneering and forming nearly pure stands on shores of ponds, lakes, streams, exposed during periods of low water; similarly frequently in moist to wet places of much mechanical soil disturbance or after fires." It is not known if the persistence of the species at the discovery site has been due to periodic fires or disturbance associated with various farming activities. Given the species' overall range, its tolerance of disturbed habitats, and the extensive field work undertaken within the sand prairies of the Missouri Bootheel within the last nine years, it is somewhat suprising that warty panicum had not previously been discovered in the state.

DISCUSSION

The discovery of *P. verrucosum* within the sand prairie region of the Missouri Bootheel follows the pattern of several other native coastal-plain disjuncts that have been documented in this area. Since the initial field investigations of Richard Carter and Charles Bryson in 1990 (Carter and Bryson, 1991), the following new state record taxa have been recorded within the sand prairies of Mississippi, New Madrid, Pemiscott, and Scott counties: *Aristida desmantha* Trin. ex Rupr. (McKenzie, 1995), *Carex longii* Mack., *Carya pallida* (Ashe) Engl. & Graebn. (Smith, 1994), *Cyperus grayoides* Muhl. (Carter and Bryson, 1991), *Cyperus hystricinus* Fernald (Holmes, 1995), *Cyperus retroflexus* Buckley (Carter and Bryson, 1991), and *Xyris jupicai* Rich. (Holmes, 1995).

In addition to the above-mentioned first state records, populations of other state-listed taxa previously thought to be restricted to other areas of the state recently have been discovered in this botanically rich region. These include *Aristida lanosa* Muhl. ex Ell., *Chamaesyce geyeri* (Engelm.) Small, *Cyperus plukenetii* Fernald, *Cyperus retrofractus* (L.) Torr., *Echinodorus tenellus* (Mart.) Buchenau var. *parvulus* (Engelm.) Fassett, *Hedyotis boscii* DC., *Hedyotis uniflora* (L.) Lam., *Paspalum bifidum* (Bertol.) Nash (McKenzie 1994), *Schoenoplectus hallii* (A. Gray) S.G. Sm., and *Stylisma pickeringii* (Torr.) A. Gray var. *pattersonii* (Gerneck & B.G. Schub.) Myint.

The discovery of yet another native species within the sand prairies of the Missouri Bootheel further highlights the wealth of botanical diversity of this region of the state, and the desperate need to protect and properly manage unique sand prairie communities. In commenting on the extensive threats to this biologically and botanically rich region of the state, Holmes (1995) pleaded, "Yet locating and describing these sites accomplishes little unless some method of protection is found to guarantee their continued existence. The challenge now is to ensure that future generations will be able to enjoy, and learn from, the variety of natural features described in this report." It is extremely unfortunate, however, that her pleas have gone unanswered as currently no sand prairie sites have been protected in the Missouri Bootheel. The acquisition, management, and restoration of these communities should be a high priority for all public agencies, given the responsibility of conserving our state's precious natural heritage. Only then will we ensure that the many treasures contained within these unique communities are preserved and maintained for all future generations to enjoy.

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CASTANEA MOLLISSIMA IN SOUTHWEST MISSOURI

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The genus *Castanea* (Fagaceae) has been represented in Missouri by two species, *C. dentata* (Marshall) Borkh. and *C. pumila* (L.) Mill. (Yatskievych and Turner, 1990). Arguments persist concerning whether the latter taxon best represents two conspecific varieties (Johnson, 1988) or two segregate species (Nixon, 1997). Since the chestnut blight introduction in the early 1900s, efforts have been made to introduce into the United States exotic species of chestnut (e.g., Spanish chestnut, *C. sativa* Mill.; and Japanese chestnut, *C. crenata* Sieb. & Zucc.) and blight-resistant hybrids of *C. dentata* (Nixon 1997).

In late 1997, a couple of puzzling chestnut trees were observed in rural Christian County. Attention was initially drawn to the mature plants, because they superficially resembled *Castanea dentata*, and were seemingly unaffected by the chestnut blight. A more critical examination of collected specimens could not be determined with confidence as *C. dentata*. Kevin Nixon (Cornell University), a leading Fagaceae authority, was consulted, and found a specimen to be consistent with *C. mollissima* Blume, the Chinese chestnut. *Castanea mollissima* is a commonly cultivated, introduced species native to China and immune to the chestnut blight (Rehder, 1947). Steyermark (1963) gives general mention to the planting of this ornamental species, but gives no specific reference of any naturalization in Missouri.

Collections were made of the two trees that are separated by approximately 10 m in distance. They were growing on private property in a former creek bed, adjacent to an oak-hickory forest. Occupying the area since the early 1960s, the owner had not planted the trees. During a visit in the fall of 1998, a core sample was taken from the largest tree. It is estimated to be 21–23 years old, and its establishment thus postdates the present owner's occupancy of the area. Both trees were freely fruiting at the time of collection. Seed viability is unknown at this time.

Presumably escaping cultivation, these trees appear to represent a naturalization of Chinese chestnut in Southern Missouri. More careful reconnaissance work in the area may uncover additional populations of this species. The authors know of plantings of *Castanea mollissima* as close as Springfield (Greene Co.).

