

CURRENT EVIDENCE
OF TALL-GRASS PRAIRIE REMNANTS
IN SOUTHWESTERN MICHIGAN

Thesis for the Degree of M. S.
MICHIGAN STATE UNIVERSITY
Edward Martin Scharrer
1971

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ABSTRACT

CURRENT EVIDENCE OF TALL-GRASS PRAIRIE REMNANTS IN SOUTHWESTERN MICHIGAN

By

Edward Martin Scharrer

A survey of the prairie flora and "prairies" in southwestern Michigan, which were thought to have vanished or be limited to disturbed sites, showed that the flora is still present in great variety (68 species). Sites containing at least a large number (11 or more) of prairie species have an aspect of a "prairie" and are rightly called such. "Prairies" on undisturbed sites are suggested criteria for referring to these sites as "remnants" of virgin (original) prairie. At least 50 "remnants" are suggested. Many sites (294) with 1-10 prairie species may similarly warrant the title of "remnant". Additional studies are suggested to verify the proposed characteristics of the "prairies" and "remnants" of tall-grass prairie in Michigan.

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IN SOUTHWESTERN MICHIGAN

By

Edward Martin Scharrer

A THESIS

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DEDICATION

TO CAROL

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INTRODUCTION

MICHIGAN TALL-GRASS PRAIRIE - THE PROBLEM

The presence of patches of tall-grass prairie vegetation (Fig. 1) influenced New England settlers to make their home in southwestern Michigan. Colorful descriptions of the settlers' impressions of the prairies and oak openings (summarized in a recent thesis by Peters, 1969) are plentiful in Michigan's historical literature.

For example, Larman in 1871 (Bingham, 1945) wrote:

"...trees, chiefly white oak (and probably bur oak), 10-60 feet apart and extending for miles like cultivated parks; sweeping to a clear stream, a fertile prairie, a brow of a transparent lake impress one with the idea he is traveling through an old rather than a newly-settled country. The openings constitute a feature which distinguishes this from most of the adjoining states. The surface of the oak openings also presents a turf of matted grass, which requires three or four yoke of oxen to break it up. You can ride for miles in a carriage under the trees that are thus widely separated".

The interrelated questions of origin and persistence of the prairies in Michigan have been discussed for more than a century (summarized recently by Benninghoff, 1961) but without full agreement. It is assumed by most that their origin and establishment resulted from a generally less humid, and perhaps warmer, climatic period during Holocene time. The persistence of these relict communities under the present climate, which favors deciduous forest, suggests a high degree of internal stability. However, post-settlement influences such as fire protection, agriculture and the introduction of non-native plant species has led to the general deterioration of the Michigan prairie.

Figure 1. Recorded tall-grass prairie relicts
in Michigan. (After Veatch, 1928; Kenoyer,
1930, 1934, 1940)

Veatch (1928) recorded sizes of pre-settlement prairies from 80 acres to 25 square miles comprising a total of about 80,000 acres. Butler (1947, 1948, 1949) described 58 prairies, some less than a hundred to a maximum of 13,000 acres (Prairie Ronde near Schoolcraft, Kalamazoo, County).

Recent workers on the prairies in Michigan recorded the following approximately 150 years after settlement began:

Robinson (1969): "With the exception of minute fragments along railroad rights-of-way, in uncultivable corners of farmsteads, and in pioneer cemeteries, virgin prairie plants (virgin prairie surfaces) are non-existent in the state today".

Brewer (1966): "Wet prairie is rare in southwestern Michigan, even relative to drier prairie....."

Hayes (1964): "Most plants indicative of the dry or mesic prairies such as Sporobolus heterolepis, Bouteloua curtipendula, Amorpha canescens, and Coreopsis palmata are no longer found in Michigan, or are found only along railroad tracks, road sides, or in abandoned weedy fields".

Hauser (1953): "Most of them (prairies) are now difficult to recognize because they have been farmed continuously since the arrival of the earliest settlers and because most surrounding forest has been cleared. In Michigan, at least, it is probably safe to say that no virgin prairies now exist".

Hanes (in Butler, 1947): "...several of these so-called prairie grasses are still scattered throughout the county (Kalamazoo) on wood borders, on roadsides, and in fence rows, and on the right-of-way of our railroads;...in some rural cemeteries, remnants of the prairie flora still persist. The prairie violet, Viola pedatifida, a rare species in Michigan, has been found in Harrison Cemetery in Prairie Ronde (township)".

Darlington (1945): "Some of the (prairie) species have undoubtedly been pushed back to the borders of swamps and railroad rights-of-way, while others have possibly suffered extinction".

Kenoyer (1934): "Unfortunately, the flora of the southwestern Michigan dry prairies has been almost destroyed by tillage. It includes Eryngium yuccifolium, Cacalia tuberosa, Silphium terebinthinaceum, Amorpha canescens, Asclepias verticillata, Petalostemum purpureum, Viola pedata, Hypoxis hirsuta, and Sisyrinchium albidum".

Veatch (1928): "Practically all the prairie land is in use at the present time for agricultural purposes.... The land was broken up for farming at an early period and it is fairly certain no virgin prairie land exists at present".

From these evaluations it is not surprising that it is generally not known that Michigan once had "grasslands". According to the above workers, whatever prairie Michigan did have has all but vanished. However, the recent studies (though few) by Brewer (1965) and Pokora (1968) in southwestern Michigan, suggest additional prairies may be found through a comprehensive survey.

The primary objective of this study was to document the present day extent and condition of tall-grass prairie remnants in southwestern Michigan. This objective necessitates criteria for identifying remnants and therefore criteria for definition of prairie species. The secondary objectives were to list the prairie species, determine and document their distribution, and to describe the prairie communities in southwestern Michigan.

MICHIGAN TALL-GRASS PRAIRIE - LITERATURE SUMMARY

Other than observations of settlers, the earliest descriptions of Michigan prairie were taxonomic. Cole (1901) listed 32 species for "oak openings" and 15 species for "the prairie", in the vicinity of Grand Rapids. Beal (1904) listed 12 species "peculiar to the prairie region of the southwestern portion of the state". Pepon (1907) described the flora of southwestern Michigan (Berrien, Cass and Van Buren counties), but he mentions few prairie species. Darlington (1945) listed five species.

The first ecological work was by Gleason (1917). Out of 27 species found in a prairie near Ann Arbor, he classified 18 into wet or dry prairie species and nine as bog, swamp or lakeshore species. He adds, "...the almost complete absence of shrubs, the dominance of grasses, and the level topography combine to give it a strong resemblance to a hydrophytic prairie of northern Illinois. Indeed, it may be assumed that this represents a relict colony of prairie plants, persisting from a time when prairies occupied a wide extent in southern Michigan...".

Veatch (1928) outlined 40 prairies in Michigan based on the location of the deep, dark, Warsaw Loam, and described four phases based on slight textural variations and variations in thickness of separate horizons. In four papers (1930, 1934, 1940, 1943) Kenoyer described the areal extent of the vegetation associations in southwestern Michigan (which included prairie) using land-survey records. Butler (1947, 1948, 1949) used historical literature to describe 58 prairies (by name) at the time of settlement.

Floras by Hebert (1934, Berrien County), Bingham (1945, Oakland County), and Hanes and Hanes (1947, Kalamazoo County; with geographic

and ecological annotations) include prairie species, but do not include a prairie list per se.

Hauser's (1953) study of the sand prairies of Newaygo County was the first major ecological study of Michigan's prairies. He described features such as geology, pedology, and climate, and measured frequency and cover in the vegetation. The relationships of these prairies to other prairies was also discussed. He recorded 25 prairie species that were present in Newaygo prairies and 11 that were not.

Recently, several ecological studies of wet prairies have been published, most from the southeastern part of Michigan and adjacent Canada. Hayes (1964) described a wet prairie on Harsen's Island in the St. Clair River. A quadrat and transect study showed this prairie to be similar to the wet prairie of Wisconsin and attributes the persistence of this prairie to flooding and burning. Hayes feels that the high frequencies and density of Habenaria leucophaea, Andropogon gerardii, A. scoparius, Panicum virgatum, and Sorghastrum nutans provide the best evidence of former prairie areas in Michigan. Rogers (1966) provides a list of species from a wet prairie near Windsor, Ontario. He also suggested that the origin of this site was due to the post glacial xerothermic period and that it persisted due to disturbance of burning and cutting. Thompson (1970) reported a wet prairie along the Huron River, Ann Arbor, suggesting that it is a prairie relic.

Brewer (1965), in one of two published studies of a prairie community in southwestern Michigan, described composition and several structural characteristics of a wet prairie site. One of the characteristics is species occurrence. He described five distributions in a Kalamazoo wet prairie: a) "...typical wet prairie species in the

sense that they are more likely to be found in this community than in any other, at least in southern Michigan. Such species include Aster novae-angliae, Gentiana andrewsii, Pycnanthemum virginianum, Solidago ohioensis, S. riddellii, Spartina pectinacea, and Vernonia fasciculata";

b) "...widespread in prairies but probably have higher presence values in less hydric ones.....such as Andropogon gerardii, A. scoparius, and Sorghastrum nutans"; c) "...species, each occurring on a variety of wetlands; of which wet prairie is one.....Eupatorium maculatum, Gentiana procera, Iris versicolor and Thelypteris palustris"; d) "...common species in a variety of open situations.....Achillea millifolium, Comandra umbellata, Fragaria virginiana, Melilotus alba, and Monarda fistulosa"; and e) "...widely distributed and here represent members of a potential successional stage.....Populus deltoides and Cornus racemosa".

A second character Brewer examined was pattern as it applies to spatial distributions and interspecific association. He found Apocynum androsaemifolium, Eryngium yuccifolium, Fragaria virginiana, Solidago canadensis, and Andropogon gerardii tending toward aggregation. Results of tests for association were largely inconclusive but suggested a positive association between Geranium maculatum and Fragaria virginiana and between G. maculatum and Cicuta maculata.

Pokora (1968) made a phenologic study of the plants in a sand prairie in Van Buren County.

Robinson (1969) summarized the factors which contribute to prairie persistence in Michigan; and described the interrelationships between climate, soil, moisture, landforms and prairie vegetation.

NORTH AMERICAN PRAIRIE

The North American prairie extended from Mexico northward to Manitoba, and from the forest margins of Indiana and Wisconsin, to the Dakotas and central Kansas. This was the prairie. Westward, an even more extensive but drier and more sparse grassland extended to the Rocky Mountains. This is the Great Plains (Weaver 1954).

Texts by Weaver (1954, 1968), Malin (1967), and Costello (1969) describe the history of and research on the tall-grass prairie. The main features of this vast prairie are the dominance of grasses, the paucity of shrubs, the absence of trees, except along rivers and streams and a characteristic drought-enduring flora. The prairie is a closed community due to a 3-6 inch deep layer of roots and rhizomes forming a dense sod. Also, the perennial nature of most species and a high degree of vegetative reproduction is characteristic of prairie vegetation (Weaver 1954).

A prairie classification into tall-, mixed-, and short- grass species had been implied by Pounds and Clements (1898), based on studies in Nebraska, a state which contained all three grassland types. The tall-grasses in the east blend into the mixed and short grasses toward the west as elevation increases and precipitation decreases. Tall-, mixed-, short-grass and other types of prairies are described by Weaver and Clements (1938). The major dominants of the tall-grass prairie are Andropogon gerardii and Sorghastrum nutans, which often attain a height of 6-8 feet. With these, occurring more or less abundantly, are Andropogon scoparius, Elymus canadensis, Panicum virgatum, and less frequently, Stipa spartea and Sporobolus asper.

The eastward extension of the tall-grass prairie (Prairie Peninsula) is described in detail by Transeau (1935). He lists 16 possible explanations for 21 observations (problems) of the Prairie Peninsula. These problems concern distribution boundaries of prairie and deciduous forest vegetation or species, such as the southern and southwestern boundary of the northeastern conifers. A second category of problems is the presence or absence of certain types of vegetation in the Peninsula, and to the north, east, or south of it, such as prairie clusters and bog or forest associations. Thirdly, he considers the problems of distribution of prairie vegetation on several kinds of soils, topography and along moisture gradients. Fourthly, the general dominance, stability, and persistence of tall-grass prairie in nine states is unaccountable from only microclimatic and edaphic factors.

Transeau suggested climatic, biological and edaphic factors that may have an important influence on the formation of the Prairie Peninsula including all the problems mentioned above, especially the distribution of prairie species. Under climate, for example, he states that the annual and seasonal precipitation-evaporation ratios are undoubtedly lower in the Prairie Peninsula than in the adjoining forest regions both north and east. Second, the midsummer relative humidity is certainly lower in the Peninsula than north or south. Third, the precipitation of the prairie region occurs largely during the growing season. Fourth, the precipitation in successive months is more irregular in the tall-grass prairie, including the Peninsula, than in the mixed forests north and south. Fifth, the distribution of precipitation in successive years varies more in the prairie than in the northern forested region, and

sixth, precipitation is notably irregular in its areal distribution on the Prairie Peninsula.

Transeau suggested that mature and immature soils may well define local tension lines between different plant communities, but that they cannot differentially effect prairie and forest except in a prairie climate. He also suggested that prairie grass communities preceded prairieerths.

Finally, the biological factors suggested are first, that tall prairie grasses once established exclude forest seedlings both by shading and, during the annual droughts, by superior utilization of available water in the deeper layers of the soil. Second; fires favor the persistence of prairie species in contrast to tree species. Third, extreme drought marked by lower precipitation, higher evaporation, higher temperatures and more intense light can change vegetation more in a few years than a century of favorable weather conditions.

One of Transeau's observations is, "...the occurrence of a distinctive prairie flora and isolated typical prairie communities as far east as northwestern Pennsylvania, as far north as central Wisconsin and Michigan, and as far south as Kentucky and Tennessee" (Fig. 2).

The most detailed description of the tall-grass prairies in the prairie-forest border States is by Curtis (1959). He defines the prairie in this ecotone as "an open area covered by low-growing plants, dominated by grasslike species of which at least one-half are true grasses, and with less than one mature tree per acre", and the areas are prairie "only if they are located south of the tension zone" (a narrow band which separates Wisconsin into two floristic provinces, this zone is also present in Minnesota, Michigan and Ohio but varies in width).

Figure 2. Tall-Grass Prairie in the U.S.
(Transeau, 1935)



Using the species-presence method, the relict prairies in Wisconsin were divided into five units along a moisture gradient (Curtis and Greene 1949). They also compiled a list of ten indicator species for each unit as well as a list of prevalent species. The list of indicator species are given in Table 1.

From the work at the University of Wisconsin, much is known about the composition, structure, and environment of xeric, mesic, and lowland prairies in the prairie-forest border. A summary of these characteristics will follow from Curtis' Vegetation of Wisconsin 1959, pp. 268-292.

Composition characteristics of the prairie segments (units) include, a) the prevalent species, as ranked in order of decreasing presence, to the number of average species density. For example, species such as Amorpha canescens, Andropogon scoparius, Bouteloua curtipendula, Petalostemum purpureum, and Aster sericeus are most prevalent in dry prairies; Aster laevis, Desmodium illinoense, Eryngium yuccifolium, Silphium laciniatum, and Solidago speciosa for mesic prairies; and Aster novae-angliae, Hypoxis hirsuta, Spartina pectinacea, and Silphium terebinthinaceum for lowland prairies; b) importance values (determined by multiplying the average frequency of a species by their presence) illustrate the extreme importance of a relatively few species in contrast to the relative frequency of the major portion of the total flora. For example, in xeric prairies, out of 223 species, 10 had values over 2000, whereas 90 had values less than 1. The importance values are similar for mesic species; c) floristic analyses show Compositae, Gramineae, and Leguminosae as the three top families in all three segments; d) phenology studies showed some distinct differences between prairie and

Table 1. Indicator species for five segments of prairie gradient.
After Curtis (1959) p. 266.

Wet prairie species

Aster novae-angliae
Calamagrostis canadensis
Hypoxis hirsuta
Oxypolis rigidior
Pycnanthemum virginianum
Solidago gigantea
Spartina pectinacea
Thalictrum dasycarpum
Veronicastrum virginicum
Zizia aurea

Dry-mesic species

Anemone cylindrica
Asclepias verticillata
Helianthus occidentalis
Linium sulcatum
Panicum oligosanthos
Petalostemum candidum
Potentilla arguta
Scutellaria leonardi
Sporobolus heterolepis
Stipa spartea

Wet-mesic species

Cicuta maculata
Desmodium canadensis
Dodecatheon meadia
Fragaria virginiana
Galium boreale
Helianthus grosserserratus
Heuchera richardsonii
Lathyrus venosus
Phlox pilosa
Rudbeckia hirta

Dry species

Andropogon scoparius
Anemone patens
Arenaria stricta
Artemisia caudata
Aster ptarmicoides
Aster sericeus
Bouteloua curtipendula
Panicum perlongum
Petalostemum purpureum
Solidago nemoralis

Mesic species

Aster laevis
Ceanothus americanum
Cirsium discolor
Desmodium illinoense
Eryngium yuccifolium
Helianthus laetiflorus
Liatris aspera
Panicum leibergii
Ratibida pinnata
Solidago missouriensis

forest. Whereas 70% of the flora is in flower before June 15 in mesic forests, in prairie only one-third of the flora blooms in the spring, the greatest number in the summer, and one-fourth flowers after August 15. The spring flora in the various segments of the prairie bloom consecutively later due to extended time needed for the soil to warm up. There was also a positive correlation between flowering date and average height of the species; e) homogeneity tests revealed the highest indexes for xeric prairies (70.3), lowest for wet prairie (56.3). One factor which contributes to the lack of spacial homogeneity is the varying moisture supply caused by slight differences in microrelief; f) geographical variations were noted in each segment. For example, in mesic prairies, Liatris spicata and Allium cernuum are limited to the poorly drained upland soils in two counties; and g) soil microfungi are described for mesic and lowland prairies.

Structural characteristics include: a) rare species of low frequency greatly outnumber the common species of high frequency in xeric and mesic stands, a character expected in any community; b) certain aspects of spatial distribution are more pronounced in the prairie than in the forest. For example, the phenomenon of aggregation, which is obscured in the forest, is very conspicuous in the prairie since there are no trees, saplings, or shrubs. Due to the problem of what constitutes a countable or measurable unit in a grassland, Anderson (p. 275) devised a measure of aggregation based upon the ratio of frequency as determined by large (1 square meter) quadrats to frequency as determined by 16 small quadrats located within each quadrat, the range being from 1 for highest and 16 for lowest aggregation. The full range of spatial patterning was found in all prairie units. In the dry

prairies, the most aggregated were Asclepias verticillata, Helianthus occidentalis, H. laetiflorus, Geum triflorum and Commandra richardsiana all with ratios of 3.0 or less. The least aggregated or non-aggregated species with ratios of 9.0 or more include annuals as Ambrosia artemesifolia, Erigeron strigosus, biennials as Lobelia spicata and single-stemmed, perennials with no apparent means of vegetative spread as Psorlea esculenta and Anemone patens. The aggregated and non-aggregated species for mesic prairies are given in Table 2. Of the aggregated species only Phlox pilosa has no means of vegetative increase. Certain species as Asclepias syriaca and Euphorbia corollata spread by rhizomes, but the clones are not distinguishable by the sampling method emphasized. The aggregated species greatly exceeded in number those which approached randomness and gave the prairie an over-all appearance of patchwork; c) several aggregated species are suspected of producing antibiotic substances e.g., (Helianthus laetiflorus, H. occidentalis, Coreopsis palmata, and Antennaria neglecta) and some species produce autotoxins also (both Helianthus species).