Castanea mollissima and *C. dentata* are, in general, similar in appearance, thus distinguishing characteristics between the two taxa are not outwardly evident. Key characters for *C. mollissima* include the presence of spreading hairs on the twigs, an abaxial cobwebby pubescence on the leaf blades, and lack of foliar glands, whereas twigs and lower leaf surfaces are generally glabrous in *C. dentata*, with large foliar glands present. Both taxa have three fruits per four-valved cupule. However, the beaks on the fruits of *C. mollissima* are shorter than those of *C. dentata* (yet longer than *C. ozarkensis* and *C. pumila*).

Vouchers of *Castanea mollissima*—**Christian County:** Highlandville, in old creek bed, 1997, *Parker* s.n. (SMS, BH). Highlandville, east of Route 160, private property off Forest Drive, in former creek bed next to oak forest and open field, abundant fruit, 16 Oct 1998, *Padgett & Parker 631* (SMS, MO).

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TYSON RESEARCH QUARRY/GLADE PROJECT: PREPARING A HABITAT FOR THE INTRODUCTION OF THE EASTERN COLLARED LIZARD

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Washington University Tyson Research Center is located in western St. Louis County, Missouri, on the north side of Interstate 44. The research center is bordered on the east and west by Lone Elk County Park and West Tyson County Park, respectively. To the north lies the Meramec River and Castlewood State Park, and to the south lies the Interstate, Forest 44 Conservation Area, and Beaumont Scout Ranch. Together these parks with Tyson form 3,035 hectares (7,500 acres) of "green space" unfragmented by development, other than I-44. The Tyson property is 795 hectares (1,960 acres), encircled by an 2.5 m (8 ft) chain-link fence with some of the property outside of the fenced area. The land is characterized by steeply sloped karst topography with a cherty overlay. Several springs and sink holes are found on Tyson, as well as some small cave-like openings. One large valley bisects Tyson from south to north following Tyson Creek to the Meramec River. Man-made ponds distributed throughout Tyson provide additional aquatic habitats for the abundant wildlife.

Tyson is dominated by upland, oak-hickory forest and associated plants. The forest comprises 85% of the total area. The forests situated on south- and west-facing slopes are or were mostly savannas. Meadows exist in low-lying areas, especially bordering Tyson Creek and on the south side of the research center adjacent to I-44. Two limestone glades in the southwest corner are now filled in by eastern red cedar (*Juniperus virginiana* L.) and other woody plants.

Evidence of human history at Tyson precedes European settlement. Native Americans quarried flint/chert from the south- and west-facing slopes of Tyson, West Tyson, and Beaumont

Scout Ranch prior to 1400 A.D. Many of these quarries can still be found today. More recent history reflects, in the main, land usage typical of the area. From 1897–1927 the Hunkins-Willis Mining Company quarried limestone on the northern edge of the property. Two quarry sites on facing ridgetops, and foundations from homes and buildings in the intervening hollow, are all that remain of the mining operation and its village of Mincke Hollow. We assume that the rest of the land was farmed and grazed in the valleys, and timbered on the hillsides. In 1941, the U.S. Army confiscated the property from landowners and built the Tyson Valley Powder Plant. Small arms ammunition was stored in the 52 igloo-style bunkers still standing today. The army continued to occupy the property up until 1950, when it was conveyed to the St. Louis County park system. It was re-confiscated in 1951 at the onset of the Korean War and remained in Army possession until part of the land was conveyed to Washington University in 1963. Most of the army's impact on the land was confined to the main valley along Tyson Creek, the perimeter road, and the quarry, where tracer bullets were tested. During the Korean War, the army introduced elk and bison, which roamed and grazed freely throughout the property. The herd was eliminated when its size caused overgrazing to become a problem. Since Washington University's ownership, land management has leaned toward that of a wildlife refuge with as little interference as possible with natural processes.

In 1994, the managers at Tyson decided to introduce the eastern collared lizard to the research center. The eastern collared lizard (*Crotaphytus collaris collaris* Say) is found on limestone, dolomite, igneous, and sandstone glades in Missouri. Individual lizards set up territories with basking areas and fend off other intruders. Their diet consists of grasshoppers, beetles, moths, spiders, small snakes, and lizards (Johnson, 1987). Washington University faculty and students have studied the population biology of collared lizards since 1960 in Jefferson County and elsewhere. Populations have declined at many sites since that time. Introduction of the lizards to Tyson would provide a nearby study site for Washington University faculty and students to continue their investigations. The area would also be protected from the increased poaching of reptiles from

other glade sites in Missouri. Before introducing the lizards, two problems had to be addressed: 1) choosing a site on the research center appropriate to the collared lizard's requirements; 2) preparing the site for the introduction.

The two existing glades at Tyson were rejected because they were overgrown and no longer provided the sunny, southern exposures the lizards require. Restoration of these glades was not feasible due to the degree of overgrowth and the relative remoteness of the sites. The eastern quarry area (Figs. 1, 2), an alternate site, provided an open southern to southwestern exposure. Earlier attempts to introduce collared lizards at the western quarry site had failed, probably to be due to insufficient food. A similar lack of food at the eastern quarry site would also be a problem, but a solvable one with proper management. A presumumption by the managers was that by increasing the amount of plants growing on the exposed quarry floor, desirable insects would move in and multiply to sufficient quantities to support the collared lizards.