Lastly, environmental characteristics include topography, soil and macroclimate. The xeric prairie remnants in Wisconsin occur on steep hillsides, usually sloping towards the southwest. Despite the characteristically lower water storage capacity of the soil, combined with the greater insolation and higher wind velocities (due to exposure), the prairie vegetation is luxuriant on xeric sites. The probable explanation is that significant quantities of water are obtained from condensation rather than precipitation.

The mesic prairies are on flat or rolling landforms. The level sites are frequently on glacial outwash with a stratified and very

Table 2. Aggregation of mesic prairie plants. After Curtis 1959, p. 281.

Species	Indices of aggregation		
	D/d (1)	A/F (2)	F/f (16:1) (3)
<u>Aggregated species</u>			
<i>Helianthus laetiflorus</i>	9.38	0.35	14.48
<i>H. occidentalis</i>	24.02	1.74	14.25
<i>Galium boreale</i>	11.60	8.08	14.43
<i>Coreopsis palmata</i>	15.03	0.58	10.00
<i>Antennaria neglecta</i>	20.50	7.23	12.31
<i>Phlox pilosa</i>	11.53	0.85	12.91
<i>Aster ericoides</i>	11.65	0.34	12.04
<i>A. laevis</i>	2.99	0.39	9.42
<u>Random species</u>			
<i>Polytaenia nuttallii</i>	1.35	0.17	
<i>Eryngium yuccifolium</i>	1.28	0.07	10.00
<i>Desmodium illinoense</i>	1.23	0.15	9.31
<i>Ambrosia artemesifolia</i>	2.31	0.08	5.80
<i>Potentilla arguta</i>	2.19	0.21	4.98
<i>Lactuca biennis</i>			1.59
<i>Asclepias syriaca</i>	1.75	0.11	
<i>Cirsium discolor</i>	1.41	0.09	

(1) D/d - Ratio of actual density to expected density for random distribution. Random=1.0

(2) A/F - Ratio of abundance to frequency. Random=0.02

(3) F/f - Ratio of frequency in large quadrats to frequency in 16 small, included quadrats. Random=16.0

porous subsoil of sand and gravel while the undulating sites may have glacial till or loess soils. The black topsoil on mesic sites is very rich in nutrients, and high organic matter content contributes to favorable water-retaining capacities. Macroclimate (or phenological) studies revealed that the growing season in the prairie begins two to three weeks earlier than in the hardwood forests. In the prairie, killing frosts occur sooner in the autumn, but many species are frost resistant (asters, gentians).

Moist prairies are usually found on lowlands subject to inundation by heavy rains and by floodwaters. In midsummer high moisture and high temperature are reflected in lush and rapid growth. The top layers of soil frequently approach a peat in structure, with a very high content of partially decomposed organic matter derived from the fibrous grass remains.

ORIGIN OF THE TALL-GRASS PRAIRIE

The origin of the tall-grass prairie in Michigan has stimulated speculation since the land was settled in the 1820's. The problem is not yet resolved, however several theories have been advanced.

Most seem to agree that the isolated communities are relicts of a more extensive prairie which migrated into Michigan from the midwest during a warmer and drier climatic period (xerothermic period). Some prairies thus established remained as relicts after further change toward a more humid climate and invasion of the deciduous forest. These relicts persisted until the time of settlement when most became occupied for agricultural purposes.

The principal differences in opinion reside in the order of events in which prairie and forest vegetation became established in post-glacial (holocene) time. Benninghof (1961), Braun (1928), Veatch (1928) and Schmidt (1938) suggest evidence favoring an early holocene prairie advance. Using the following geoseral stages of Sears (1942); Spruce-Fir, Pine-Spruce, Pine, Pine-Oak, Hardwoods-Oak, Oak-Hickory, and Oak-Hardwoods, Benninghof (1961) described pollen analyses which showed non-arboreal pollen in large percentages (20-100%) in the Spruce-Fir stage, which drops to about 5% before Pine dominance. Secondly, beech (Fagus) and hemlock (Tsuga) pollen was present in southern Michigan before it appeared in northern Indiana. The earlier records in Michigan indicate the trees were already present or migrated from the east suggesting that the Prairie Peninsula was a barrier to plant migration.

Braun (1928), using floristic evidence from Ohio, suggested two prairie advances, one early post-glacial (post Wisconsin) and the other

pre-Illinoian. The evidence she suggests is the presence of prairie vegetation on non-glaciated areas.

Veatch (1928), writing of the prairie-formed Warsaw Loam, "the thickness of the humus horizon indicates age", called the soil mature and found "no evidence of a degraded forest soil".

Schmidt (in Benninghoff 1961) concluded that certain amphibians and reptiles achieved their present ranges by using the Prairie Peninsula as a migration route because it was relatively free of animal life.

Transeau (1935) suggested that the advance was late post-glacial during an expanded period of drought, "indicated by bog pollen studies, by soil profiles, by the succession in bog profiles, by the absence or rare occurrence of many tree, shrub and herbaceous species from the region of the Peninsula, and by the present distribution of prairie colonies and prairie species".

Most workers feel that the xerothermic period was the cause of the advance of the prairie, but Benninghoff (1961) cites evidence to show this theory is questionable. He indicates "...we need more evidence, and in greater variety, to indicate in more detail the nature of this fluctuation and associated climatic changes".

Other theories on the origin of the Prairie Peninsula such as fire, grazing, evaporation-rainfall ratios, and soil drainage or glacial lake drainage do not consider post-glacial history. However, these environmental and biological factors probably account for the invasion of prairie vegetation locally, the origin of certain types of prairie, and collectively for the persistence of the flora.

METHODS

Rationale

Originally, the method for determining the status of relict prairies was to search out and examine those previously recorded. However, early visits to a few recorded sites in Kalamazoo County, showed few of the expected prairie species to be present. At the time, a prairie by prairie search appeared to be fruitless and this method was abandoned. Instead a prairie flora survey on a large scale was adopted.

Since sites with a history of little or no soil disturbance have yielded the best examples of prairie vegetation, railroad rights-of-way were selected as the sites to survey. These locations are, or at least have been in the past, frequently burned and/or cut, factors which probably favor the persistence of a prairie flora.

Study Area

The survey was to include the Counties of Berrien, Cass, St. Joseph, Branch, Calhoun, Kalamazoo, and Van Buren in which most of the original prairies were recorded. These counties contain the major portion of the Prairie Peninsula as defined by Transeau (1935). Some counties in part or entirely outside of the Peninsula were also surveyed to determine the presence of prairie species away from major original prairies. Thus Jackson and Hillsdale Counties were also included.

Survey Methods

During the summer and fall of 1969, from June 18 to October 4, almost all railroad grade crossings were systematically surveyed for prairie species in the nine southwestern Michigan counties. In order to

cover this much area, only presence data were obtained. At each crossing, both sides of the track and road were checked and the species recorded. The tracks between crossings were surveyed by vehicle when a road or lane was available. When one or more prairie species were spotted, the area was surveyed in more detail on foot. Other sites such as roadsides, cemeteries, and abandoned fields were included in the survey when prairie species were recognized. Forth-two trips were taken encompassing over 700 miles.

Early in the study much collecting was done at each crossing (hereafter referred to as a "site" whether prairie plants were present or absent). Unknown species were identified using Fernald (1950), and Gleason and Cronquist (1963), and all species were checked for prairie distribution. Later in the study, trips to the restored prairies at the Morton Arboretum, Lisle, Illinois and the guidance of Mr. Ray Schulenberg, provided additional training for recognition of the prairie flora. Also, a list of prairie species from the Arboretum (Schulenberg, 1968) became the basic source for selecting prairie species for Michigan. As the study progressed, less time was needed for collecting and more for surveying.

In all, 158 species were recorded for presence during the survey. Deciding which species were prairie species was a problem. Only 68 species were chosen as representing the prairie flora and will be discussed from this survey. These 68 are listed in Table 3. They were selected as prairie species for one of the following reasons: a) they appeared on the Morton Arboretum restored prairie list, b) they have been cited by authorities (manuals or prairie authors) as prairie species, and c) the species was found only with other prairie species. All

Table 3. List of prairie species in southwestern Michigan - Summer and Fall, 1969.

Prairie Species	Family
<i>Allium cernuum</i> Roth.	Liliaceae
<i>Amorpha canescens</i> Pursh.	Fabaceae
<i>Andropogon gerardii</i> Vitm.	Poaceae
<i>Andropogon scoparius</i> Michx.	Poaceae
<i>Anemone cylindrica</i> Gray	Ranunculaceae
<i>Asclepias amplexicaulis</i> Sm.	Asclepiadaceae
<i>Asclepias tuberosa</i> L.	Asclepiadaceae
<i>Asclepias verticillata</i> L.	Asclepiadaceae
<i>Asclepias viridiflora</i> Raf.	Asclepiadaceae
<i>Aster azureus</i> Lindl.	Compositae
<i>Aster ericoides</i> L.	Compositae
<i>Aster laevis</i> L.	Compositae
<i>Aster sericeus</i> L.	Compositae
<i>Baptisia leucantha</i> T. & G.	Fabaceae
<i>Cacalia atriplicifolia</i> L.	Compositae
<i>Carex bicknellii</i> Britt.	Cyperaceae
<i>Ceanothus americanus</i> L.	Rhamnaceae
<i>Comandra richardsoniana</i> Fern.	Santalaceae
<i>Coreopsis palmata</i> Nutt.	Compositae
<i>Coreopsis tripteris</i> L.	Compositae
<i>Corylus americana</i> Walt.	Betulaceae
<i>Desmodium canadense</i> (L.) DC.	Fabaceae
<i>Desmodium illinoense</i> Gray	Fabaceae
<i>Desmodium sessilifolium</i> (Torr.) T. & G.	Fabaceae
<i>Echinacea pallida</i> Nutt.	Compositae
<i>Elymus canadensis</i> L.	Poaceae
<i>Eryngium yuccifolium</i> Michx.	Umbelliferae
<i>Euphorbia corollata</i> L.	Euphorbiaceae
<i>Helianthus mollis</i> Lam.	Compositae
<i>Helianthus occidentalis</i> Riddell.	Compositae
<i>Heuchera richardsonii</i> R.Br.	Saxifragaceae
<i>Hieracium longipilum</i> Torr.	Compositae
<i>Kuhnia eupatorioides</i> L.	Compositae
<i>Lespedeza capitata</i> Michx.	Fabaceae
<i>Liatris aspera</i> Michx.	Compositae
<i>Liatris cylindracea</i> Michx.	Compositae
<i>Liatris spicata</i> (L) Willd.	Compositae
<i>Lithospermum canescens</i> (Michx.) Lehm.	Boraginaceae
<i>Lithospermum caroliniense</i> (Walt.) MacMill.	Boraginaceae
<i>Panicum oligosanthos</i> Schult.	Poaceae
<i>Panicum virgatum</i> L.	Poaceae
 <i>Potentilla arguta</i> Pursh.	 Rosaceae
<i>Pycnanthemum virginianum</i> (L) Durand & Jackson	Labiatae
<i>Ratibida pinnata</i> (Vent.) Barnh.	Compositae
<i>Rosa carolina</i> L.	Rosaceae

Table 3. (continued)

<i>Rudbeckia hirta</i> L.	Compositae
<i>Ruellia humilis</i> Nutt.	Acanthaceae
<i>Salix humilis</i> Marsh.	Salicaceae
<i>Silphium laciniatum</i> L.	Compositae
<i>Silphium integrifolium</i> Michx.	Compositae
<i>Silphium perfoliatum</i> L.	Compositae
<i>Silphium terebinthinaceum</i> Jacq.	Compositae
<i>Sisyrinchium albidum</i> Raf.	Iridaceae
<i>Solidago graminifolia</i> (L.) Salisb.	Compositae
<i>Solidago nemoralis</i> Ait.	Compositae
<i>Solidago rigida</i> L.	Compositae
<i>Solidago speciosa</i> Nutt.	Compositae
<i>Sorghastrum nutans</i> (L.) Nash.	Poaceae
<i>Spartina pectinacea</i> Link	Poaceae
<i>Sporobolus asper</i> (Michx.) Kunth	Poaceae
<i>Sporobolus cryptandrus</i> (Torr.) Gray	Poaceae
<i>Stipa spartea</i> Trin.	Poaceae
<i>Tephrosia virginiana</i> (L.) Pers.	Fabaceae
<i>Verbena stricta</i> Vent.	Verbenaceae
<i>Veronicastrum virginicum</i> (L.) Farw.	Scrophulariaceae
<i>Viola pedata</i> L.	Violaceae
<i>Viola pedatifida</i> G. Don.	Violaceae
<i>Viola sagittata</i> Ait.	Violaceae

species recorded during the survey are listed in Appendix A. Voucher specimens from the study are deposited in the Beal-Darlington Herbarium, Michigan State University.

Other Studies

Late in the summer, certain sites were selected to determine composition. Nineteen sites were sampled. Sites were chosen that had either many prairie species (sites rich in prairie flora) or a dominant prairie species (common or rare). However, not all sites rich in prairie flora were sampled. Once a site was chosen, one of several linear sampling designs of various sizes was used to examine frequency of the prairie species. Designs of 100 meter transects of various widths or 25 square-meter plots of various shapes were used to determine the frequency of both prairie and non-prairie species present. Random samples were paced off and all species found in a $\frac{1}{4}$ square meter quadrat were recorded.

Data were taken on the topography and soil at selected sites.

RESULTS

Sites

528 sites were visited, most of them along railroad rights-of-way. 345 sites (67%) contained at least one prairie plant (all data and discussion refer to the 68 prairie species previously discussed unless stated otherwise). All sites visited are shown in Figure 3.

Distribution of Prairie Flora

Selected distribution maps of the prairie species (Figures 16 to 20) are contained in Appendix D. Each figure represent observation records during the summer and fall of 1969. Herbarium and literature records are included on several of the maps.

If it is assumed that the boundary of the Prairie Peninsula is determined by the major portion of recorded original (relict) prairies, then the Peninsula boundaries might appear like the outline shown on Figure 4. The distribution maps illustrate several patterns of species occurrence. First, at least 17 species (Table 6) are limited to within the Peninsula. Examples are Silphium integrifolium (Figure 19), Ruellia humilis (Figure 18), Coreopsis palmata (Figure 16). Second, at least nine species (Table 5) occur throughout the survey area (Panicum virgatum, Figure 17). Third, at least 26 species (Table 4) have a western occurrence coinciding with the western boundary of the Peninsula. Examples are Silphium integrifolium (Figure 19) and Coreopsis palmata (Figure 16). And fourth, at least 16 species (Table 7) occur within the western boundary of the Peninsula and beyond the eastern boundary (Silphium terebinthinaceum, Figure 20).

Figure 3. Sites visited during prairie flora survey in southwestern Michigan. (Summer and fall, 1969)

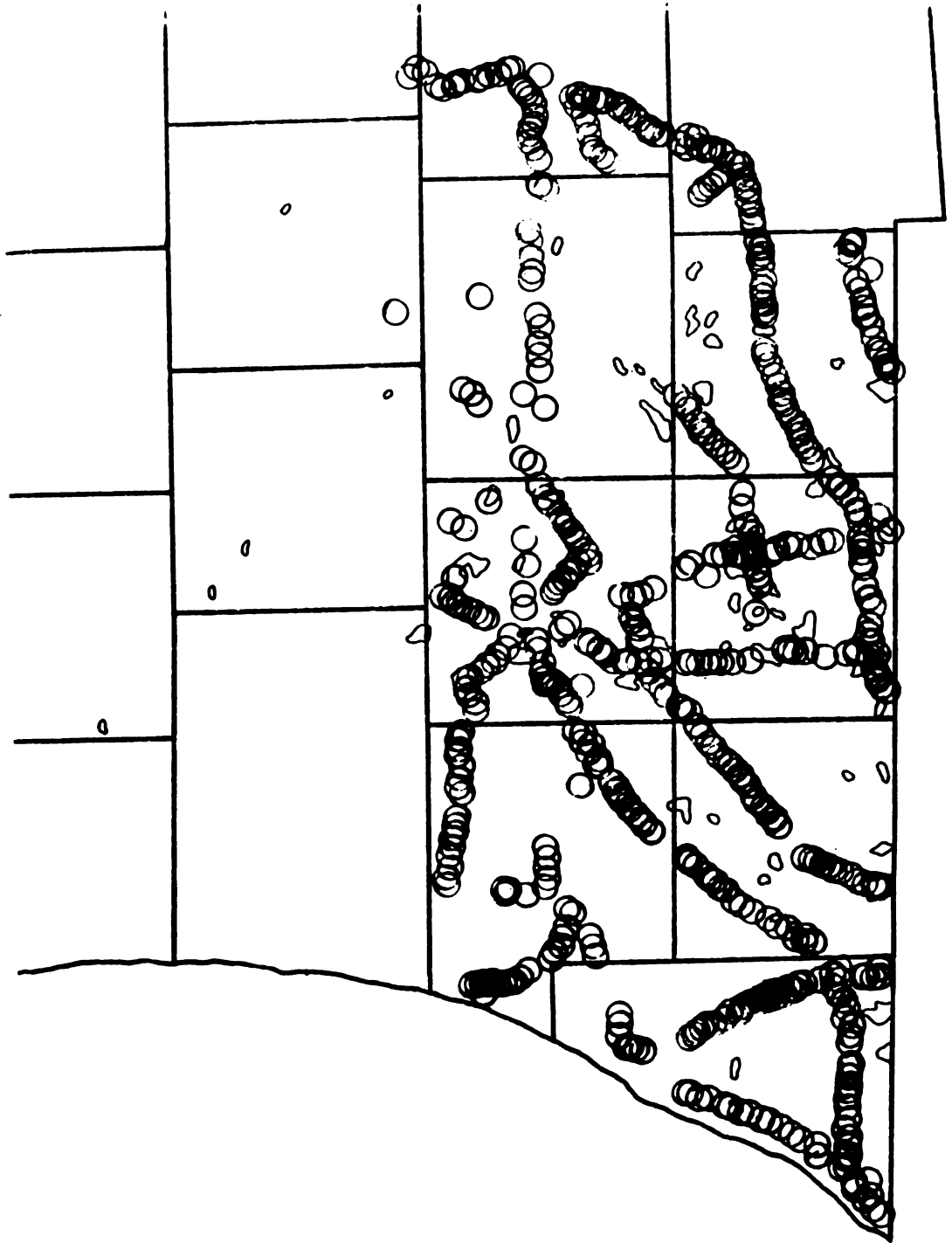


Figure 4. Outline of the Prairie Peninsula
based on presence of original prairies.

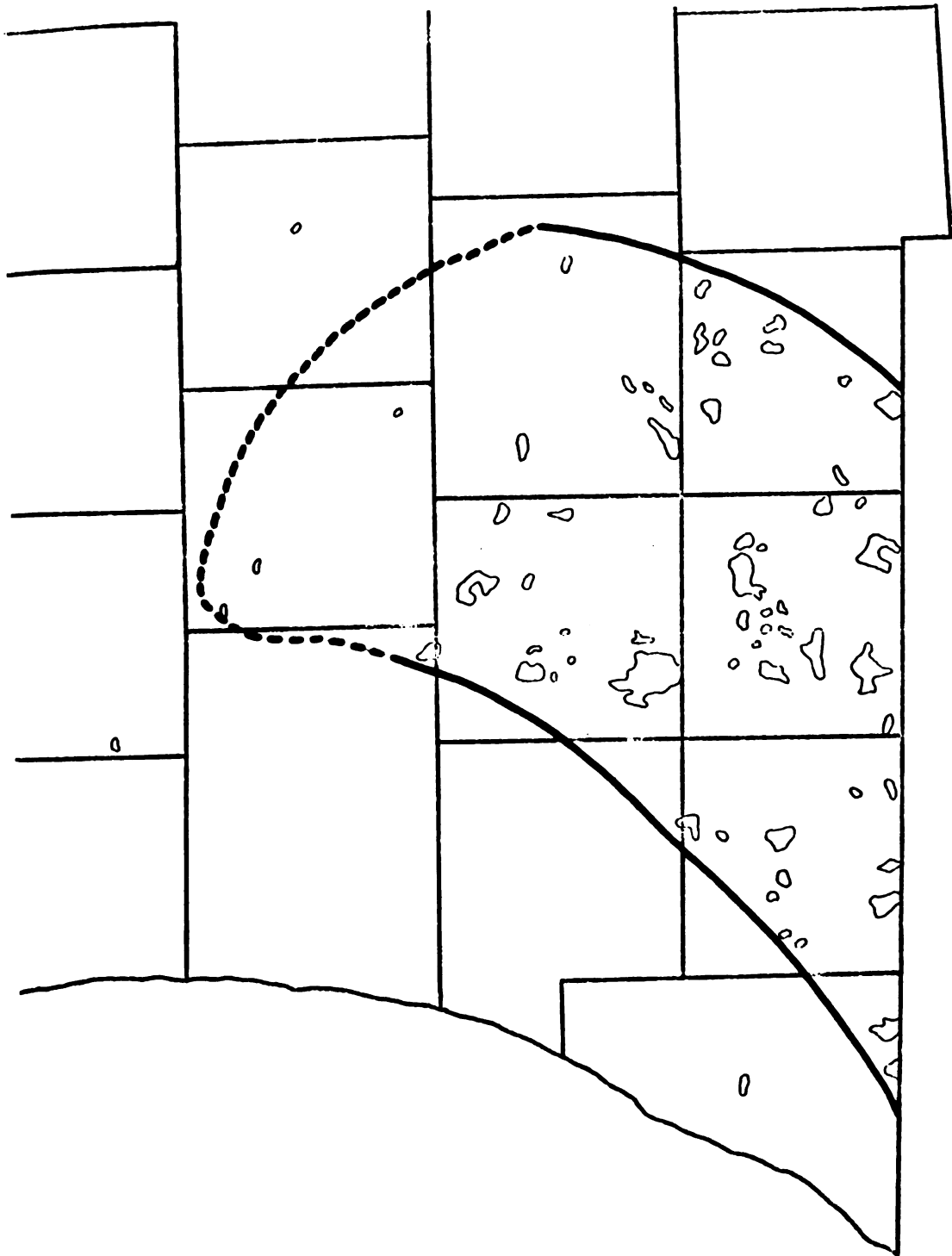


Table 4. List of prairie species in southwestern Michigan which emphasize the limits of the western boundary of the Prairie Peninsula.

<i>Anemone cylindracea</i>	<i>Lithospermum canescens</i>
<i>Asclepias amplexicaulis</i>	<i>Panicum oligosanthos</i>
<i>Cacalia atriplicifolia</i>	<i>Potentilla arguta</i>
<i>Ceanothus americanus</i>	<i>Ratibida pinnata</i>
<i>Comandra richardsiana</i>	<i>Rosa carolina</i>
<i>Coreopsis palmata</i>	<i>Salix humilis</i>
<i>Corylus americana</i>	<i>Silphium integrifolium</i>
<i>Desmodium canadense</i>	<i>Solidago rigida</i>
<i>Elymus canadensis</i>	<i>Solidago speciosa</i>
<i>Helianthus occidentalis</i>	<i>Sorghastrum nutans</i>
<i>Hieracium longipilum</i>	<i>Sporobolus asper</i>
<i>Liatris aspera</i>	<i>Tephrosia virginiana</i>
<i>Liatris cylindracea</i>	<i>Veronicastrum virginicum</i>

Table 5. List of prairie species which occur throughout the area surveyed in southwestern Michigan.

<i>Andropogon gerardii</i>	<i>Lespedeza capitata</i>
<i>Andropogon scoparius</i>	<i>Panicum virgatum</i>
<i>Asclepias tuberosa</i>	<i>Rudbeckia hirta</i>
<i>Coreopsis tripteris</i>	<i>Sporobolus cryptandrus</i>
<i>Euphorbia corollata</i>	

Table 6. List of prairie species limited to the Prairie Peninsula in southwestern Michigan.

<i>Amorpha canescens</i>	<i>Kuhnia eupatorioides</i>
<i>Asclepias amplexicaulis</i>	<i>Liatris spicata</i>
<i>Asclepias verticillata</i>	<i>Potentilla arguta</i>
<i>Asclepias viridiflora</i>	<i>Ruellia humilis</i>
<i>Aster azureus</i>	<i>Silphium integrifolium</i>
<i>Comandra richardsoniana</i>	<i>Tephrosia virginiana</i>
<i>Coreopsis palmata</i>	<i>Verbena stricta</i>
<i>Desmodium sessilifolium</i>	<i>Viola pedata</i>
<i>Eryngium yuccifolium</i>	

Table 7. List of prairie species which suggest the extension of the eastern boundary of the prairie peninsula.

<i>Anemone cylindrica</i>	<i>Rosa carolina</i>
<i>Aster laevis</i>	<i>Salix humilis</i>
<i>Ceanothus americanus</i>	<i>Silphium terebinthinaceum</i>
<i>Corylus americana</i>	<i>Solidago graminifolia</i>
<i>Liatris aspera</i>	<i>Solidago rigida</i>
<i>Panicum oligosanthos</i>	<i>Solidago speciosa</i>
<i>Pycnanthemum virginianum</i>	<i>Sorghastrum nutans</i>
<i>Ratibida pinnata</i>	<i>Veronicastrum virginicum</i>

The presence values for the prairie flora are given in Table 8. Because the sites were not uniform, the percent occurrence of each species is expressed as presence rather than frequency. Andropogon gerardii had the highest presence value (42%). Note that no species occurred in over half the sites. Figure 5 illustrated the rare and infrequent occurrence of most of the prairie flora. Using 20 presence categories (5% intervals), 47 species (68%) fall into the first category (#1). The first category (1-5% of the sites) illustrate the rare flora. Fourteen species fall into the second category (between 6 and 10% of the sites) and represent between 30 and 53 sites. The 14 species are listed in Table 8 from Anemone cylindrica (30 sites) to Desmodium illinoense (53 sites). The first two categories represent 61 (88%) of the prairie species. The other seven species, two respectively in the 3rd, 4th, and 5th categories and one species in the 9th category represent the more common prairie species e.g. Sorghastrum nutans, Panicum virgatum, Lespedeza capitata, Euphorbia corollata, Andropogon scoparius, Asclepias tuberosa, and Andropogon gerardii.

The prairie flora was found in 345 (67%) of the sites visited. The prairie species found at each site are given in Table 9. The sites are ordered from those with most species (site 247 with 28 species) to those with one species. A description of each site and number of prairie species is given in Appendix B.

From Table 9, several characteristics concerning a prairie species associated flora can be recognized. First, there are species that are associated with large numbers of other prairie species. These are infrequent or rare. Potentilla arguta (15 sites) was found with 15 or more prairie species in 13 sites. Coreopsis palmata (10 sites) was

Table 8. Presence of prairie species in 528 sites.

<i>Andropogon gerardii</i>	218	42.6%
<i>Asclepias tuberosa</i>	131	25.6
<i>Andropogon scoparius</i>	124	24.2
<i>Euphorbia corollata</i>	97	19.0
<i>Lespedeza capitata</i>	86	16.8
<i>Panicum virgatum</i>	70	13.7
<i>Sorghastrum nutans</i>	57	11.1
<i>Desmodium illinoense</i>	53	10.4
<i>Coreopsis tripteris</i>	51	10.0
<i>Solidago graminifolia</i>	45	8.8
<i>Ratibida pinnata</i>	45	8.8
<i>Ceanothus americanus</i>	43	8.4
<i>Panicum oligosanthos</i>	43	8.4
<i>Veronicastrum virginicum</i>	42	8.2
<i>Helianthus occidentalis</i>	39	7.6
<i>Rudbeckia hirta</i>	35	6.8
<i>Solidago rigida</i>	35	6.8
<i>Corylus americana</i>	33	6.4
<i>Solidago nemoralis</i>	31	6.0
<i>Sporobolus cryptandrus</i>	30	5.9
<i>Anemone cylindrica</i>	30	5.9
<i>Liatris aspera</i>	29	5.7
<i>Rosa carolina</i>	28	5.5
<i>Elymus canadensis</i>	28	5.5
<i>Silphium terebinthinaceum</i>	24	4.7
<i>Asclepias amplexicaulis</i>	21	4.1
<i>Kuhnia eupatorioides</i>	20	3.9
<i>Salix humilis</i>	20	3.9
<i>Sporobolus asper</i>	20	3.9
<i>Solidago speciosa</i>	19	3.7
<i>Desmodium sessilifolium</i>	18	3.5
<i>Asclepias verticillata</i>	17	3.3
<i>Aster laevis</i>	17	3.3
<i>Desmodium canadense</i>	17	3.3
<i>Hieracium longipilum</i>	17	3.3
<i>Potentilla arguta</i>	16	3.1
<i>Baptisia leucantha</i>	15	2.9
<i>Spartina pectinacea</i>	14	2.7
<i>Verbena stricta</i>	13	2.5
<i>Amorpha canescens</i>	11	2.1
<i>Aster azureus</i>	11	2.1
<i>Tephrosia virginiana</i>	11	2.1
<i>Cacalia atriplicifolia</i>	11	2.1
<i>Aster ericoides</i>	10	1.8
<i>Comandra richardsiana</i>	10	1.8
<i>Coreopsis palmata</i>	10	1.8
<i>Liatris cylindracea</i>	10	1.8
<i>Lithospermum canescens</i>	10	1.8
<i>Pycnanthemum virginianum</i>	10	1.8
<i>Stipa spartea</i>	10	1.8
<i>Silphium integrifolium</i>	8	1.7

Table 8. (continued)

<i>Heuchera richardsonii</i>	5	1.0
<i>Ruellia humilis</i>	5	1.0
<i>Viola pedata</i>	5	1.0
<i>Carex bicknellii</i>	3	0.6
<i>Liatris spicata</i>	3	0.6
<i>Lithospermum caroliniense</i>	3	0.6
<i>Silphium laciniatum</i>	3	0.6
<i>Asclepias viridiflora</i>	2	0.4
<i>Eryngium yuccifolium</i>	2	0.4
<i>Viola pedatifida</i>	1	0.2
<i>Allium cernuum</i>	1	0.2
<i>Aster sericeus</i>	1	0.2
<i>Echinacea pallida</i>	1	0.2
<i>Helianthus mollis</i>	1	0.2
<i>Silphium perfoliatum</i>	1	0.2
<i>Sisyrinchium albidum</i>	1	0.2
<i>Viola sagittata</i>	1	0.2

Figure 5. Distribution of the presence values (expressed as percentages) of 68 prairie species. Presence categories represent 5% intervals.

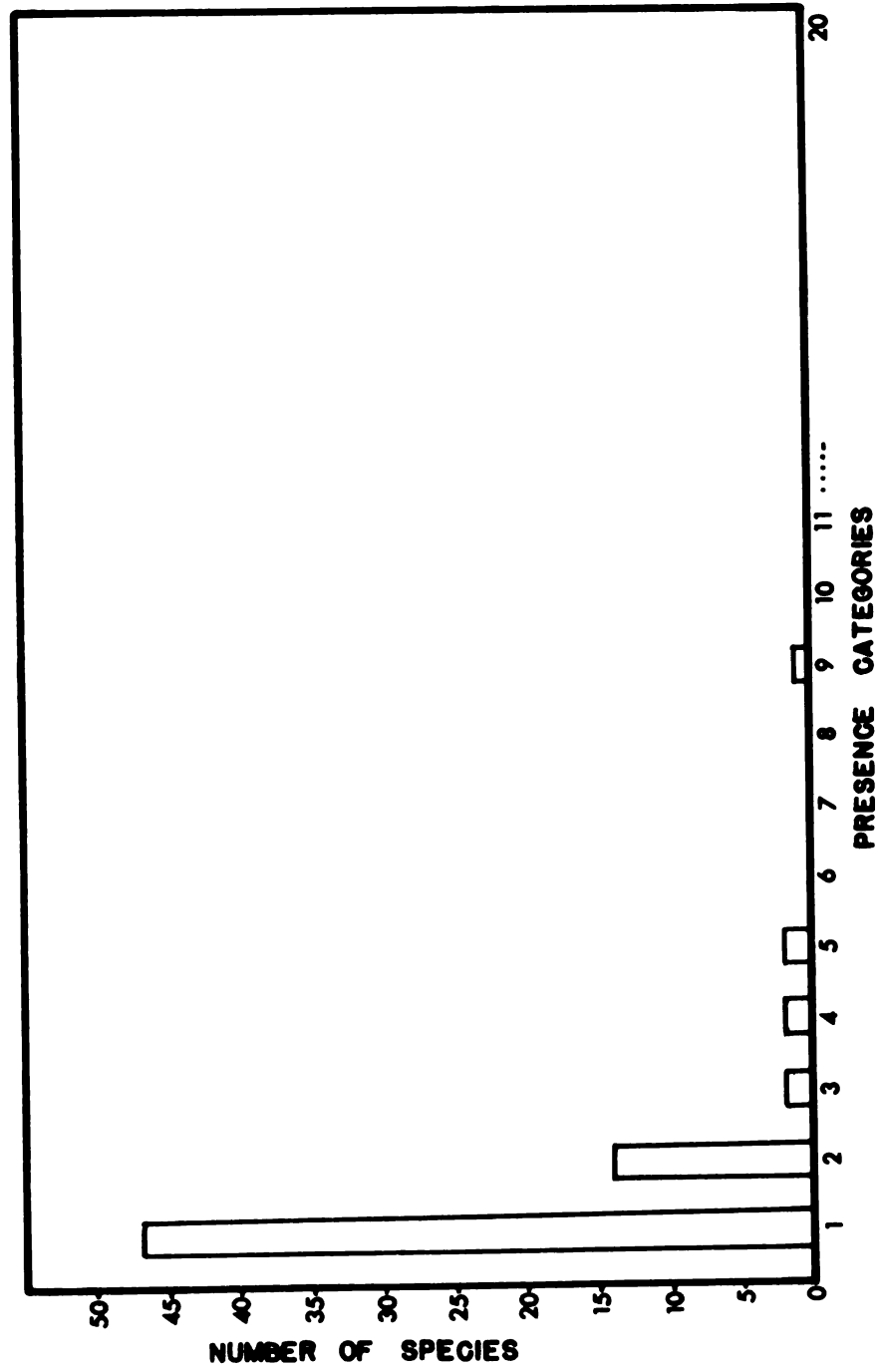


Table 9. The prairie species of all sites containing at least one species. Sites are ordered according to decreasing number of prairie species per site. Locations of numbered sites are described in Appendix B.

[illegible]

[illegible]

[illegible]

222222223333333333333333333344444444444444444444444555

[illegible]

found with 13 or more species in all sites. Eryngium yuccifolium (2 sites) was found with 27 and 28 species. Other similar examples are: Lithospermum canescens, Helianthus occidentalis, Stipa spartea, Allium cernuum, Aster sericeus, Helianthus mollis, and Viola pedata. Second, there were species that were associated with few prairie species. Echinacea pallida (one site) was found with six species. Other examples were Silphium laciniatum and S. perfoliatum. A third category is formed by species which are usually common such as Andropogon gerardii, A. scoparius, Lespedeza capitata. These are often found in communities rich in prairie species as well as those which are impoverished. In addition they are not infrequently found in non-prairie habitats, perhaps as invaders.

Distribution of Individual Prairie Remnants.

The number of prairie species for each of the sites is expressed in the county maps (Figures 6-13). Symbols are used to indicate the number of species. Using these maps an evaluation of the prairie remnants was made by comparing the location of "good" sites with original prairie (relicts). "Good" sites are arbitrarily defined as having 11 or more prairie species (this includes the symbols for 11-15, 16-20, 21-25, and >25 species in Figures 6-13; there are 50 sites with 11 or more prairie species). If a "good" site is within or near original recorded prairie (Veatch, 1928; Kenoyer, 1930, 1934, 1940; Butler, 1937, 1938, 1939) then it is considered a remnant of a recorded relict. If the "good" site is not near original prairie, it will also be considered a remnant, but of the probably numerous unrecorded relicts. There is also the possibility that any one of the "good" sites represent an invaded disturbed site.

Figure 6. Number of prairie species for all sites visited in Berrien County, Michigan. All sites containing at least one species are coded. Code numbers are described in Appendix B.

Legend: empty circle - no prairie species
 empty triangle - 1- 5
 empty square - 6-10
 half-colored circle - 11-15
 half-colored square - 16-20
 full-colored circle - 21-25
 full-colored triangle - >26

stippling - selected cities

horizontal lines - original prairies
 (after Veatch 1928, Kenoyer 1930,
 1934, 1940, and Butler 1937, 1938,
 1939).