We had to decide which plants would thrive at the site to provide food for the necessary insects, and what preparations were necessary to enhance plant survival. The southwestern exposure of the quarry, the limestone substrate, and shallow soils most closely matched the characteristics of some of the glades in nearby Jefferson and Franklin counties. We used Valley View Glades Natural Area as a well-studied model, and compiled a list of plants to introduce to the quarry. Plant introduction would be by hand-broadcasting seed over the area. The final seed mix ratio decided on was 50% grasses and 50% forbs (Table 1). Seeds were purchased from Missouri Wildflowers Nursery, near Jefferson City. All the forb seed was collected in Missouri. The grass seed was from locales outside of Missouri. Species of plants that had already been found on Tyson were given priority, then species on glades in St. Louis County, and finally, species found at Valley View Glades.

QUARRY SITE DESCRIPTION AND HISTORY

Tyson quarry is a wide, long shelf that follows the contour of the hill. Limestone was blasted away from the hillside with

Table 1. List of seeds purchased from Missouri Wildflowers Nursery and sown at Tyson quarry. The list includes percentage of total mix for each species. Nomenclature follows that of Yatskievych and Turner (1990).

Species	Common Name	Proportion of Seed Mix
Allium stellatum	wild onion	2.5%
Amorpha canescens	lead plant	2.5%
Bouteloua curtipendula	sideoats grama	20.0%
Coreopsis lanceolata	tickseed coreopsis	12.5%
Dalea candida	white prairie clover	2.5%
Dalea purpurea	purple paririe clover	2.5%
Echinacea pallida	pale purple coneflower	2.5%
Eryngium yuccafolium	rattlesnake master	2.5%
Liatris aspera	rough blazing star	2.5%
Liatris scariosa	tall blazing star	2.5%
Oenothera macrocarpa	Missouri evening primrose	2.5%
Rudbeckia missouriensis	Missouri coneflower	12.5%
Schizachyrium scoparium	little bluestem	20.0%
Silphium terebinthinaceum	prairie dock	0.3%
Sporobolus heterolepis	prairie dropseed	10.0%

dynamite, leaving behind a 35 m cliff face on the uphill side and tailings on the downslope. The quarry floor is at an elevation of 160–165 m above sea level. Above the cliff, the hill continues upward to 207–210 m above sea level and is covered with oak-hickory forest. Below, the trees had been cleared from the valley, according to William Barnes, a former resident of the village of Mincke Hollow (pers. comm. to Tyson staff). These trees have since been replaced through succeession by lowland tree species such as sycamore (*Platanus occidentalis* L.), American elm (*Ulmus americana* L.), and pawpaw (*Asimina triloba* (L.) Dunal). Toward the eastern end of the quarry is a mining tunnel with three entrances. Outside the first tunnel entrance are the remains of an army loading dock. Beyond the third tunnel entrance is a former firing range used to test tracer bullets. A road goes up to the quarry from Mincke Hollow, dividing the bed of the quarry along its longitudinal axis (Fig. 1). On the southeastern side of the quarry, the road ends at the first tunnel entrance. At the northwestern end, the road turns northeast just before the fence line and joins the perimeter road.

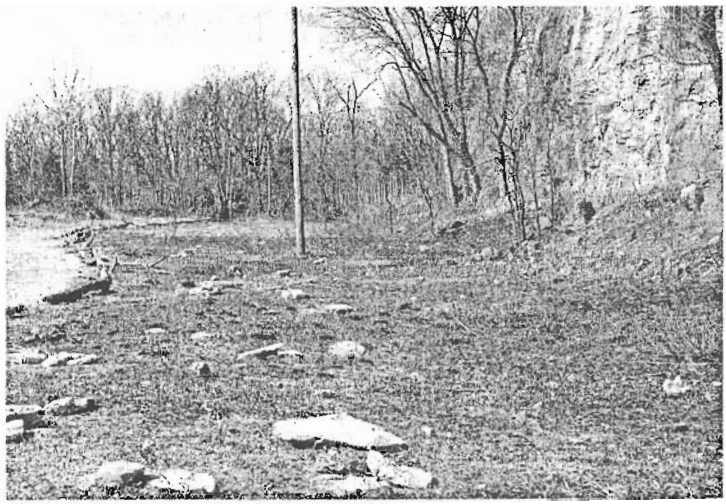

Fig. 1. View of quarry study site looking north from near the tunnel entrance. Photograph taken April 1996, one week after burning. The cliff is on the right.

The perimeter fence at this end of the quarry is on the edge of a bluff overlooking the Meramec River.

The quarry floor is flat with little gradient. Most of the floor is exposed bedrock with areas where eroded soil from above has accumulated. The soil is 1.2–1.8 m deep against the cliff face, thinning out to 2–3 inches toward the middle of the floor. The bedrock floor, the cliff face, and the tunnel are all part of a thick layer of late Ordovician Kimmswick limestone (Depke, 1973). Soil samples were collected from four places along the cliff side of the road. This soil sample was sent to the University of Missouri Extension for analysis. The results showed an expected pH of 7.6. The sample was found to be low in potassium and magnesium, very low in phosphorus, and very high in calcium.

From 1877–1927 the Hunkins-Willis Mining Company quarried limestone on land leased from the Mincke family. The quarry was located on what is now the north side of Tyson Research Center. The mining company established a village to house the miners and their families. Foundations of the miner's homes, a school, and other buildings can still be found today. The village was named after the landowner—Mincke Hollow.