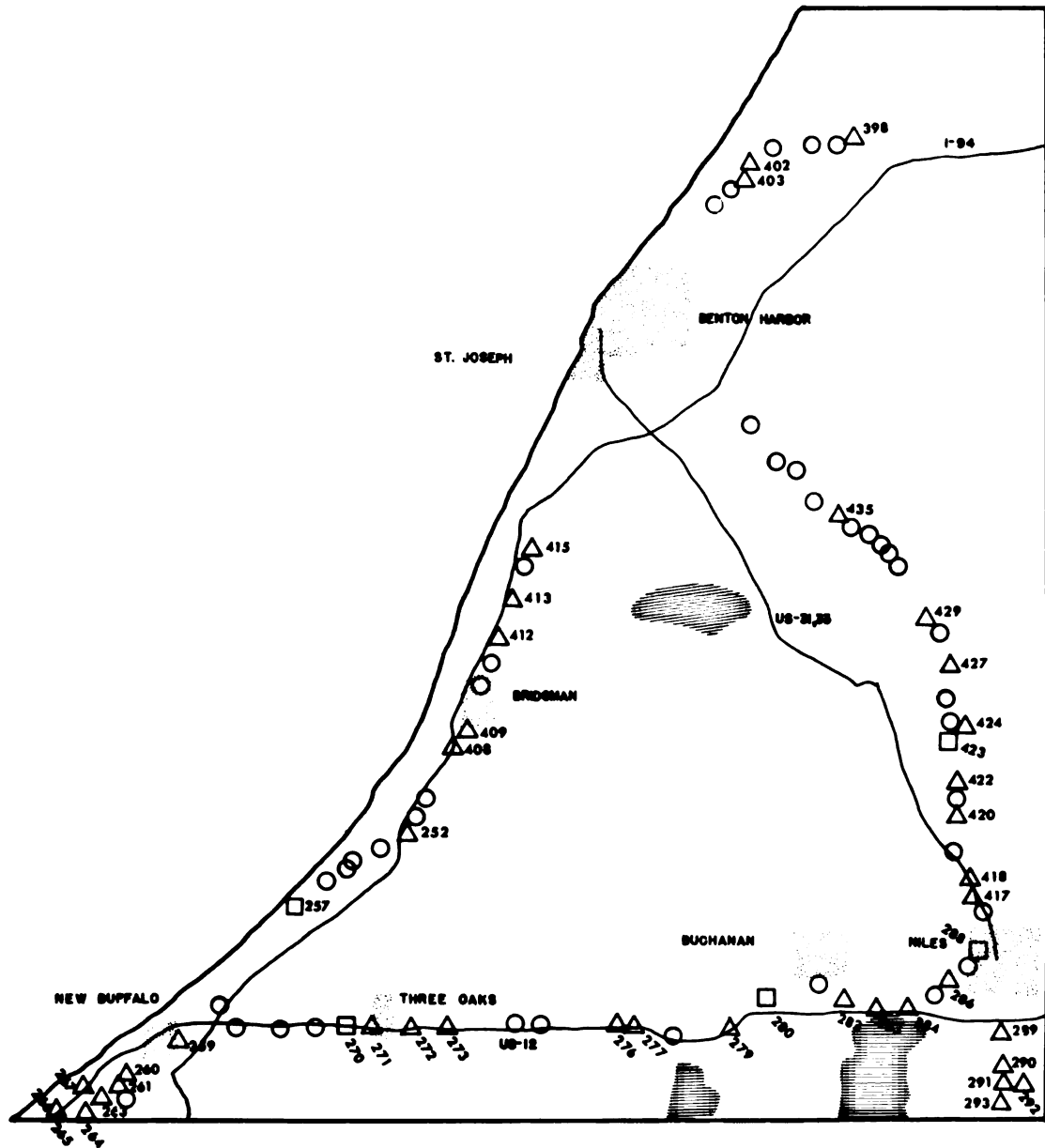


Figure 7. Number of prairie species for all sites visited in Branch County, Michigan. All sites containing at least one species are coded. Code numbers are described in Appendix B.

Legend: empty circle - no prairie species
 empty triangle - 1-5
 empty square - 6-10
 half-colored circle - 11-15
 half-colored square - 16-20
 full-colored circle - 21-25
 full-colored triangle - >26

stippling - selected cities

horizontal lines - original prairies
 (after Veatch 1928, Kenoyer 1930,
 1934, 1940, and Butler 1937, 1938,
 1939).

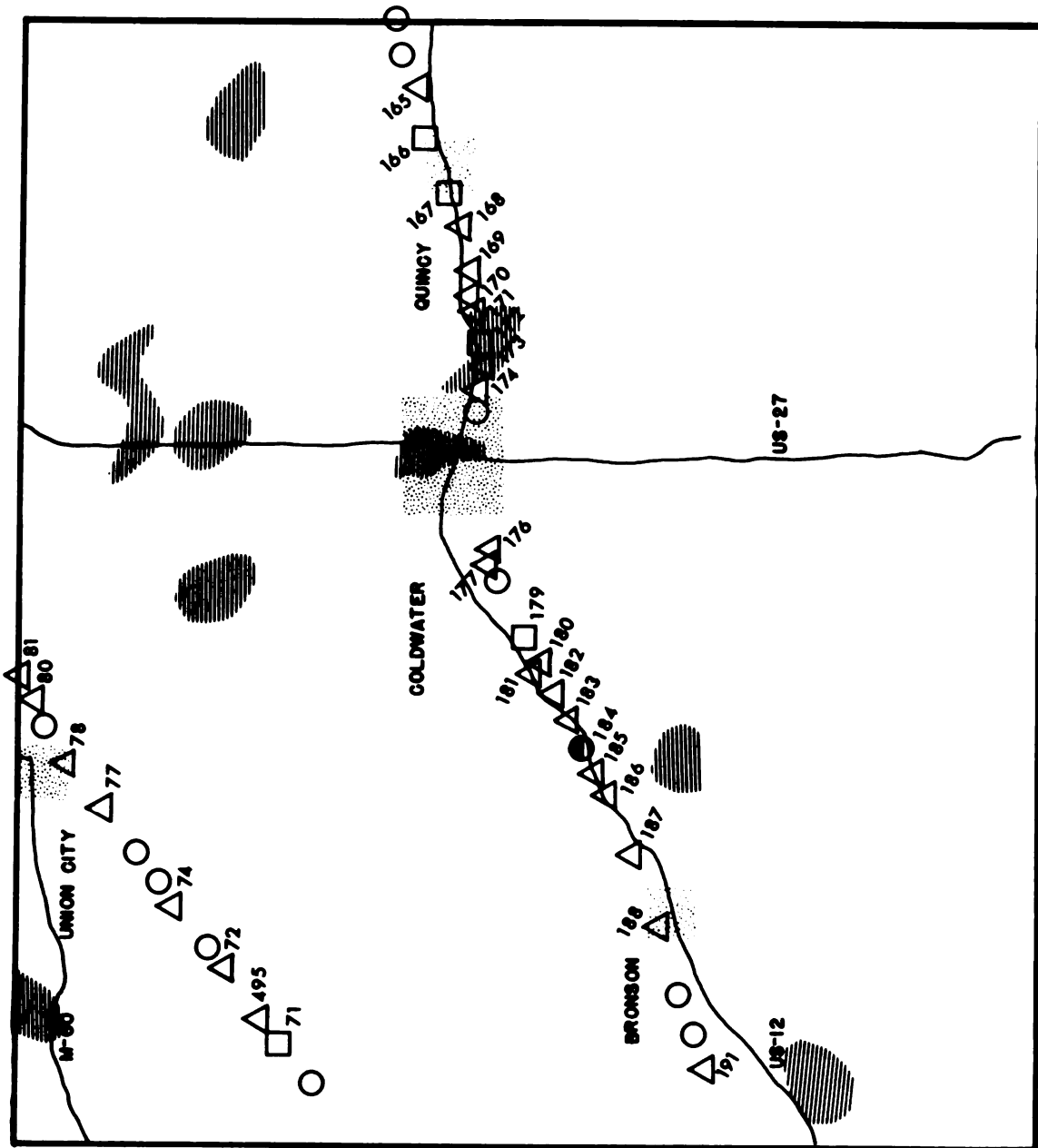


Figure 8. Number of prairie species for all sites visited in Calhoun County, Michigan. All sites containing at least one species are coded. Code numbers are described in Appendix B.

Legend: empty circle - no prairie species
 empty triangle - 1-5
 empty square - 6-10
 half-colored circle - 11-15
 half-colored square - 16-20
 full-colored circle - 21-25
 full-colored triangle - >26

stippling - selected cities

horizontal lines - original prairies
 (after Veatch 1928, Kenoyer 1930,
 1934, 1940, and Butler 1937, 1938,
 1939).

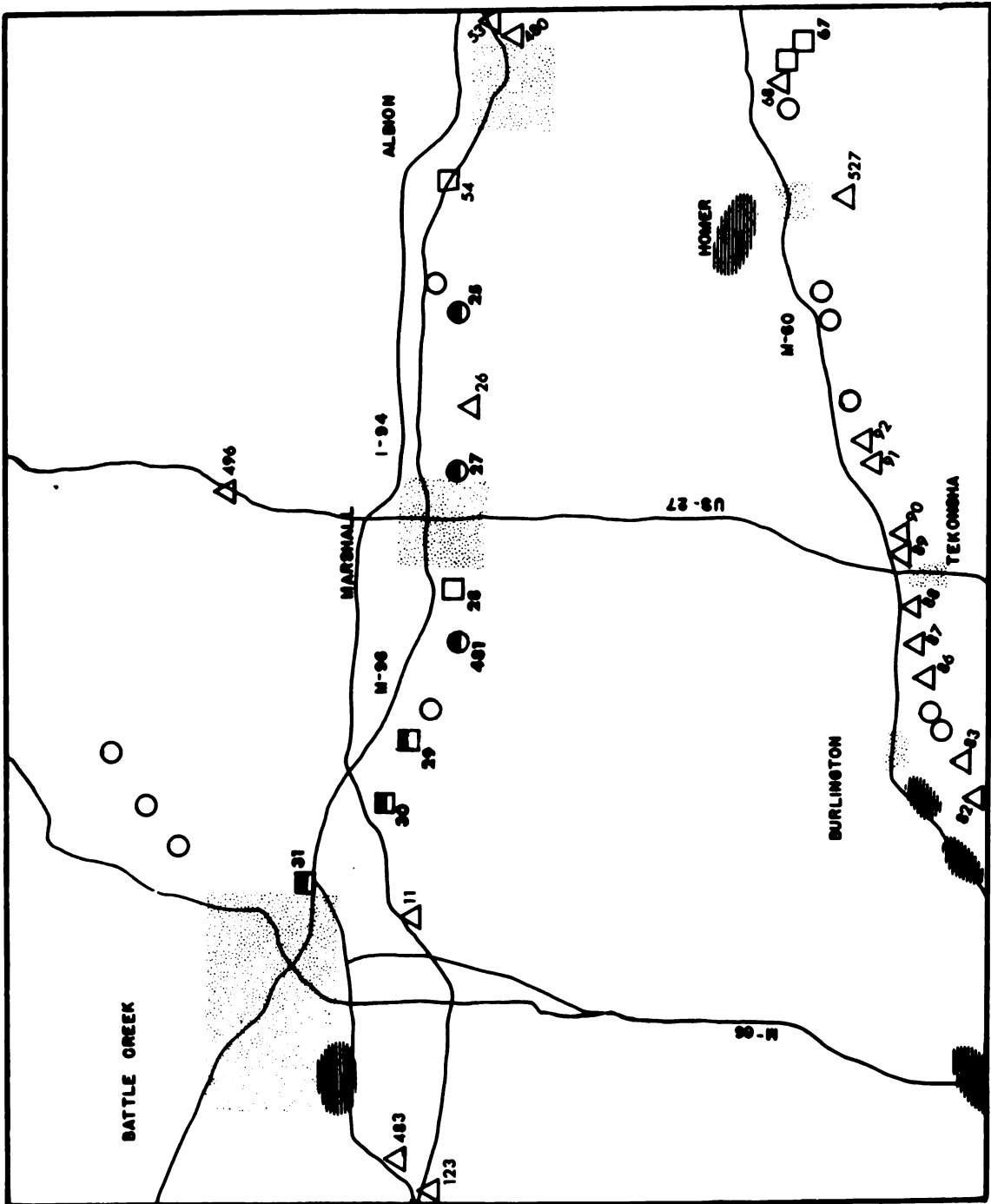


Figure 9. Number of prairie species for all sites visited in Cass County, Michigan. All sites containing at least one species are coded. Code numbers are described in Appendix B.

Legend: empty circle - no prairie species
 empty triangle - 1- 5
 empty square - 6-10
 half-colored circle - 11-15
 half-colored square - 16-20
 full-colored circle - 21-25
 full-colored triangle - >26

stippling - selected cities

horizontal lines - original prairies
 (after Veatch 1928, Kenoyer 1930,
 1934, 1940, and Butler 1937, 1938,
 1939).

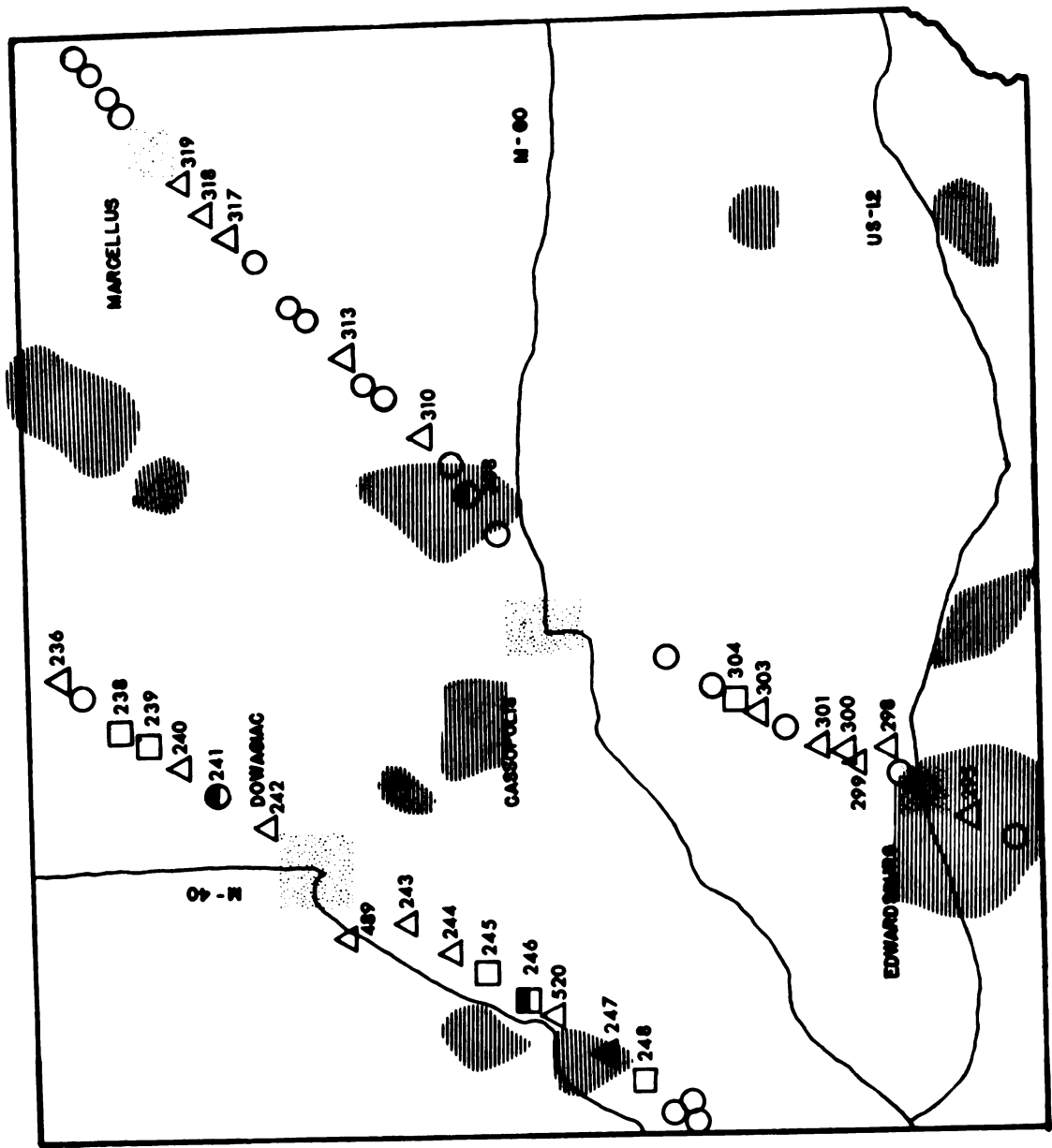


Figure 10. Number of prairie species for all sites visited in Kalamazoo County, Michigan. All sites containing at least one species are coded. Code numbers are described in Appendix B.

Legend: empty circle - no prairie species
 empty triangle - 1-5
 empty square - 6-10
 half-colored circle - 11-15
 half-colored square - 16-20
 full-colored circle - 21-25
 full-colored triangle - 26

stippling - selected cities

horizontal lines - original prairies
 (after Veatch 1928, Kenoyer 1930,
 1934, 1940, and Butler 1937, 1938,
 1939).

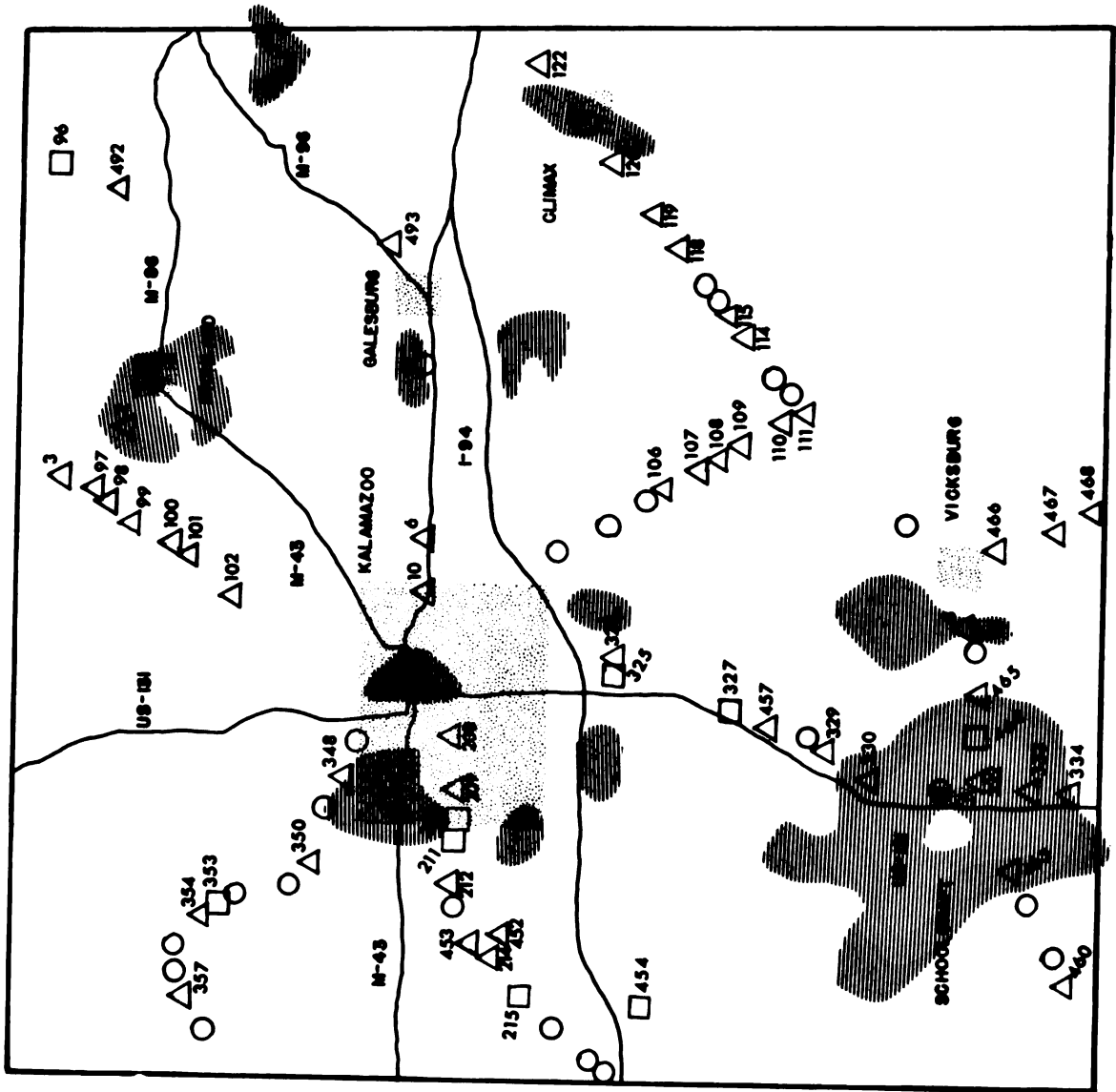


Figure 11. Number of prairie species for all sites visited in St. Joseph County, Michigan. All sites containing at least one species are coded. Code numbers are described in Appendix B.

Legend: empty circle - no prairie species
 empty triangle - 1- 5
 empty square - 6-10
 half-colored circle - 11-15
 half-colored square - 16-20
 full-colored circle - 21-25
 full-colored triangle - >26

stippling - selected cities

horizontal lines - original prairies
 (after Veatch 1928, Kenoyer 1930,
 1934, 1940, and Butler 1937, 1938,
 1939).

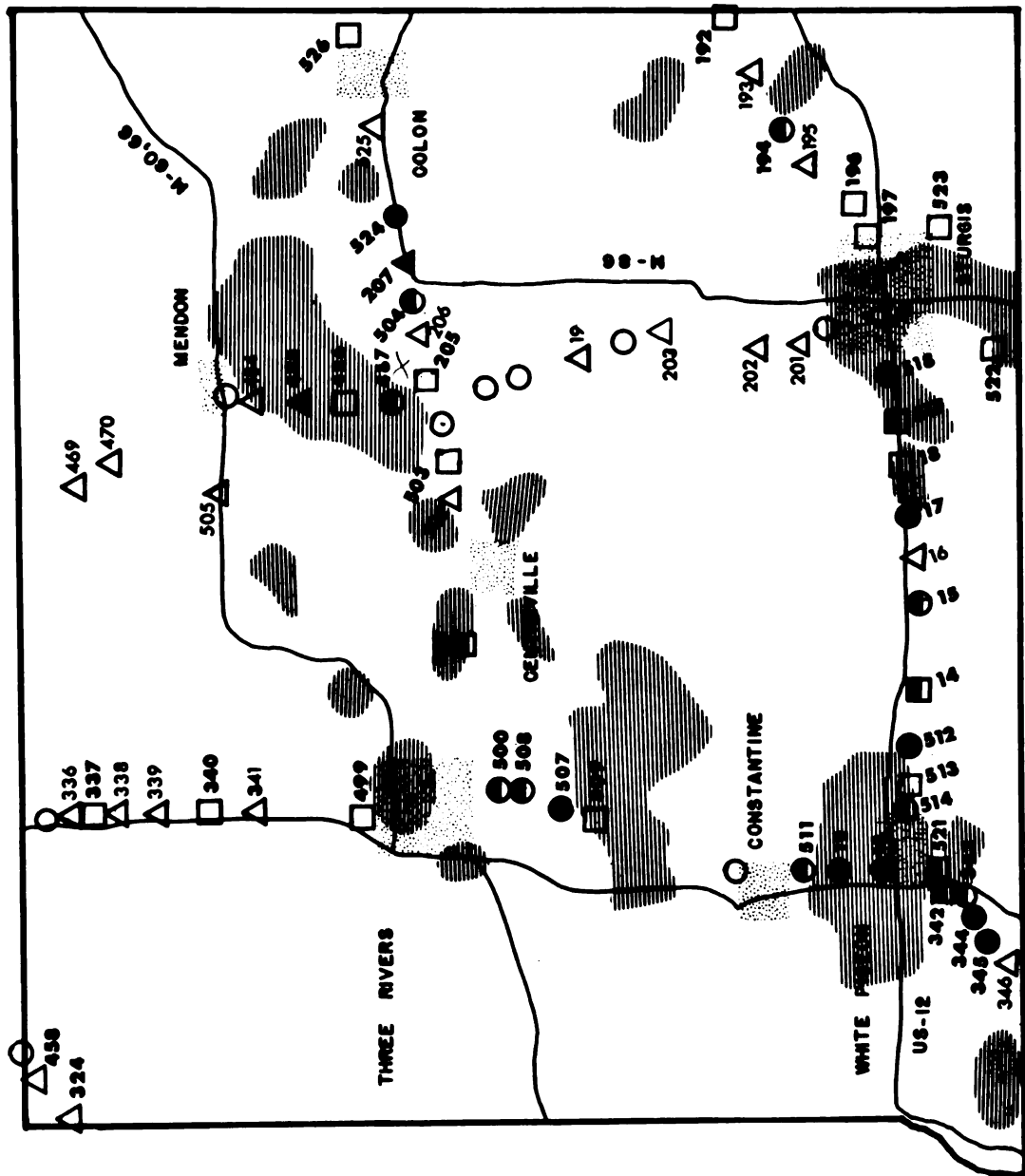


Figure 12. Number of prairie species for all sites visited in Van Buren County, Michigan. All sites containing at least one species are coded. Code numbers are described in Appendix B.

Legend: empty circle - no prairie species
 empty triangle - 1-5
 empty square - 6-10
 half-colored circle - 11-15
 half-colored square - 16-20
 full-colored circle - 21-25
 full-colored triangle - >26

stippling - selected cities

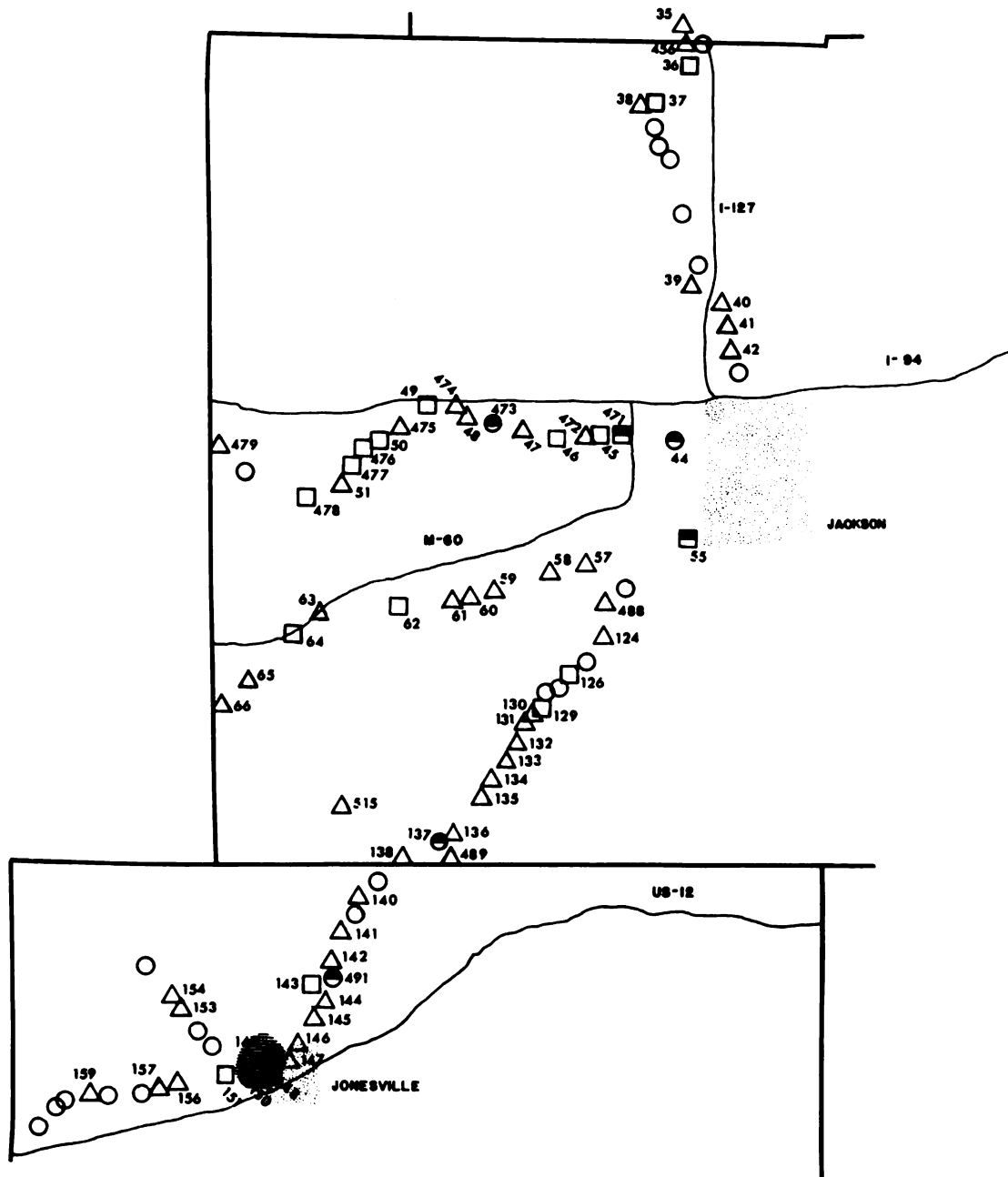
horizontal lines - original prairies
 (after Veatch 1928, Kenoyer 1930,
 1934, 1940, and Butler 1937, 1938,
 1939).

Figure 13. Number of prairie species for all sites visited in Ingham, Jackson, and Hillsdale Counties, Michigan. All sites containing at least one species are coded. Code numbers are described in Appendix B.

Legend: empty circle - no prairie species
 empty triangle - 1- 5
 empty square - 6-10
 half-colored circle - 11-15
 half-colored square - 16-20
 full-colored circle - 21-25
 full-colored triangle - >26

stippling - selected cities

horizontal lines - original prairies
 (after Veatch 1928, Kenoyer 1930,
 1934, 1940, and Butler 1937, 1938,
 1939).



Sites Representing Remnants of Recorded Prairie Relicts

In the discussion below, the recorded relicts may have been described by Veatch (1928), Kenoyer (1930, 1934, 1940) and Butler (1937, 1938, 1939), any two of them or just one of them. Occasional references will be made to illustrate this. References to the size and historical name of an original prairie was taken from Butler (1937, 1938, 1939). Reference to frequency studies of selected sites (Table 10) will be made throughout the discussion when a statement is made concerning the names of dominant prairie species, percentage of prairie species, the frequency of the dominant prairie species, or rank of prairie species. A listing of all species for each site (and their frequencies) selected for a frequency study is given in Appendix C. St. Joseph County (Figure 11) contains at least 16 sites representing remnants of seven different prairie relicts. Site 501 (19 prairie species), northwest of Centreville, represents a remnant of a relict recorded only by Kenoyer (1934). A frequency study showed a high percentage (32%) of prairie species with the dominant prairie species Andropogon scoparius (40%), Amorpha canescens (16%), Anemone cylindrica (16%) and Euphorbia corollata (16%). Site 507 (23 prairie species), between Constantine and Three Rivers is a remnant of a relict also recorded by Kenoyer (1934). Sites 511 (15 prairie species), 12 (25 prairie species), 13 (21 prairie species), 514 (12 prairie species), and 512 (21 prairie species) at White Pigeon represent the 28 square mile White Pigeon Prairie. Sites 12 and 13 illustrate the typical topographical (flat), and edaphic (more than 24 inches of the dark Warsaw Loam), as well as the vegetation aspects of an original prairie. Three different frequency studies at site 12 illustrate a high percentage of prairie species. Forty-two percent

Table 10. Summary of frequency studies from 20 prairie sites in southwestern Michigan. Sites are ordered according to decreasing percentage of prairie species.

Dominant Prairie Species	% Freq.	Total Prairie Species	Total Species	% Prairie Species	Rank of Prairie Species	No. of Quadrats Sampled	Site No.	County, Township
<i>Stipa spartea</i>	89	17	35	49	1	$\frac{100}{4800}$	30	Calhoun, Emmett
<i>Andropogon gerardii</i>	46				3			
<i>Helianthus occidentalis</i>	34				5			
<i>Kuhnia eupatorioides</i>	56	17	41	42	1	$\frac{50}{1200}$	12a	St. Joseph, Constantine
<i>Stipa spartea</i>	30				4			
<i>Panicum oligosanthos</i>	28				6			
<i>Euphorbia corollata</i>	50	24	59	41	2	$\frac{50}{4800}$	247	Cass, Howard
<i>Spartina pectinacea</i>	38				3			
<i>Rosa carolina</i>	34				4			
<i>Andropogon gerardii</i>	100	7	17	41	1	$\frac{28}{2400}$	143	Hillsdale, Scorpion
<i>Hieracium longipilum</i>	64				2			
<i>Lespedeza capitata</i>	36				4			
<i>Andropogon gerardii</i>	96	12	30	40	1	$\frac{50}{2400}$	512	St. Joseph, White Pigeon
<i>Euphorbia corollata</i>	54				2			
<i>Rosa carolina</i>	40				3			
<i>Euphorbia corollata</i>	83	15	40	38	2	$\frac{80}{700}$	31	Calhoun, Emmett
<i>Andropogon scoparius</i>	83				3			
<i>Lespedeza capitata</i>	40				6			
<i>Andropogon gerardii</i>	85	8	22	36	1	$\frac{40}{400}$	12c	St. Joseph, Constantine
<i>Euphorbia corollata</i>	65				2			
<i>Stipa spartea</i>	63				3			

Table 10. (continued)

Dominant Prairie Species	% Freq.	Total Prairie Species	Total Species	% Prairie Species	Rank of Prairie Species	No. of Quadrats Sampled	Site No.	County, Township
Andropogon scoparius	40	13	41	32	2	$\frac{50}{2400}$	501	St. Joseph, Lockport
Amorpha canescens	16				8			
Anemone cylindrica	16				9			
Kuhnia eupatorioides	49	19	62	31	3	$\frac{150}{14,400}$	485	St. Joseph, Nottawa
Euphorbia corollata	43				4			
Panicum oligosanthos	38				5			
Andropogon scoparius	76	8	26	31	2	$\frac{50}{4800}$	96	Kalamazoo, Ross
Solidago nemoralis	30				4			
Euphorbia corollata	26				5			
Andropogon gerardii	82	10	32	31	1	$\frac{50}{2400}$	15	St. Joseph, White Pigeon
Rosa carolina	70				2			
Euphorbia corollata	54				3			
Andropogon scoparius	96	10	32	31	1	$\frac{100}{4800}$	497	Van Buren, Antwerp
Lespedeza capitata	39				3			
Euphorbia corollata	29				6			
Andropogon scoparius	75	17	59	29	1	$\frac{150}{14,400}$	221	Van Buren, Antwerp
Sorghastrum nutans	26				4			
Andropogon gerardii	20				6			
Euphorbia corollata	90	5	17	29	5	$\frac{10}{100}$	12b	St. Joseph, Constantine
Ruellia humilis	70				6			
Kuhnia eupatorioides	50				9			

Table 10. (continued)

Dominant Prairie Species	% Freq.	Total Prairie Species	Total Species	% Prairie Species	Rank of Prairie Species	No. of Quadrats Sampled	Site No.	County, Township
<i>Andropogon gerardii</i>	27	13	46	28	3	$\frac{100}{4800}$	471	Jackson, Blackman
<i>Silphium terebinthaceum</i>	22				6			
<i>Euphorbia corollata</i>	22				7			
<i>Solidago nemoralis</i>	60	7	25	28	5	$\frac{10}{100}$	270	Berrien, Three Oaks
<i>Silphium laciniatum</i>	40				9			
<i>Rudbeckia hirta</i>	40				11			
<i>Cyperus filiculmis</i>	80	8	35	23	3	$\frac{50}{4800}$	491	Hillsdale, Scorpio
<i>Andropogon scoparius</i>	52				5			
<i>Liatris cylindracea</i>	14				14			
<i>Panicum virgatum</i>	96	7	37	19	1	$\frac{50}{2400}$	1	Eaton, Bellvue
<i>Panicum oligosanthos</i>	20				7			
<i>Solidago nemoralis</i>	18				9			
<i>Silphium perfoliatum</i>	70	1	8	13	3	$\frac{10}{100}$	463a	Kalamazoo, Prairie Ronde
<i>Amorpha canescens</i>	50	2	15	13	3	$\frac{10}{100}$	327	Kalamazoo, Portage
<i>Salix humilis</i>	30				6			

(site 12a), 36% (site 12c), and 29% (site 12b) prairie species strongly indicate a remnant status. The most frequent prairie species at each site were: at 12a, Kuhnia eupatorioides (56%) and Stipa spartea (30%); at 12c, Andropogon gerardii (85%), Euphorbia corollata (65%), and Stipa spartea (63%); and at 12b, Euphorbia corollata (90%) and Ruellia humilis (70%). A frequency study at site 512 also showed a high percentage of prairie species (40%) with five prairie species as the five highest ranking species: Andropogon gerardii (96%), Euphorbia corollata (54%), Rosa carolina (40%), Solidago rigida (28%), and Andropogon scoparius (28%). Sites 342 (20 prairie species), 343 (13 prairie species), and 521 (16 prairie species), south of White Pigeon, probably are remnants of the original Indian Prairie. Site 17 (23 prairie species), west of Sturgis, is a remnant of a relict recorded by Kenoyer (1934). Sites 517 (17 prairie species) and 518 (12 prairie species), at Sturgis represent the western edge of the 1400 acre Sturgis Prairie. Site 194 (13 prairie species), east of Sturgis suggests the northern edge of a relict recorded by Kenoyer (1934). Sites 485 (26 prairie species) and 487 (11 prairie species), south of Mendon, are remnants of the 10,000 acre Nottawa Prairie. The flat topography and Warsaw Loam are again characteristic aspects of this once massive prairie. Frequency studies at site 485 showed 31% prairie species with the dominant prairie species Kuhnia eupatorioides (49%) and Euphorbia corollata (43%). Cass County (Figure 9) contains two sites which indicate remnants of two relict prairies. Site 247 (28 prairie species) southwest of Pokagon, is a remnant of the 70 acre original Sand Prairie. A frequency study showed a high percentage (41%) of prairie species with Euphorbia corollata (50%) and Spartina pectinacea (38%) as the dominant prairie species. Site 308 (11 prairie species), northeast of Cassopolis is a remnant of the 6000 acre

Young's Prairie. The flat topography and a rare flora indicate further that this is a remnant. This remnant contains one of three sites of Silphium laciniatum and Liatris spicata. In Hillsdale County (Figure 13) sites 150 (12 prairie species) and 148 (11 prairie species), at Jonesville, are remnants of the Allen Prairie recorded only by Butler (1937). The NYCRR right-of-way west from Jonesville contain dense stands of Andropogon gerardii.