Fig. 2. View of quarry study site looking south from near the tunnel entrance. Photo taken November 1994, the year before seeds were sown in the quarry. The cliff is on the left.

Remnants of the kilns used to process the limestone can be found at the north end of the valley or hollow where the mining company operated. Just north of the kilns and just outside the Tyson fence, the St. Louis and San Francisco Railway picked up the processed limestone and delivered it to the Portland Cement Company in St. Louis. This stopping site was know as Mincke Station. In 1907, this quarry was one of the largest in the state and the equipment that Hunkins-Willis used was considered "state of the art" at the time (Buehler, 1907).

Using dynamite, the mining company blasted limestone away from the hillside. The rock was broken into smaller sizes with sledge hammers before being added to the kiln for firing. Towards of the end of the lease period, miners began tunneling directly into the hillside. The remaining tunnel is a shallow cavern, approximately 0.7 hectare (300×250 ft) in size. Most

of the unused limestone rubble was dumped over the hillside. One large pile of rubble forms a hill on one side of the quarry floor and is encircled by a turn-around loop of the road. Toward the eastern end of the quarry, beginning at the first tunnel entrance, large blocks of unbroken limestone remain behind. Other remains of the quarry operation include a concrete cistern on the southwestern edge of the quarry and metal artifacts such as cables, drill bits, and rails from the mining car tracks. Evidence of drilling can be seen in the cliff face and in the mining tunnel.

Later, during the army occupation, the quarry was used to test tracer bullets. The mining tunnel was used for storage of some ammunition, jeeps, and trucks. At the southeastern end of the quarry remnants of the firing range can be found, including the firing platform and the viewing hut. Part of a loading dock remains outside the first tunnel entrance. It is covered with big bluestem (*Andropogon gerardii* Vitman). An electrical line runs through the middle of the quarry bed, parallel to the road.

Today, the quarry is used by the Field Science Program at Tyson for educational purposes. The road up to the quarry gives school bus loads of students access to the area to learn about Missouri geology and mining. Students also visit the quarry tunnel/cavern to view and learn about hibernating bats. The tunnel is home to endangered gray bat colonies in the summer and hibernating big brown bats in the winter.

SITE PREPARATION

The actual study site for collared lizards and plant introduction is bounded by the road on the south-southwest, the cliff on the northeast, the first tunnel opening on the east, and the perimeter fence on the northwest of the quarry. Before introducing plants to the quarry, we had to make some initial preparations. First, the Tyson staff cleared trees and brush from the area to increase the amount of sunlight. Although the quarry was not overgrown with trees, some species, including American elm (*Ulmus americana*), northern hackberry (*Celtis occidentalis* L.), and eastern red cedar (*Juniperus virginiana*) could be found

growing on the quarry floor. The staff at Tyson cut out most of the trees along the cliff face, in the quarry bed, on the rubble hill, and along the outer edge of the hillside. Those trees left behind were too large and too close to the electrical line to be removed safely without professional help. Troop 868 of the Girl Scout Council of Greater St. Louis helped haul brush from the quarry floor. They piled some of the brush to create habitat for insects, rodents, lizards, and snakes. The rest of the brush was hauled to sites outside the perimeter of the quarry. After the brush removal, the areas covered by soil were raked out, removing organic matter and exposing the soil surface for seed sowing.

To create basking sites for the collared lizards, large concrete slabs leftover from highway construction, and the discarded slate tops of lab-tables from Washington University were set out on the quarry floor. A bed of coarse sand 3–8 inches thick was laid under the "basking platforms" for the lizards to dig and hide under. In addition to basking areas, maintenance personnel built a "hibernaculum" against the cliff face to promote a hibernating area for the collared lizards and other reptiles living in the quarry.

Seed purchased from Missouri Wildflowers Nursery was hand-broadcast on a raked soil surface on 22 March 1995. The seed was mixed with sand and peat to promote even distribution. Grasses and forbs were broadcasted separately. The seed was carefully strewn in areas where the soil base was at least 2–3 inches deep. Three-fourths of the seed was distributed along the cliff side of the road. The remainder was filtered in the soil areas at the base of the hill in the turn-around area. Rain during the next week helped bind the seed to the soil. The first seedlings to germinate were observed toward the end of May 1995. They included: pale purple cone flower (*Echinacea pallida* (Nutt.) Nutt.), Missouri primrose (*Oenothera macrocarpa* Nutt.), tickseed coreopsis (*Coreopsis lanceolata* L.), and prairie dock (*Silphium terebinthinaceum* Jacq.). Grass seedlings were difficult to discern from existing grasses and therefore success of germination was not determined until two years later when grasses were large enough to be identified.

Table 2. Additional potted plants and seeds added after intial sowing. Numbers in parentheses indicate the number of plants introduced.

Plants	Seeds
Asclepias tuberosa (9)	*Echinacea simulata*
Carex meadii (4)	*Liatris aspera*
Coreopsis lanceolata (5)	*Schyizachyrium scoparium*
Coreopsis palmata (5)	*Silphium laciniatum*
Liatris pycnostachya (3)	*Sorghastrum nutans*
Manfreda viginica (3)	
Oenothera macrocarpa (3)	
Penstemon digitalis (3)	

Additional potted plants were added to the study site after the first germinating seedlings appeared (Table 2). The only plant not added at this time was finger coreopsis (*Coreopsis palmata* Nutt.), which was added in the spring of 1998. Rough blazing star (*Liatris aspera* Michx.) and compass plant (*Silphium laciniatum* L.) seeds were added in small quantities in the fall of 1995. Seed of little bluestem (*Schizachyrium scoparium* (Michx.) Nash) and pale purple cone flower (*Echinacea simulata* McGregor) from a local ecotype obtained from the Shaw Arboretum, was sown around the base of the rubble hill in the spring of 1996. Seed collected in 1995 from a colony of Indian grass (*Sorghastrum nutans* (L.) Nash) growing in the quarry beyond the study site was sown in the spring of 1996 (Table 2).

After the first seedlings appeared, we began identifying the other existing plants in the study site (Table 3). Although this list is incomplete we did find some significant prairie/glade species. Toward the loading dock end of the site a small colony of native big bluestem (*Andropogon gerardii*) was well established. Since the beginning of the project, this colony has spread to the opposite (north) end of the quarry. In some places the big bluestem is very thick and stands 1.5 m tall. Other existing prairie grasses include Canada wild rye (*Elymus canadensis* L.) and rough dropseed (*Sporobolus asper* (Michx.) Kunth). Both tickseed coreopsis (*Coreopsis lanceolata* and grayhead prairie coneflower (*Ratibida pinnata* (Bent.) Barnhart) were present in small patches. The deer have kept the *Ratibida pinnata* clipped and it does not bloom every year. Wild petunia

Table 3. Incomplete list of plants existing at Tyson quarry prior to sowing seed in the spring 1995. Nomenclature follows Yatskievych and Turner (1990).

Grasses	
Andropogon gerardii	big bluestem
Bromus japonicus	Japanese brome
Bromus pubescens	Canada brome
Bromus tectorum	downy chess
Dichanthelium oligosanthes var. *scribnerianum*	a panic grass
Elymus canadensis	Cananda wild rye
Eragrostis spectabilis	purple love grass
Paspalum pubiflorum var. *glabrum*	a bead grass
Poa pratensis	Kentucky bluegrass
Setaria pumila	yellow foxtail
Sporobolus asper	rough dropseed
Sorghastrum nutans	Indian grass
Tridens flavus	purpletop
Forbs	
Achillea millefolium	yarrow
Ailanthus altissima	tree of heaven
Allium stellatum	wild onion
Androsace occidentalis	western rock jasmine
Aster patens	spreading aster
Brickellia eupatorioides	false boneset
Celtis sp.	hackberry
Cercis canadensis	eastern redbud
Cirsium vulgare	bull thistle
Coreopsis lanceolata	tickseed coreopsis
Draba verna	vernal whitlow grass
Erigeron strigosus	daisy fleabane
Geranium carolinianum	Carolina cranesbill
Hedyotis nigricans	narrow-leaved bluets
Heliopsis helianthoides	ox-eye
Lepidium virginicum	pepper grass
Lonicera maackii	bush honeysuckle
Monarda bradburiana	beebalm
Medicago lupulina	black medick
Melilotus albus-	hite sweet clover
Parthenocissus quinquefolia	Virginia creeper
Penstemon pallidus	pale beardtongue
Plantago aristata	bracted plantain
Plantago virginica	hoary plantain
Phlox pilosa	prairie phlox
Ratibida pinnata	grayhead prairie coneflower

Table 3 (continued).

Forbs (continued)	
Rhamnus caroliniana	Carolina buckthorn
Rhus aromatica	aromatic sumac
Ruellia humilis	wild petunia
Solanum carolinense var. *carolinense*	horse nettle
Symphoricarpos orbiculatus	coral berry
Teucrium canadense var. *canadense*	wood sage
Toxicodendron radicans	poison ivy
Tradescantia ohioensis	spiderwort
Tragopogon dubius	goat's beard
Trichostema brachiatum	false pennyroyal
Triodanis perfoliata	Venus' looking glass
Ulmus americana	American elm
Verbascum thapsus	mullein
Verbena simplex	narrow-leaved vervain
Viola rafinesquii	Johnny-jump-up

(*Ruellia humilis* Nutt.) is abundant throughout the quarry. Many of the of the plants growing in the shallow soils are typically found in waste or disturbed areas.

SITE MAINTENANCE

Once the seeds were introduced to the quarry, logs from cut trees were placed along the cliff side of the road to discourage foot traffic over the seed bed. Other maintenance included removal of exotic plant species and prescribed burning. At the outset, tree of heaven (*Ailanthus altissima* (Mill.) Swingle) proved to be the most difficult exotic plant to eradicate. Herbicide applications were initially inconsistent and not applied with the best method. The present procedure is to treat freshly cut stems with Pathway herbicide. This method has proven relatively successful in eliminating *Ailanthus altissima*. We also had a thick crop of bull thistle (*Cirsium vulgare* (Savi) Ten.), growing right out of the bedrock. Staff and volunteers spent two days removing flower- and seed-heads with loppers and pruning shears. The seed-heads were carefully placed in bags and disposed of off-site. This method of removal seems to work. Most of the thistle is gone, with very few new rosettes

appearing. Other plants to be removed in the future include: Amur honeysuckle (*Lonicera maackii* (Rupr.) Maxim.), white sweet clover (*Melilotus albus* Medic.), Kentucky bluegrasse (*Poa pratensis* L.), and mullein (*Verbascum thapsus* L.). These plants are not as plentiful and will be controlled using a combination of pulling by hand and herbicides.