Sites Which are Remnants of Unrecorded Prairie Relicts.

Again, statements concerning results of frequency studies refer to Table 10 and Appendix C. In Cass County (Figure 9) site 241 (15 prairie species), northeast of Dowagiac is one and one half mile long. The flat topography and a population of Stipa spartea and Coreopsis palmata indicate this area as a remnant. Nine sites representing four different areas in St. Joseph County (Figure 11) indicate remnants of relicts. Sites 500 (14 prairie species) and 508 (14 prairie species), south of Three Rivers are remnants. Sites 344 (24 prairie species) and 345 (23 prairie species) indicate remnants. Sites 14 (17 prairie species) and 15 (13 prairie species), east of White Pigeon, indicate remnants. A frequency study at site 15 showed 31% prairie species with three prairie elements the dominant species; Andropogon gerardii (82%), Rosa carolina (70%), and Euphorbia corollata (54%). Sites 504 (12 prairie species), 207 (27 prairie species), and 524 (25 prairie species), west of Colon indicate remnants. All are a mile long. Besides the large number of prairie species, the presence of a few rare species indicate this area as a remnant, (Eryngium yuccifolium, Viola sagittata, and Liatris spicata). In Van Buren County (Figure 12), eight sites along the NYCRR right-of-way between Decatur and Mattawan

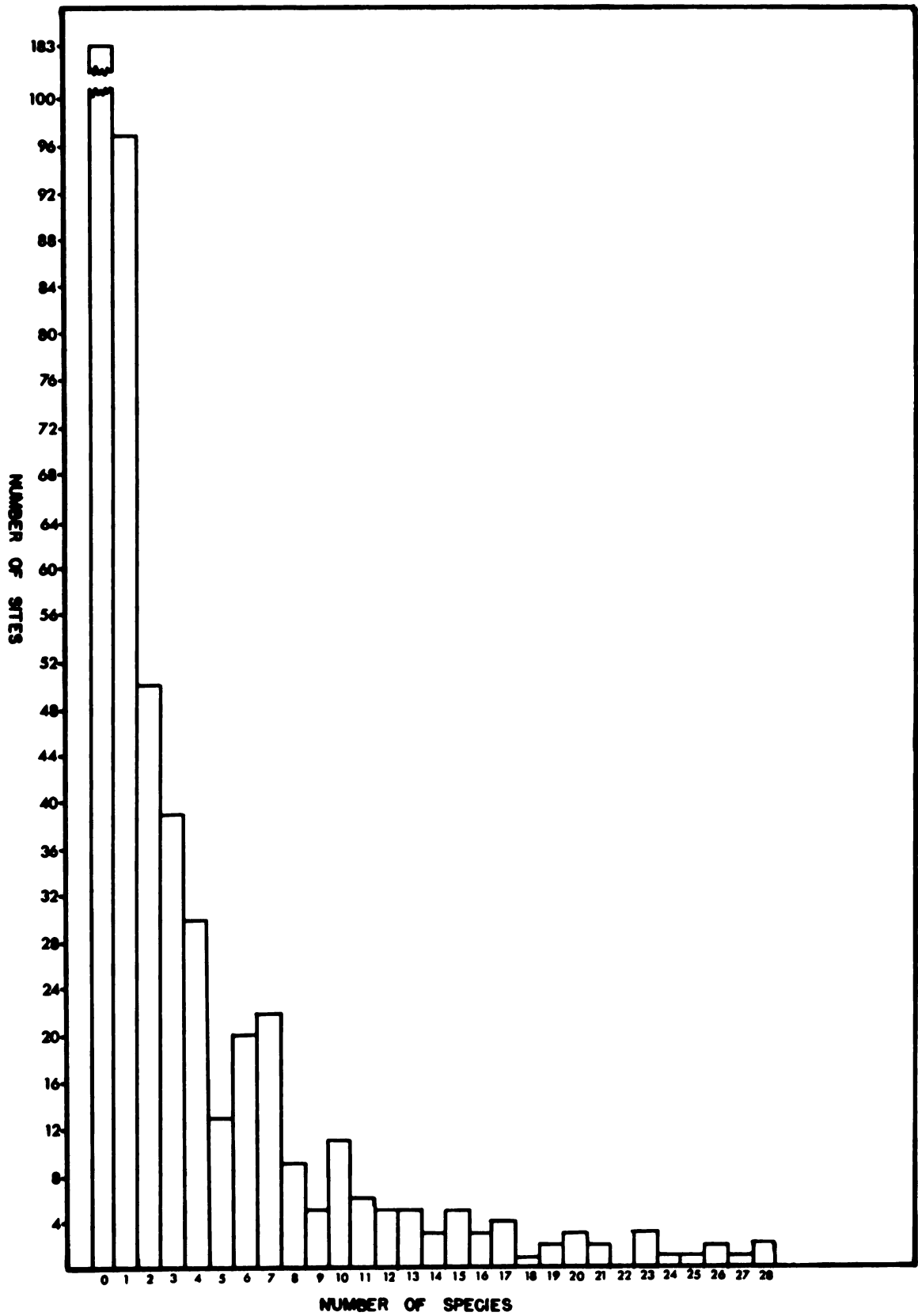
probably represent oak opening remnants. This right-of-way is wider than usual. Sites 233 (13 prairie species), 232 (15 prairie species), 231 (11 prairie species), 230 (27 prairie species), 229 (12 prairie species), 228 (16 prairie species), 222 (11 prairie species), and 221 (18 prairie species) contain dry-mesic prairie species as, Anemone cylindrica, Aster azureus, Ceanothus americanus, Helianthus occidentalis, Liatris aspera, L. cylindracea, Tephrosia virginiana, and the rare Aster sericeus, as well as a predominance of Andropogon gerardii and A. scoparius. A frequency study of site 221 showed 29% prairie species with the predominant prairie species, Andropogon scoparius (75%), Sorghastrum nutans (26%), and Andropogon gerardii (20%). In Calhoun County (Figure 8), six sites along the NYCRR right-of-way between Battle Creek and Albion indicate remnants. The six sites are: 31 (16 prairie species), 30 (20 prairie species), 29 (17 prairie species), 481 (15 prairie species), 27 (11 prairie species), and 25 (11 prairie species). Although these sites are distant from the small recorded relicts in the western and southern part of this country, "good" remnants are definitely present. Site 30 contains the most extensive population of Stipa spartea found in this study. A frequency study revealed Stipa in 89% of the sample quadrats. This site also had the highest percentage of prairie species (49%). Other high ranking prairie species were Andropogon gerardii (46%), and Helianthus occidentalis (34%). A frequency study at site 31 showed a high percentage of prairie species (36%) with Euphorbia corollata (83%) and Andropogon scoparius as the predominant prairie species. In Branch County (Figure 7), site 148 (11 prairie species), east of Bronson is a remnant with Andropogon gerardii as the predominant species. In Jackson County (Figure 13), five sites indicate remnants. Sites 473 (15 prairie species), 471 (19 prairie

species), and 44 (14 prairie species), west of Jackson, represent various kinds of prairies along the NYCRR right-of-way. Site 473 is one and one-half miles long with wet, mesic, and dry prairie species present due to a wide range of moisture conditions present on the site. A frequency study at site 471 showed 28% prairie species with Andropogon gerardii (29%) and Silphium terebinthinaceum (22%), the 3rd and 6th ranked of the 46 species present. This is a wet-mesic prairie remnant. Site 55, (20 prairie species), southwest of Jackson, also contains prairie species representing various types of moisture conditions. Site 137 (11 prairie species) indicates an oak opening but heavily invaded with woody species. In Hillsdale County (Figure 13), site 491 (13 prairie species), north of Jonesville suggests a remnant of a dry prairie. This site is an abandoned pasture. A frequency study showed 23% prairie species with Cyperus filiculmis (80%) and Andropogon scoparius (52%) the predominant prairie species.

If any of the 19 "good" sites which indicate remnants of recorded original prairie or any of the 29 "good" sites which indicate remnants of unrecorded original prairie are in fact invaded disturbed sites (certain parts of a given site may be disturbed) this can only be verified by future study of the soil surfaces. Most of the sites described above do not have obvious evidence of disturbance.

A majority of the 297 sites with 10 prairie species or less (except zero) Figure 14, or lacking a predominant prairie species, are noteworthy "fair" to "poor" remnants or invaded sites. Only a few of these sites will be described to further show the evidence of numerous remnants of prairie in southwestern Michigan. For example, the flora was predominantly non-prairie at sites 270 (6 prairie species) and 272 (4 prairie species) in

Figure 14. Distribution of the number of prairie species found at 528 sites.



Berrien County (Figure 4) where the rare Silphium laciniatum was found. Yet, an analysis of the vegetation at site 270 showed the prairie species to have high frequency values (28%) and three of the prairie species were ranked highly in the 25 species present: (Solidago nemoralis, fifth ranked; Silphium laciniatum, ninth ranked; Rudbeckia hirta, 10th ranked). Similarly, non-prairie species dominate at site 474 (four prairie species) in Kalamazoo County (Figure 8), where Silphium integrifolium and Kuhnia eupatorioides was found. These few prairie species indicate a remnant of Michigan's largest relict prairie, Prairie Ronde, but the remnant is a "poor" one. An impressive population of Silphium perfoliatum was found on the western border of Prairie Ronde, however it was the only prairie species and it was growing on the steep railroad ballast (i.e. an invaded site). A frequency study showed Silphium in 70% of the sample quadrats. A few of the sites dominated by prairie grasses also suggest "fair" remnants. Examples were the long stretches of Andropogon gerardii in Cass County at sites 245 (10 prairie species), 238 (9 prairie species) and 239 (10 prairie species). Extensive Andropogon scoparius sites in Kalamazoo County were found in abandoned fields and open sandy areas. Examples are sites 96 (8 prairie species), 215 (10 prairie species), and 457 (4 prairie species). A frequency study at site 96 showed a high percentage of prairie species (31%) with Andropogon scoparius the predominant prairie species (76%). However, this site was found to have a disturbed soil surface. A Panicum virgatum site in Eaton County (site 1, 10 prairie species) suggests a remnant. A frequency study showed 19% of the species to be prairie species with Panicum virgatum as the conspicuous dominant (96%). An extensive Andropogon scoparius prairie was sampled in Van Buren County (site 497, 10 prairie species). Thirty-one percent of the species were

prairie species with Andropogon scoparius the conspicuous dominant (96%). In a unused portion of a cemetery in Hillsdale County (site 143) six prairie species were found. A very high percentage of prairie species (41%) was found with Andropogon gerardii the conspicuous dominant (100%). Other prairie species ranked very high: Hieracium longipilum (64%, ranked 2nd), Lespedeza capitata (36%, ranked 4th).

Most of the relict prairies were found in St. Joseph County (Kenoyer, 1934). St. Joseph County still contains the richest concentration of prairie (as remnants). Table 11 illustrates that of the 12 sites with 21 or more prairie species, 10 occur in St. Joseph County. Also of the 52 sites with 11 or more prairie species, 25 occur in St. Joseph County.

Table 11. Summary of the number of prairie plants per site for each of nine counties in SW Michigan (plus one site in Eaton County)

Number of species	Figure symbol	Counties												
		BERRIEN-KALAMAZOO-ST.	JOSEPH-VAN BUREN-JACKSON-CASS-BRANCH-CALHOUN-HILLSDALE-EATON											
0	○	40	26	9	37	12	21	11	11	10	0	177		
1-5	△	39	49	23	18	32	18	25	18	13	0	235		
6-10	□	5	9	16	6	13	5	5	4	2	1	66		
11-15	◐	0	0	9	2	3	2	1	3	3	0	23		
16-20	◑	0	0	5	5	2	1	0	3	0	0	16		
21-25	●	0	0	8	0	0	0	0	0	0	0	8		
26-30 (28)	▲	0	0	2	1	0	1	0	0	0	0	4		
Total		84	84	72	69	62	48	42	39	28	1	529		

DISCUSSION

The relative absence of literature on prairie vegetation in Michigan is, in part, symptomatic of the difficulties encountered during this study. Except for two recently published papers (Brewer, 1965; Pokora, 1968) little information is available concerning the prairie flora and consequently, remnants of the tall grass prairies in southwestern Michigan. Moreover, most authors who have dealt with the subject of tall grass prairie in Michigan suggest that it, as well as much of the prairie flora, has all but vanished from the state. Therefore, the search for remnants during this study was principally exploratory.

Kinds of Prairies

Besides wet, mesic, and dry prairies, each defineable by a moisture gradient and flora, there are other categories which describe the quality and history of a site having a "prairie" aspect. Virgin prairie, original prairie, relict prairie, remnant, revegetated prairie, disturbed and undisturbed prairie are such categories.

The views of what constitutes a "prairie" or even "virgin prairie" are variable and often vague or undefined. As long as there are prairie species present, a few conspicuously dominant ones with several locally dominant species, the site is called a "prairie". This is the view implied by Thompson (1970) and Brewer (1965). Thompson (1970) refers to an Ann Arbor wet prairie as a "relic of pioneer days" based on presence of the prairie flora alone. To define "prairie", others have used characteristics as, complete absence of trees (treelessness), dominance of grasses, level topography (Gleason, 1917), shade intolerant herbs, deep roots or extensive rhizomes which favor the survival of plants

following extended droughts or fire (Hayes, 1964). Rogers related his reasons to those of Curtis', Vegetation of Wisconsin, 1959. Gleason (1917) used the characteristics he cited to describe the site as a "relic colony of prairie plants, persisting from a time when prairies occupied a wide extent in southern Michigan, and now somewhat mixed with various marsh species which have immigrated in recent times from neighboring swamps and bogs". All have disregarded any consideration of the soil surface. One can conclude that criteria for distinguishing types of prairie from one another especially between virgin or original prairie and populations of prairie plants on disturbed sites such as old fields, are vague and the condition of the soil surface is not important. If just the presence of prairie species constitutes a prairie, this survey revealed at least 345 sites which can be called prairie. Certainly, a site called "prairie" in Michigan warrants more restrictions than just presence of one prairie species. The authors cited above implied the site was impressive due to a large number of prairie species and therefore called them "prairies". But the number of species, the extent of the populations, and the proportion of non-prairie herbs and woody vegetation that is acceptable for a site to be called "prairie", is unknown. The condition of the surface may not really be important. It may not make any difference if the prairie flora is on a disturbed site or undisturbed site.

It seems that if one were concerned with the prairie as a functional array, disturbance is an important factor. Phytosociological relationships characteristic of tall-grass prairie may be different or break down under a given amount of disturbance. And perhaps a different set of relationships is operating if prairie vegetation invades a

disturbed site. Distinguishing between sites with a prairie flora on disturbed and undisturbed surfaces appears to be important. And distinguishing between sites on disturbed and undisturbed surfaces with many and few species may also be important. Therefore, there seem to be several categories of "prairie" depending on the quality and therefore history of the site. Four categories appear evident:

- A. Undisturbed surface, large number of prairie species.
- B. Undisturbed surface, few prairie species.
- C. Disturbed surface, large number of prairie species.
- D. Disturbed surface, few prairie species.

All studies in Michigan describing characteristics of prairies (except Hauser 1953) disregarded soil surface. The present study included a preliminary examination of soil at various sites, therefore, no categorization can be made for all 345 sites containing at least one species. However, of the 25 sites examined for soil surface disturbance (by digging one or more soil pits and if no plow line or excavation line was evident it was considered undisturbed) 12 were considered undisturbed, 9 disturbed and in 4 sites separate pits suggested both disturbed and undisturbed surfaces (31, 37, 221, 368). If the last four sites are considered in the two previous categories, and these sites are classified into the proposed four categories above (A, B, C, D) A=9 sites, B=6, C=5, D=6 (site 368 had no prairie species). One can conclude that there is about equal chance that a site with prairie species may be disturbed or undisturbed.

Distinguishing between disturbed and undisturbed sites is very important when one wishes to determine if the site is a remnant of an original prairie (virgin prairie, relict prairie). An original prairie must have an unbroken surface. Therefore prairies under the category of

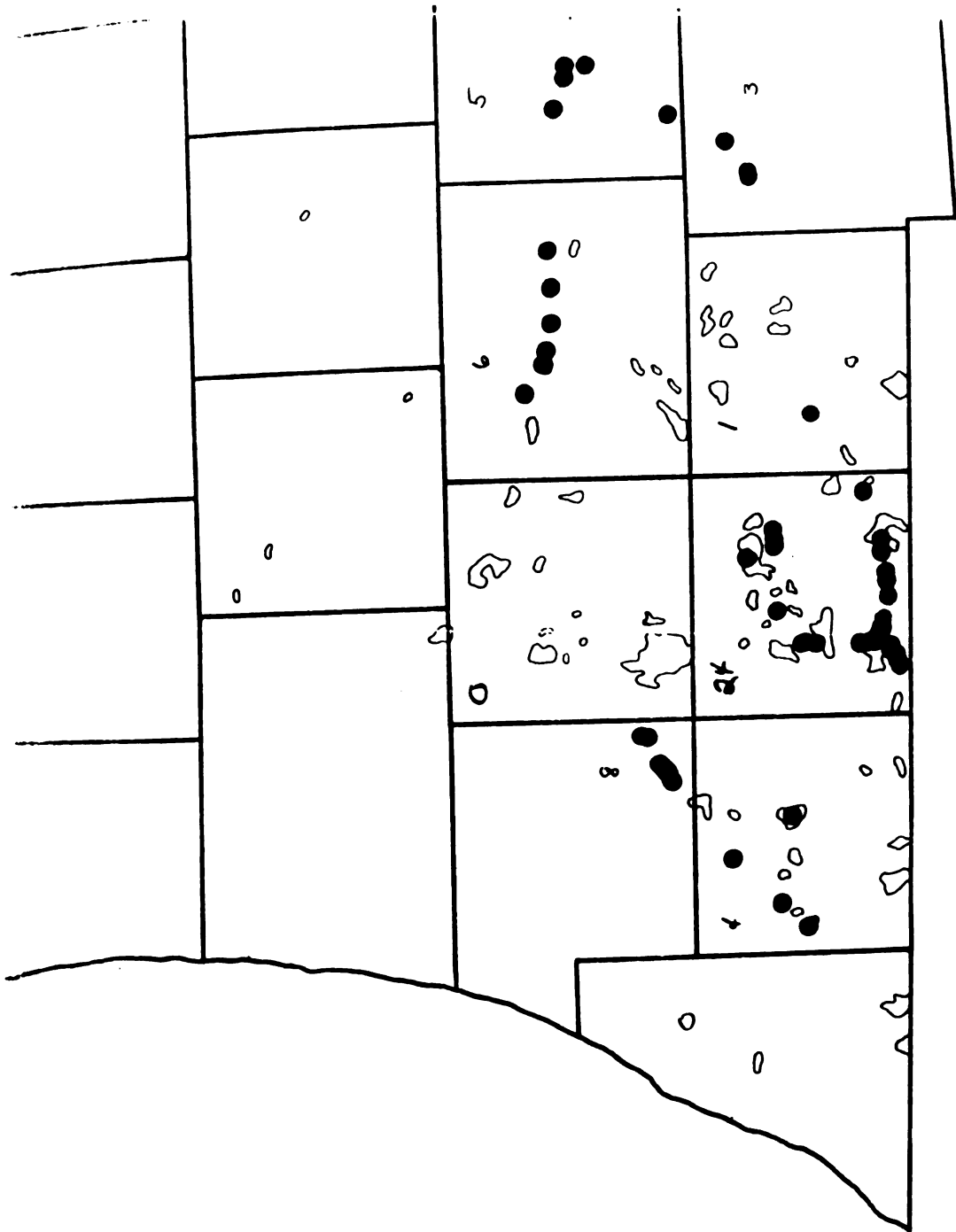
"A" or "B" would be considered remnants. The greater the number of prairie species, the more extensive the populations, the more value this site has as a remnant of an original prairie.

Applying the term "remnant" (implying undisturbed surfaces) to disturbed sites (C and D), even when a large number of prairie species are present, is questionable. Perhaps, then, the flora is relict but the surface is not. Hauser (1953) concluded that the Newaygo prairies he examined contained no virgin prairie. Nor did he apply "remnant" or any other term to describe the quality or history of these prairies, even though at present this is the largest area with a collection of prairie plants, some of them the most rare species (Geum triflorum, Aster sericeus, Phlox pilosa). How one might tell if a given site with prairie species is on a disturbed surface or not (without checking) may be possible. One might infer that sites dominated by one species would imply a disturbed surface. Frequency studies of disturbed and undisturbed sites do not support this (sites 96 and 221 are disturbed sites, sites 30, 143, and 512 are undisturbed) Table 10.

Without surface disturbance data on all 345 sites with one or more prairie species, the question of the number of remnants as well as quality, is still unanswered.

If one considers 11 or more species as a "large number of species", then 50 "good" sites (Figure 15) are in categories "A" and "C". Almost all 50 "good" sites described in the results section suggest remnants ("A") even though all were not tested for disturbance. Disturbance checks on several "good" sites did reveal plow lines such as in sites 221, 222 in Van Buren County and site 31 in Calhoun County. In most sites the topography of the right-of-way was very similar to adjacent

Figure 15. Sites with 11 or more prairie species in southwestern Michigan. Sites are suggested to be remnants of recorded and unrecorded relicts.



areas, suggesting no soil disturbance. It must also be remembered that all sites as described in Appendix B do not always contain continuous populations of prairie species. Much non-prairie and woody vegetation is present as is disturbed surfaces, such as slopes, land-fills. Such is the usual character of railroad rights-of-way.

The results of this survey confirm the belief that no large remnants of virgin prairie still exist in southwestern Michigan. If the criteria for identifying virgin prairie included that the site must contain only prairie species in addition to the unbroken surface, then Michigan still has virgin prairie, but its extent would be a few square meters. These remnants are difficult to find. The frequency studies showed that 65 (0.05%) of the 1178 quarter meter quadrats (in 11 sites) contained all prairie species, and not all of the sites tested were undisturbed surfaces. However, the criterion concerning the supposition that sites must contain only prairie species to be remnants of virgin prairie seems to limiting. There must be value in these sites with prairie species even if non-prairie species are present. Sites with 11 or more species (though arbitrary) is at least a criterion based on variety. Many of the "good" sites, in addition to the "large number of species" had high percentages of prairie species (13-49%), they had rare flora, and high ranking prairie species.

The "good sites (remnants) do not always correspond with a previously recorded prairie. One must conclude then that there were unrecorded prairies. Possible reasons why these sites were unrecorded are that, 1) they are areas which were too small to be included in the original survey and were similarly missed by others (Veatch, 1928; Kenoyer, 1930, 1934, 1940). Good sites can be found on other soils

besides the dark Warsaw Loam. For example, the row of "good" sites in Calhoun County, between Battle Creek and Marshall, closely correspond to the vegetation area noted by Kenoyer (1940) as bur oak forest. Also, this row of sites corresponds to a narrow band of the Fox, Oshtemo soil series (Whiteside, Schneider, and Cook, 1963), a soil closely related to the Warsaw Loam. The row of sites also corresponds closely to a narrow stretch of sandy lake beds and the Kalamazoo River valley (Martin, 1955). Bur oak forests, in addition to grassy prairies, should be considered as sites which contain remnants of the prairie flora. It is not surprising to find some of the best prairie sites in Michigan coinciding with the original bur oak forests (site # 30 is an impressive Stipa spartea prairie remnant, 49% prairie species). The row of remnants in southwestern Van Buren County also represents a different soil series and surface formations. Here, the soils are also sandy loam but the terrain is rolling to steeply sloping (Whiteside, Schneider, and Cook, 1963). The surface formations are unlike the features where prairies usually are found, namely the outwash plains. In Van Buren County, the remnants appear to be present on ground moraine, ponded waters, and moraines (Martin, 1955). Perhaps these peripheral areas represent areas where the prairie species have found refuge.

Prairie Flora

The best prairie indicators are those species which occurred most frequently in the remnants. Coreopsis palmata and Lithospermum canescens are the best indicators. All 10 sites of each species occurred in remnants (100% Table 12). Eleven other species had all sites in remnants, among them Ruellia humilis, Viola pedata, and Eryngium yuccifolium.

Table 12. Prairie species which were found most frequently in sites with 11 or more species. These species with the highest percentages suggest the best indicators of prairie, whereas those with the lowest percentages are the poorest indicators. There were 50 sites with 11 or more species.

Prairie species	Total sites	Sites >10	Percentage
<i>Coreopsis palmata</i>	10	10	100
<i>Lithospermum canescens</i>	10	10	100
<i>Ruellia humilis</i>	5	5	100
<i>Viola pedata</i>	5	5	100
<i>Carex bicknellii</i>	3	3	100
<i>Asclepias viridiflora</i>	2	2	100
<i>Eryngium yuccifolium</i>	2	2	100
<i>Allium cernuum</i>	1	1	100
<i>Aster sericeus</i>	1	1	100
<i>Helianthus mollis</i>	1	1	100
<i>Sisyrinchium albidum</i>	1	1	100
<i>Viola pedatifida</i>	1	1	100
<i>Viola sagittata</i>	1	1	100
<i>Potentilla arguta</i>	16	14	88
<i>Salix humilis</i>	20	17	85
<i>Desmodium sessilifolium</i>	18	15	83
<i>Aster azureus</i>	11	9	82
<i>Aster ericoides</i>	11	8	80
<i>Stipa spartea</i>	10	8	80
<i>Comandra richardsoniana</i>	10	8	80
<i>Verbena stricta</i>	13	10	77
<i>Helianthus occidentalis</i>	39	29	74
<i>Aster laevis</i>	17	12	71
<i>Kuhnia eupatorioides</i>	20	14	70
<i>Solidago rigida</i>	35	24	69
<i>Anemone cylindrica</i>	30	20	67
<i>Liatris spicata</i>	3	2	67
<i>Lithospermum carolinense</i>	3	2	67
<i>Panicum oligosanthos</i>	43	29	67
<i>Liatris aspera</i>	29	19	65
<i>Ratibida pinnata</i>	45	29	65
<i>Ceanothus americanus</i>	43	28	65
<i>Amorpha canescens</i>	11	7	64
<i>Corylus americana</i>	33	21	64
<i>Tephrosia virginiana</i>	11	7	64
<i>Heuchera richardsonii</i>	5	3	60
<i>Liatris cylindracea</i>	10	6	60
<i>Asclepias verticillata</i>	17	10	59
<i>Solidago speciosa</i>	19	11	54
<i>Baptisia leucantha</i>	15	8	53
<i>Rosa carolina</i>	28	15	53
<i>Sorghastrum nutans</i>	57	29	51
<i>Pycnanthemum virginianum</i>	10	5	50
<i>Silphium integrifolium</i>	8	4	50
<i>Solidago nemoralis</i>	31	15	50

Table 12. (continued)

<u>Prairie species</u>	<u>Total sites</u>	<u>Sites >10</u>	<u>Percentage</u>
<i>Elymus canadensis</i>	28	14	50
<i>Spartina pectinacea</i>	14	8	52
<i>Asclepias amplexicaulis</i>	21	11	48
<i>Desmodium canadense</i>	17	8	47
<i>Desmodium illinoense</i>	53	25	47
<i>Veronicastrum virginianum</i>	42	19	45
<i>Euphorbia corollata</i>	97	40	41
<i>Lespedeza capitata</i>	86	35	41
<i>Coreopsis tripteris</i>	51	19	37
<i>Hieracium longipilum</i>	17	6	35
<i>Solidago graminifolia</i>	45	16	35
<i>Silphium laciniatum</i>	3	1	33
<i>Asclepias tuberosa</i>	131	42	32
<i>Andropogon scoparius</i>	124	37	30
<i>Sporobolus asper</i>	20	6	30
<i>Rudbeckia hirta</i>	35	10	29
<i>Silphium terebinthinaceum</i>	24	7	29
<i>Cacalia atriplicifolia</i>	11	3	27
<i>Panicum virgatum</i>	70	17	24
<i>Andropogon gerardii</i>	218	48	22
<i>Sporobolus cryptandrus</i>	30	6	20
<i>Echinacea pallida</i>	1	0	0

Twenty-four species with percentages of 70% or greater constitute a sizable group of indicators of prairie remnants.

The best indicators are in general the ones usually limited to remnants, such as those previously mentioned.

From Table 12 one can predict what species may drop out from the prairie flora in Michigan. Species occurring at one locality in any kind of site ("good" or "poor") such as Allium cernuum, Aster sericeus, Silphium laciniatum, Silphium perfoliatum, Eryngium yuccifolium and Echinacea pallida may be first to go. Hanes and Hanes (1949) reported Aster sericeus in Kalamazoo County as well as the site in Van Buren County. They also reported the population of Silphium perfoliatum as the only population in the county. Several sites in Kalamazoo County were reported to contain Eryngium yuccifolium. It was found to be quite common in one site by Brewer (1965). No specimens were found in this survey in Kalamazoo County. Eryngium seems to be disappearing quite rapidly.

From Table 12, one can also predict the species which will continue to spread to non-prairie habitats, (i.e. not necessarily limited to remnants). The best examples are those species with a large number of sites (at least 20) such as Silphium terebinthinaceum (a species found eastward from the Peninsula center), Coreopsis tripteris, Veronicastrum virginicum, and Desmodium illinoense. Some have spread extremely far and wide such as Andropogon gerardii, A. scoparius, Lespedeza capitata, and Euphorbia corollata.

Evaluation of Prairie Peninsula

Results of this study provide evidence with which to evaluate the Prairie Peninsula in Michigan. The extent of the Peninsula is vague for several reasons. Transeau's map (1935) shows only the prairie described by Veatch (1928). Veatch mapped only dry prairies, and his use of the term "dry" is different from that of Curtis (1958). The dry prairies referred to by Veatch are probably mesic prairies (and a few oak openings). The wet and dry prairies had not been mapped before Transeau's report and therefore the Peninsula is most likely more extensive. The additional prairies mapped by Kenoyer (1930, 1934, 1940) and Butler (1937, 1938, 1939) were never used to evaluate the Peninsula. The Peninsula was probably more extensive to the east than previously suggested by Transeau and others. This is supported by Kenoyer and Butler, and the occurrence of a prairie flora and unrecorded relicts in Calhoun, Jackson, and Hillsdale counties. It can also be noted that several species which have a western occurrence coinciding with the western boundary of the Peninsula, and the presence of large numbers of species at several sites along this boundary suggests that this boundary is quite accurate. This line also represents to the west the well drained deep sands, a soil association which does not contain large numbers of prairie species, nor contains many of the mesic or wet prairie species.

The number and size of prairie communities as well as the richness of the flora become "poorer" as one moves from the midwest prairies towards the outliers of the Prairie Peninsula into Michigan. A similar change should be present in Michigan from the center of the Peninsula to more distant areas. The data from this survey tend to confirm this

trend. St. Joseph County is Michigan's center of the Peninsula as the large number of "rich" sites indicates (Figure 11). Towards the west, north, and east, the sites as well as the flora appear to become impoverished. However, it may be predicted that a similar pattern ought to be present between St. Joseph County and the Newaygo Prairies.

Additional evidence for this pattern are species which are limited to prairie remnants in Michigan, but are found in additional habitats towards the tall-grass prairie center. Ruellia humilis is limited to the prairie remnants in St. Joseph County (Figure 18 Appendix D) whereas it is not limited to prairies in the Midwest. Ruellia, being limited to the prairies in Michigan is therefore a prairie species and as previously mentioned, one of the best indicators of remnants.

Prairie Species of Michigan

The literature also does not contain a list of criteria for distinguishing prairie species, especially in the periphery of the tall-grass prairie as in Michigan. As was pointed out above, some species not considered prairie in the Midwest are considered prairie in Michigan. The criteria used to select prairie species is of extreme importance because remnants of virgin prairie and prairies in general are defined based on the presence of prairie species. It had been assumed during the field work of this study that the species that are characteristic of the wet, mesic, and dry prairies of the tall-grass prairie center are also the prairie species comprising the outlying areas of the Prairie Peninsula, including Michigan. Most of the species that were selected were satisfactory for this study. Not all possible species were considered (such as Galium boreale, Hypoxis hirsuta, Aristida

oligantha). Some species known to be present in the state were not found during the survey (Koeleria cristata, Solidago riddellii, Geum triflorum, Phlox pilosa, and others). Some of the species are prairie species in Illinois and not in Michigan. Cole (1901) referred to Rudbeckia hirta as "Native only on the western prairies. Widely distributed in the east as a weed". Other species perhaps in this category are Solidago graminifolia, Asclepias tuberosa, and Helianthus tuberosus. Species considered prairie species in Michigan, but not necessarily in the Midwest are Ruellia humilis and Elymus canadensis. One can conclude then that there are different prairie species (or prairie indicators) in different parts of the tall-grass prairie.

The preceding speculation on characteristics of the prairie remnants and the flora are based on the assumption that present criteria of a prairie species are valid. The most important condition to be clarified before evidence can be gathered to test the above statements is the investigation and verification of what constitutes a prairie species in Michigan.

Suggestions for further study

Search the literature and authorities on prairie to collect the best criteria for selecting prairie species.

The areas studied (especially those that are rich in flora) need to be resurveyed for the spring and early summer prairie flora since the study did not include these aspects.

Additional areas suspected of containing a prairie flora such as water courses, lake shores, sand hills, and waste places need to be checked because this survey was only a partial survey of prairie habitats.

Additional counties need to be surveyed such as the area towards the prairies of Newaygo County and the counties east of the survey area. The presence of the flora in Hillsdale and western Jackson counties, and the prairie found in Ann Arbor (Thompson 1970) suggest that more remnants can be found.

With a large number of prairie sites now known as well as the location of 68 prairie species, continued studies can be made. Several ideas will follow.

All sites containing at least one prairie species need to be resurveyed to describe more precisely the extent of prairie populations.

All sites containing at least one prairie species need to have the surfaces examined for disturbance.

All sites containing at least one prairie species need to have the invasion of non-prairie species and woody vegetation evaluated.

Will the rare species persist (such as Silphium laciniatum and S. perfoliatum)? If they do, why?

Why are certain species limited to the prairie remnants (such as Ruellia humilis, Coreopsis palmata and Kuhnia eupatorioides)?

Will the "rich" sites (remnants) become more invaded or will the present prairie flora persist to a greater extent?

Are the other species such as Ruellia humilis, limited to prairie remnants in Michigan, which are found in different habitats in the mid-west?

Could management revive and maintain the railroad prairies?

Are there different ecotypes of prairie species that are found in remnants as well as in invaded sites. In other words, are the relationships between prairie flora similar or different in disturbed and undisturbed prairies?

Is there a relationship between disturbance and the kind of prairie flora or non-prairie flora present in a "prairie"?

What appears to be, if any, the pattern of invasion of prairie sites?

What appears to be, if any, the pattern of invasion of prairie species at disturbed sites?

CONCLUSION

A survey of the prairie flora and "prairies" in southwestern Michigan, which were thought to have vanished or be limited to disturbed sites, showed that the flora is still present, in great variety (68 species). Sites containing at least a large number (11 or more) of prairie species, have an aspect of a "prairie" and are rightly called such. "Prairies" on undisturbed sites are suggested criteria for referring to these sites as "remnants" of virgin (original) prairie. At least 50 "remnants" are suggested. Many sites (294) with 1-10 prairie species may similarly warrant the title of "remnant". Additional studies are suggested to verify the proposed characteristics of the "prairies" and "remnants" of tall-grass prairie in Michigan.

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APPENDICES

APPENDIX A

A list of species occurring along railroad rights-of-way in southwestern Michigan. Summer and Fall, 1969.

APPENDIX A

A list of species occurring along railroad rights-of-way in southwestern Michigan. Summer and Fall, 1969.

<i>Allium cernuum</i> Roth.	<i>Aster pilosus</i> Willd.
<i>Allium sativum</i> L.	<i>Aster sagittifolius</i> Willd.
<i>Allium vineale</i> L.	<i>Aster sericeus</i> L.
<i>Amorpha canescens</i> Pursh.	<i>Baptisia leucantha</i> T. & G.
<i>Andropogon gerardii</i> Vitm.	<i>Baptisia tinctoria</i> (L.) R.Br.
<i>Andropogon scoparius</i> Michx.	<i>Bromus inermis</i> Leyss.
<i>Andropogon virginicus</i> L.	<i>Cacalia atriplicifolia</i> L.
<i>Anemone cylindrica</i> Gray	<i>Carex bicknellii</i> Britt.
<i>Apocynum androsaemifolium</i> L.	<i>Carex siccata</i> Dewey
<i>Apocynum sibiricum</i> Jacq.	<i>Ceanothus americanus</i> L.
<i>Aristida oligantha</i> Michx.	<i>Chaenorrhinum minus</i> (L.) Lange
<i>Aristida purpurascens</i> Poir.	<i>Chrysanthemum leucanthemum</i> L.
<i>Artemisia campestris</i> L.	<i>Cicuta maculata</i> L.
<i>Artemisia vulgaris</i> L.	<i>Cirsium discolor</i> (Muhl.) Spreng.
<i>Asclepias amplexicaulis</i> Sm.	<i>Comandra richardsiana</i> Fern.
<i>Asclepias tuberosa</i> L.	<i>Convolvulus arvensis</i> L.
<i>Asclepias verticillata</i> L.	<i>Coreopsis palmata</i> Nutt.
<i>Asclepias viridiflora</i> Raf.	<i>Coreopsis tripteris</i> L.
<i>Aster azureus</i> Lindl.	<i>Cornus racemosa</i> Lam.
<i>Aster ericoides</i> L.	<i>Corylus americana</i> Walt.
<i>Aster laevis</i> L.	<i>Cyperus filiculmis</i> Vahl.
<i>Aster novae-angliae</i> L.	<i>Desmodium canadense</i> (L.) DC.