We have burned the quarry floor twice, in March 1996 and early April 1998. The first fire burned out repeatedly due to the low fuel load. Plant growth appeared to be lush after the burn. Summer heat and drought, however, took their toll and the lushness was less noticeable by August. We did get a second year of germination from the sown seed, even after the fire. This year (1998), the fire burned more evenly because of the increased amount of grasses, which substantially boosted the fuel load for the fire. The plant growth across the quarry is very thick and has remained so due to rain throughout the summer.

OBSERVATIONS AND CONCLUSIONS

Since the first sowing of seed in March 1995, the biomass of plant material in the quarry appears to have increased greatly. The number of grasshoppers has also visually increased. Although these observations are not quantitative, we feel that we are achieving the goals of increased numbers of plants and hence insects. The introduction of collared lizards is on hold at this time. One factor we did not take fully into account is the seasonality of certain insect populations. From early spring until midsummer the insects' presence is less noticeable, i.e., many are in juvenile stages and are too small to observe. They are also too small to provide sufficient food for collared lizards emerging from hibernation in April. We may have to introduce insect species that overwinter as adults to provide food from lizard emergence time until midsummer.

With the plants, our greatest success has been the increase in the grass cover. In addition to big bluestem, both sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), little bluestem, and Indian grass have taken hold and are flowering and reseeding. Burning may have facilitated the success of the grasses, if the

lushness of grass growth after each burn is an indication. The forbs have been less successful. Although germination appeared to be good, both in the spring of 1995 and after the burn in 1996, the seedlings disappeared when the hot, dry weather started in June. The thin soil became too dry to support the forbs. Some species did make it. Tickseed coreopsis bloomed in 1997 and Missouri coneflower (*Rudbeckia missouriensis* Engelm.) in 1998. Other forbs that germinated may still be hanging on, but cannot be seen. Most of the potted plant introductions also did not succeed. The large root base in these plants may have prevented them from surviving the heat and drought period.

Future plans include more seed/plant introductions. These introductions will concentrate on the Asclepiadaceae and Fabaceae families, both of which are underrepresented in the quarry flora and are significant food plants for many insects. In order to improve the survival of these plants, fall sowing or planting may prove to be a better method. Plants will receive more water from fall and spring rains and become better established. Heaving and thawing in the winter may work seed deeper in the soil so that germinating seed may have deeper roots.

Removal of exotics and other woody plants will be an on-going maintenance effort. Finally, we may withhold prescribed burning for a few more years in order to allow organic matter to accumulate and add to the soil base. The shade of the grasses early in the season can "nurse" any emerging seedlings along by slowing the evaporation of moisture from the soils.

ACKNOWLEDGMENTS

I wish to thank the many people who helped on the project from the beginning to the present. First, and foremost, I thank Dr. Richard W. Coles, who planned and initiated the project. Second thanks goes to the Tyson maintenance staff, Ross Vollmar, Bob Lewis, Dave Schilling and Angelo Oldani, for removing trees and brush, and applying herbicide to the tree of heaven. Joyce Duncan and Girl Scout Troop 868 were a

tremendous help in hauling brush away from the quarry. I appreciate Joe Smentowski and Earl Biffle for donating their time in brush removal and herbicide treatment of tree of heaven, respectively. Janice Starke—thanks for editing the paper. Finally, thanks to Dr. Owen J. Sexton for taking over the project, encouraging my efforts, and commenting on this paper.

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HIGHLIGHTS OF MISSOURI FIELD BOTANY (1997–1998)

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The Natural History Section of the Missouri Department of Conservation annually compiles a document called the Wildlife Diversity Report (Figg, 1992; Figg, 1993; Figg and Priddy, 1994; Figg and Bessken, 1995; Figg and Davit, 1997; Davit, 1999). A section of that report entitled "Highlights of Field Biology" describes important discoveries of Missouri plants and animals that were made during the past year. The flora section of that report is reproduced here, with minor alteration, in order to reach a wider readership of persons interested in Missouri's flora. I hope that these highlights can be reported in *Missouriensis* annually and will inspire readers to further study of our flora, which continues to provide surprises to the close observer. This brief listing is not intended to replace the reporting of new state record species or other significant discoveries that merit a more detailed account in this or other journals.

NATIVE PLANTS

Acalypha deamii (Weath.) H.E. Ahles, large seeded mercury (Euphorbiaceae).—A native species for which we previously had only historical records was relocated by George Yatskievych in Pike County. George reports that other collections (St. Louis County) also exist from the 1990s.

Aconitum uncinatum L., wild monkshood (Ranunculaceae).—A new state record, discovered during a Natural History Section field exercise at the Jerry J. Presley Education Center, Shannon County, in September 1997 (Summers, 1997). Bill Summers returned to the area in September 1998 and found a few additional nearby locations.

Carex longii Mack., a sedge (Cyperaceae).—A Missouri state record sedge recently reported by Dr. Anton A. Reznicek (University of Michigan) from a 1992 collection by Stanley D. Jones, a Texan, from a sandy depression in Scott County.

Carex willdenowii Schkuhr ex Willd., a sedge (Cyperaceae).—A new state record, discovered by Bill Summers in Reynolds County (Mark Twain National Forest) (Summers, 1997).

Geocarpon minimum Mack., geocarpon (Caryophyllaceae).—A new site that is a new county record was found in Henry County by Dr. Jay Raveill and Dr. Belshe (both of Central Missouri State University) on a sandstone glade on U.S. Army Corps of Engineers land near Truman Lake. This is the northernmost occurrence known for the species.

Hypericum adpressum Barton, a St. John's wort (Clusiaceae).—Previously documented from Missouri by only two 1933 collections from sandy prairies in Bootheel counties. Bill summers and George Yatskievych collected a specimen from a sand praire swale in Scott County in September 1998, proving that is it not extirpated from the state.

Lesquerella filiformis Rollins, Missouri bladderpod (Brassicaceae).—An additional population was discovered in the spring of 1998 at Nathan Boone State Historic Site in Greene County. This find is important, because it adds to the populations in public ownership and those managed (by Missouri Department of Natural Resources) to maintain Missouri bladderpod.

Panicum verrucosum Muhl., warty panic grass (Poaceae).—A new state record for Missouri, discovered by Paul McKenzie and others in September 1998 on a privately owned sand prairie in Scott County (see more information elsewhere in this issue).

Polygonum amphibian L. var. *stipulaceum* N. Coleman, water smartweed (Polygonaceae).—A species not seen since the 1890s, and then only in a pond in Greene County, was discovered at

Hazel Creek Lake, Adair County, in July 1998. Previously listed as extirpated from Missouri, *P. amphibian* var. *stipulaceum* was found floating in several locations near the lakeshore (see more information elsewhere in this issue).

Ruppia maritima L. var. *rostrata* J. Agardh, ditchgrass (Ruppiaceae).—Ditchgrass has only been collected from two locations in Missouri, in Henry and Ralls counties. The Henry County population was last seen in 1938, and the site has not been relocated since. Specimens were originally collected from the Ralls County site in 1937 and again in 1979. Craig Anderson visited the site in the summer of 1998 and found a robust and healthy population still present (see more information elsewhere in this issue).

Sacciolepis striata (L.) Nash, American cupscale (Poaceae). —The third station in Missouri for this perennial grass was discovered by Paul McKenzie and others along a pond margin in Scott County.

Trifolium stoloniferum Muhl. ex Eat., running buffalo clover (Fabaceae).—Ann Wakeman located the second naturally occurring site for this federally endangered plant in May 1998. The Maries County site on the banks of the Gasconade River points to another region where future surveys may be productive (see more information elsewhere in this issue).

INTRODUCED PLANTS

Akebia quinata (Houtt.) Dcne., akebia (Lardizabalaceae).—A new record for Missouri, this woody vine was discovered by Stephen Timme in Barton County at Lester R. Davis Memorial Forest (Timme, 1997).

Ammoselinum butleri (Engelm. ex S. Watson) Coult. & Rose, sand parsley (Apiaceae).—A new record for Missouri, Discovered by Stanton Hudson in Butler County (Poplar Bluff). Subsequently, a second site was discovered by Bill Summers and

George Yatskievych in Pemiscot County (Carruthersville). This plant is native to Texas, Oklahoma, and southern Arkansas.

Cynanchum nigrum (L.) Pers., black swallow-wort (Asclepiadaceae).—A new record for Missouri, this herbaceous perennial vine native to Europe was discovered by Randy Walker in Adair County (Kirksville).

Cyperus difformis L., (Cyperaceae).—A new record for Missouri. A native of the Old World tropics, this sedge was col-lected by Rhett Johnson in a fallow field along the Missouri River in Carroll County (see more information elsewhere in this issue).

Rhodotypos scandens (Thunb.) Makino, jetbead (Rosaceae).—A new state record. Native to China and Japan, this shrub is used in ornamental landscaping. It was discovered as an escape from cultivation by Bill Summers in Emmenegger Park, St. Louis County. Subsequent plants were collected as escapes in Forest Park, city of St. Louis, by Alan Brant.

Sporobolus pyramidatus (Lam.) A.S. Hitchc., whorled dropseed (Poaceae).—Native from South America north to Kansas and Colorado, this grass had not been documented from Missouri since 1896 until found by Brad Jacobs in Boone County in September 1998.

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ANNOUNCEMENTS

Copies of plant lists and other information relating to the flora are requested for inclusion in the Society's flora file. Please send items to the archivist, Jim Bogler (see address on inside front cover).

Visit the MONPS Web Site at its new address:

www.missouri.edu/~umo-herb/monps

BOOK REVIEWS

Kucera, Clair L. 1998. The Grasses of Missouri, revised edition. University of Missouri Press. ix, 305 pp. $34.95 (ISBN 0-8262-1164-X). Paperbound.

The revision of Clair Kucera's *Grasses of Missouri* was published this summer by the University of Missouri Press. A lot has changed since the original was published in 1961. This book updates nomenclature and includes all additions to the flora since the first edition. It provides species accounts for 273 species and 3 hybrids, keys, glossary, index, and a short section on grass terminology. It is small and light enough to be taken into the field with little trouble. The book appears to be well constructed with the text and drawings sharp and clear. Most of the drawings, though, are not new and many are only partial depictions of the species.

The biggest complaint I had with the book was the price. At $34.95, it seemed overpriced for a paperbound book of this size. Also, I think it would have benefited from the addition of range maps. The author states that they were not included to conserve space. I would gladly carry a few extra pages in the field to have that information available. Updated county range maps would facilitate the collection of new county record vouchers.

Several of the species accounts could have benefited from additional information. Some species are more likely to be found vegetatively than in flower. *Calamagrostis porteri* ssp. *insperata*, for example, flowers so infrequently that it wasn't collected for many years, but can be recognized vegetatively with practice. More discussion of species not seen in many years also would have been useful.

All in all, this book's usefulness outweighs any weaknesses. As the only comprehensive guide to Missouri grasses presently available, it should be in the field pack of every student of Missouri's flora.

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Harris, James G., and Melinda Wolf Harris. 1994. Plant Identification Terminology. An Illustrated Glossary. Spring Lake Publishing, P.O. Box 266, Payson UT 84651, ix, 196 pp., 1733 illus. $ 17.95 (ISBN 0-9640221-5-X). Paperbound.

A common complaint of plant enthusiasts is the bewildering array of strange and confusing terms in plant literature. This is especially true for people without formal botany training who become deeply involved in botanical or horticultural activity and must use technical literature.

Botanical terminology, because of the need to be precise and unambiguous, is unique and involves many unfamiliar terms. Descriptions of minute differences in hairiness, color, shape, and anatomy must convey exactly the same meaning to the describer as to the interpreter of the description. Thus a formalized and, to an outsider, arcane terminology has evolved. Attempts to simplify this terminology typically cause more problems than they alleviate. It is not axiomatic that plant science should involve few complicated terms, any more than it would be desirable for physicians to forgo their lexicon of precise and elegantly adapted terminology, which is equivalently confusing to the uninitiated. In each case, the demands of the subject impose descriptive requirements that limit simplified generic terminology.

What is needed is a bridge facilitating access to this terminology. *Plant Identification Terminology*, by James and Melinda Harris, accomplishes this task without requiring special training or insulting the intelligence of more experienced readers. This unassuming little paperback is a profusely illustrated glossary of nearly 2,500 botanical terms widely employed in field botany and botanical descriptions. The book is constructed with the unwavering intent of clearly and simply describing the terminology required to make plant literature accessible. Concise synoptic definitions are largely rendered in everyday terminology and more than 1,700 clear pen and ink illustrations.

The bulk of the book, comprising the first two thirds, is an illustrated dictionary of descriptive plant terminology. Attempts

are made to keep the illustrations on the same page as the relevant descriptions, and where necessary to insure this, illustrations have been repeated at some points in the book—a handy adaptation facilitating usability. The last third of the book is a category by category collection of terminology for related topics or concepts, such as leaf morphology and inflorescence types. All of the terms illustrated and defined here are included in the main alphabetical listings in the first part of the book, but it is often helpful to see, for instance, all the leaf shapes named and illustrated in a single section. This type of redundancy, so helpful to the user, is often foolishly precluded by publishers obsessed with space efficiency without regard to the ultimate use of the product. It is refreshing to see a publisher willing to produce a more user oriented product.

As the authors point out in the foreword, there has always been a strong historical component to descriptive botany. As the culture and language have evolved, inevitably so also have the definitions of certain terms. Rather than attempt to codify these terms with an absolute meaning filtered through the mold of contemporary culture, the authors have instead wisely presented the spectrum of definitions for such terms. In this manner, the work is rendered useful for accessing the historical literature which is so rich and compellingly relevant for botanical work.

As with any work attempting to coalesce and distinguish among a complex array of terminology, there are some areas that are vague or not mutually exclusive. For example, some of the leaf apex figures on p. 136 (Figs. 1391a, b) are confusing. There is insufficient distinction among the illustrations for acuminate, aristulate, and mucronate, and these are further obfuscated by different venation patterns on the imaginary leaves used as illustration points. The figure should utilize analogous venation patterns for all the leaves illustrated, and insure that aristulate tips are illustrated as awn-like, and not the broad based apices of acuminate leaves. There are a few similar minor points, but these are trivial wrinkles that do not compromise the overall work, and could easily be improved in a future edition.

At The Nature Conservancy here in Missouri, we have provided this book to our field vegetation crews, and it has increased their access to technical keys, as well as making them

more enthusiastic about using these keys. It has also improved their descriptive abilities when making notes about unknown taxa, or writing descriptive features while studying herbarium sheets. Thoroughly understanding the terminology induces greater understanding of and familiarity with the organisms themselves.

This book effectively navigates the universe of descriptive plant terminology from Accumbent to Zygomorphic, with thousands of interim stops at terms like Dissepiment, Multiparous, Sterigma, and Tridynamous. Students and advanced amateurs in particular will find it an indispensable tool to facilitate access to the rich literature of plant information. Professional botanists and ecologists will use it perhaps less frequently, but with equally gratifying results. This is a useful, thoughtfully prepared work that belongs near at hand for every land manager, field biologist, and plant enthusiast. Spring Lake Publishing is to be commended for keeping the price reasonable and producing an eminently useable work.

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