- Desmodium illinoense* Gray
Desmodium marilandicum (L.) DC.
Desmodium paniculatum (L.) DC.
Desmodium sessilifolium (Torr.)
 T. & G.
Dianthus armeria L.
Digitaria filiformis (L.) Koeler
Echinacea pallida Nutt.
Elymus canadensis L.
Equisetum arvense L.
Eragrostis spectabilis (Pursh.)
 Steud.
Eryngium yuccifolium Michx.
Eupatorium altissimum L.
Eupatorium perfoliatum L.
Eupatorium semiserratum DC.
Euphorbia corollata L.
Euphorbia serpyllifolia Pers.
Fragaria virginiana Duchesne.
Galium asprellum Michx.
Galium boreale L.
Gentiana flavida Gray
Gerardia purpurea L.
Gnaphalium obtusifolium L.
Helianthemum canadense (L.) Michx.
Helianthus divaricatus L.
Helianthus giganteus L.
Helianthus grosserserratus
 Martens
Helianthus hirsutus Raf.
Helianthus mollis Lam.
Helianthus occidentalis Riddell
Helianthus strumosus L.
Helianthus tuberosus L.
Heuchera richardsonii R.Br.
Hieracium longipilum Torr.
Hypericum perforatum L.
Hyssopus officinalis L.
Kuhnia eupatorioides L.
Lactuca canadensis L.
Lathyrus maritimus (L.) Bigel.
Lespedeza capitata Michx.
Lespedeza hirta (L.) Hornem
Lespedeza intermedia (Wats.) Britt.
Liatris aspera Michx.
Liatris cylindracea Michx.
Liatris novae-angliae (Lunell)
 Shinnars
Liatris spicata (L.) Willd.
Lilium philadelphicum L.
Lithospermum canescens (Michx.) Lehm.
Lithospermum carolinense (Walt.)
 MacMill.
Lupinus perennis L.
Lycium halimifolium Mill.
Lysimachia ciliata L.
Lysimachia lanceolata Walt.

- Monarda fistulosa* L.
Monarda punctata L.
Oxybaphus nyctagineus (Michx.) Sweet
Panicum depauperatum Muhl.
Panicum oligosanthos Schult.
Panicum virgatum L.
Panicum xanthophysum Gray
Parthenium hispidum Raf.
Pastinaca sativa L.
Pimpinella saxifraga L.
Plantago patagonica Jacq.
Polanisia dodecandra (L.) DC.
Polygonella articulata (L.) Meissn.
Potentilla arguta Pursh.
Prunella vulgaris L.
Pycnanthemum virginianum (L.) Durand & Jackson
Ratibida pinnata (Vent) Barnh.
Rosa blanda Ait.
Rosa caroliniana L.
Rosa palustris Marsh.
Rubus flagellaris Willd.
Rudbeckia hirta L.
Rudbeckia triloba L.
Ruellia humilis Nutt.
Sabatia angularis (L.) Pursh
Salix humilis Marsh.
Silphium integrifolium Michx.
Silphium laciniatum L.
Silphium perfoliatum L.
Silphium terebinthinaceum Jacq.
Sisyrinchium albidum Raf.
Solanum carolinense L.
Solidago canadensis L.
Solidago graminifolia (L.) Salisb.
Solidago missouriensis Nutt.
Solidago nemoralis Ait.
Solidago rigida L.
Solidago rugosa Mill.
Solidago speciosa Nutt.
Sorghastrum nutans (L.) Nash
Spartina pectinacea Link
Sporobolus asper (Michx.) Kunth
Sporobolus cryptandrus (Torr.) Gray
Stachys hyssopifolia Michx.
Stipa spartea Trin.
Tephrosia virginiana (L.) Pers.
Thalictrum dasycarpum Fisch. & Ave-Lall.
Thaspium trifoliatum (L.) Gray
Tradescantia ohimensis Raf.
Triodia flava (L.) Smyth
Verbena stricta Vent.

Vernonia missurica Raf.

Veronica officinalis L.

Veronicastrum virginianum (L.)
Farw.

Vicia cracca L.

Vicia sativa L.

Viola arvensis Murr.

Viola pedata L.

Viola pedatifida G. Don.

Viola sagittata Ait.

APPENDIX B

Descriptions of sites containing at least one prairie species. Included in the description are: county, township, tier (T), range (R), section or sections, railroad track and road, and number of prairie species. Railroads are abbreviated: CORR (Chesapeake and Ohio Railroad), GTWRR (Grand Trunk Western Railroad), MCRR (Michigan Central Railroad), NYCRR (New York Central Railroad), and PCRR (Pennsylvania Central Railroad). Names of roads and railroads were based on county maps, Michigan Department of Conservation (1961 edition).

APPENDIX B

Descriptions of sites containing at least one prairie species.

1. (only site with prairie species that is not mapped)
Eaton Co., Bellvue Twp.; T1N,R6W,Sec.23,24; along GTWRR and M-78.
10 species.
2. Kalamazoo Co., Richland Twp.; T1S,R10W,Sec.16; along MCRR at 30th St. 4 species.
3. Kalamazoo Co., Richland Twp.; T1S,R10W,Sec.8; along MCRR at 27th St. 1 species.
6. Kalamazoo Co., Comstock Twp.; T2S,R10W,Sec.22,23; along NYCRR and M-96. 3 species.
8. Kalamazoo Co., Schoolcraft Twp.; T4S,R11W,Sec.14,23; along GTWRR at W Ave. 2 species.
10. Kalamazoo Co., Kalamazoo Twp.; T2S,R11W,Sec.14,24; along NYCRR and M-96. 4 species.
11. Calhoun Co., Emmett Twp.; T2S,R7W,Sec.19,20; the sw. corner of the I-94 and Beadle Lake Rd (7½ mile Rd.) crossing. 6 species.
12. St. Joseph Co., Constantine Twp.; T7S,R12W,Sec.36; along NYCRR between Stears and Brown Rds. 25 species.
13. St. Joseph Co., White Pigeon Twp.; T8S,R12W,Sec.1; along NYCRR between Brown Rd. and U.S. 12 (112). 21 species.
14. St. Joseph Co., White Pigeon Twp.; T8S,R11W,Sec.10; along NYCRR at Crooked Creek Rd. 17 species.
15. St. Joseph Co., White Pigeon Twp.; T8S,R11W,Sec.11,12; along NYCRR at Huff Rd. 13 species.
16. St. Joseph Co., White Pigeon-Sturgis Twp. line; T8S,R11W(White Pigeon)R10W(Sturgis)Sec.12(R11W)Sec.7(R10W); along NYCRR at Klinger Lake Rd. 4 species.
17. St. Joseph Co., Sturgis Twp.; T8S,R10W,Sec.7; along NYCRR between U.S. 12(112) and Shimmel Rd. 23 species.
18. St. Joseph Co., Sturgis Twp.; T8S,R10W,Sec.4,5; along NYCRR at Stubey Rd. 7 species.
19. St. Joseph Co., Sherman-Nottawa Twp. line; T7S(Sherman)T6S(Nottawa), R10W,Sec.35(T7S)Sec.2(T6S); along PCRR at Findley Rd. 1 species.
25. Calhoun Co., Marengo Twp.; T2S,R5W,Sec.25,26; along NYCRR at B Dr. 11 species.

26. Calhoun Co., Marengo Twp.; T2S,R5W,Sec.32; along NYCRR at corner of B Dr. and 20 mile Rd. 3 species.
27. Calhoun Co., Marengo Twp.; T2S,R5W,Sec.30,31; along NYCRR and B Dr. 11 species.
28. Calhoun Co., Marshall Twp.; T2S,R6W,Sec.27; along NYCRR at 15 $\frac{1}{2}$ mile Rd. 6 species.
29. Calhoun Co., Emmett Twp.; T2S,R7W,Sec.24; along NYCRR between 11 and 12 mile Rds. 17 species.
30. Calhoun Co., Emmett Twp.; T2S,R7W,Sec.22,23; along NYCRR between F Dr. and 11 mile Rd. 20 species.
31. Calhoun Co., Emmett Twp.; T2S,R7W,Sec.8,9; along NYCRR between Raymond St. and BL-94 (M-96). 16 species.
35. Ingham Co., Leslie Twp.; T1N,RLW,Sec.28,33; along NYCRR at Olde Rd. 1 species.
36. Jackson Co., Rives Twp.; T1S,RLW,Sec.4,5; along NYCRR between Territorial and Churchill Rds. 7 species.
37. Jackson Co., Rives Twp.; T1S,RLW,Sec.7; along NYCRR at Rives Junction Rd. 8 species.
38. Jackson Co., Rives Twp.; T1S,RLW,Sec.20; along NYCRR at Boughwell Rd. 5 species.
39. Jackson Co., Blackman Twp.; T2S,RLW,Sec.4; along Ridge Rd. between Van Horn and Walcott Rds. 1 species.
40. Jackson Co., Blackman Twp.; T2S,RLW,Sec.9; along NYCRR at Morrill Rd. 2 species.
41. Jackson Co., Blackman Twp.; T2S,RLW,Sec.15; along NYCRR at Cunningham Rd. 1 species.
42. Jackson Co., Blackman Twp.; T2S,RLW,Sec.15,22; along NYCRR at Parnall Rd. 4 species.
44. Jackson Co., Blackman Twp.; T2S,RLW,Sec.32; along NYCRR and Michigan Ave. 14 species.
45. Jackson Co., Sandstone Twp.; T2S,R2W,Sec.36; along NYCRR and Michigan Ave. at O'Brien Rd. 6 species.
46. Jackson Co., Sandstone Twp.; T2S,R2W,Sec.34,35; along NYCRR at Sandstone Rd. 6 species.
47. Jackson Co., Sandstone Twp.; T2S,R2W,Sec.34; along NYCRR at Dearing Rd. 4 species.

48. Jackson Co., Sandstone Twp.; T2S,R2W,Sec.29,32; along NYCRR at Harrington Rd. 4 species.
49. Jackson Co., Sandstone Twp.; T2S,R2W,Sec.30; along NYCRR at McLain Rd. 7 species.
50. Jackson Co., Parma Twp.; T2S,R3W,Sec.35,36; along NYCRR at Little Rd. 6 species.
51. Jackson Co., Concord Twp.; T3S,R3W,Sec.10; along NYCRR at Concord Rd. 5 species.
53. Calhoun Co., Sheridan Twp.; T2S,R3W,Sec.36; along NYCRR and Davison Rd. 4 species.
54. Calhoun Co., Sheridan Twp.; T2S,R3W,Sec.29; along NYCRR and M-96. 6 species.
55. Jackson Co., Summit Twp.; T3S,R1W,Sec.16; along NYCRR at Park Rd. 20 species.
57. Jackson Co., Spring Arbor Twp.; T3S,R2W,Sec.23,24; along NYCRR at Reynolds Rd. 1 species.
58. Jackson Co., Spring Arbor Twp.; T3S,R2W,Sec.22,23; along NYCRR at Moscow Rd. 2 species.
59. Jackson Co., Spring Arbor Twp.; T3S,R2W,Sec.28; along NYCRR at Teft Rd. 3 species.
60. Jackson Co., Spring Arbor Twp.; T3S,R2W,Sec.29; along NYCRR at Mathews Rd. 1 species.
61. Jackson Co., Spring Arbor Twp.; T3S,R2W,Sec.29; along NYCRR at Cross Rd. 2 species.
62. Jackson Co., Concord Twp.; T3S,R3W,Sec.25; along NYCRR at Parsons Rd. 6 species.
63. Jackson Co., Concord Twp. T3S,R3W,Sec.27; along NYCRR at Pulaski St. 1 species.
64. Jackson Co., Concord Twp.; T3S,R3W,Sec.33; along NYCRR and Spring Arbor Rd. (M-60). 8 species.
65. Jackson Co., Pulaski Twp.; T4S,R3W,Sec.5,6; along NYCRR at Wheeler Rd. 1 species.
66. Jackson-Calhoun Co. line, Pulaski-Homer Twp. line; T4S,R3W(Pulaski) R4W(Homer);Sec.7(R3W)Sec.12(R4W); along NYCRR at Van Wert Rd. 4 species.
67. Calhoun Co., Homer Twp.; T4S,R4W,Sec.11,12; along NYCRR at 29th mile Rd. 10 species.

68. Calhoun Co., Homer Twp.; T4S,R4W,Sec.2,3; along NYCRR at 28th mile Rd. 1 species.
71. Branch Co., Sherwood Twp.; T5S,R8W,Sec.32,33; along NYCRR at Ladyman Rd. 6 species.
72. Branch Co., Sherwood Twp.; T5S,R8W,Sec.27; along NYCRR at Locke Rd. 2 species.
74. Branch Co., Sherwood Twp.; T5S,R8W,Sec.23,24; along NYCRR at Thrans Rd. 3 species.
77. Branch Co., Union Twp.; T5S,R7W,Sec.7,8; along NYCRR at Arborgast Rd. 3 species.
78. Branch Co., Union Twp.; T5S,R7W,Sec.8,9; along NYCRR at South Rd. 1 species.
80. Branch Co., Union Twp.; T5S,R7W,Sec.3,4; along NYCRR at Railroad Rd. 3 species.
81. Branch-Calhoun Co. line, Union-Burlington Twp. line; T5S(Union)T4S(Burlington),R7W,Sec.3(T5S)Sec.34(T4S); along NYCRR at Wagner Rd. (County Line Rd.) 1 species.
82. Calhoun Co., Burlington Twp.; T4S,R7W,Sec.34,35; along NYCRR at 10 mile Rd. 2 species.
83. Calhoun Co., Burlington Twp.; T4S,R7W,Sec.35,36; along NYCRR at 11 mile Rd. 3 species.
86. Calhoun Co., Tekonsha Twp.; T4S,R6W,Sec.29,30; along NYCRR at 13 mile Rd. 1 species.
87. Calhoun Co., Tekonsha Twp.; T4S,R6W,Sec.29; along NYCRR at Jackson Rd. 1 species.
88. Calhoun Co., Tekonsha Twp.; T4S,R6W,Sec.28; along NYCRR at 15 mile Rd. 1 species.
89. Calhoun Co., Tekonsha Twp.; T4S,R6W,Sec.23; along NYCRR at T Dr. 2 species.
90. Calhoun Co., Tekonsha Twp.; T4S,R6W,Sec.23; along NYCRR at Jackson Rd. 1 species.
91. Calhoun Co., Claredon Twp.; T4S,R5W,Sec.19; along NYCRR at 18½ mile Rd. 1 species.
92. Calhoun Co., Claredon Twp.; T4S,R5W,Sec.18,19; along NYCRR at corner of 19 mile Rd. and R Dr. 2 species.

96. Kalamazoo Co., Ross Twp.; TLS,R9W,Sec.4; the ne. corner at 42nd and B Ave. Rds. 8 species.
97. Kalamazoo Co., Richland Twp.; TLS,R10W,Sec.8; along NYCRR at 27th St. 2 species.
98. Kalamazoo Co., Richland Twp.; TLS,R10W,Sec.8,17; along NYCRR at C Ave. 2 species.
99. Kalamazoo Co., Richland Twp.; TLS,R10W,Sec.18; along NYCRR at CD Ave. 1 species.
100. Kalamazoo Co., Richland Twp.; TLS,R10W,Sec.19; along NYCRR at 25th St. 1 species.
101. Kalamazoo Co., Richland Twp.; TLS,R10W,Sec.19; along E Ave. west of NYCRR crossing. 2 species.
102. Kalamazoo Co., Cooper Twp.; TLS,R11W,Sec.25,26; along NYCRR at Riverview Rd. 2 species.
106. Kalamazoo Co., Pavilion Twp.; T3S,R10W,Sec.8,17; along GTWRR at P Ave. 2 species.
107. Kalamazoo Co., Pavilion Twp.; T3S,R10W,Sec.20,21; along GTWRR at 28th St. 3 species.
108. Kalamazoo Co., Pavilion Twp.; T3S,R10W,Sec.21; along GTWRR at QR Ave. 1 species.
109. Kalamazoo Co., Pavilion Twp.; T3S,R10W,Sec.28; along GTWRR at 29th St. 1 species.
110. Kalamazoo Co., Pavilion Twp.; T3S,R10W,Sec.27,34; along GTWRR at S Ave. 1 species.
111. Kalamazoo Co., Pavilion Twp.; T3S,R10W,Sec.34; along GTWRR at 30th St. 1 species.
114. Kalamazoo Co., Pavilion Twp.; T3S,R10W,Sec.24,25,26; along GTWRR at corner of 34th St. and R Ave. 1 species.
115. Kalamazoo Co., Pavilion Twp.; T3S,R10W,Sec.24; along GTWRR at 35th St. 4 species.
118. Kalamazoo Co., Climax Twp.; T3S,R9W,Sec.17,18; along GTWRR at 38th St. 1 species.
119. Kalamazoo Co., Climax Twp.; T3S,R9W,Sec.8,17; along GTWRR at P Ave. 4 species.
120. Kalamazoo Co., Climax Twp.; T3S,R9W,Sec.9,10; along GTWRR at 42nd St. 1 species.

122. Kalamazoo Co., Charlston Twp.; T2S,R9W,Sec.36; along GTWRR at MN Ave. 3 species.
123. Calhoun Co., Battle Creek Twp.; T2S,R8W,Sec.30; along GTWRR at C Dr. 1 species.
124. Jackson Co., Spring Arbor Twp.; T3S,R2W,Sec.36; along NYCRR at Sears Rd. 1 species.
126. Jackson Co., Hanover Twp.; T4S,R2W,Sec.2; along NYCRR at Coats Rd. 8 species.
129. Jackson Co., Hanover Twp.; T4S,R2W,Sec.10; along NYCRR at Tripp Rd. 9 species.
130. Jackson Co., Hanover Twp.; T4S,R2W,Sec.10; along NYCRR at Weeks Rd. 2 species.
131. Jackson Co., Hanover Twp.; T4S,R2W,Sec.10,15; along NYCRR at Fowler Rd. 3 species.
132. Jackson Co., Hanover Twp.; T4S,R2W,Sec.15,16; along NYCRR at Snow Rd. 4 species.
133. Jackson Co., Hanover Twp.; T4S,R2W,Sec.16,21; along NYCRR at Folks Rd. 2 species.
134. Jackson Co., Hanover Twp.; T4S,R2W,Sec.21; along NYCRR at Rountree Rd. 1 species.
135. Jackson Co., Hanover Twp.; T4S,R2W,Sec.29; along Hanover Rd. 1 species.
136. Jackson Co., Hanover Twp.; T4S,R2W,Sec.31,32; along NYCRR at Strait Rd. 2 species.
137. Jackson Co., Hanover Twp.; T4S,R2W,Sec.31; along NYCRR and Stoneypoint Rd. 11 species.
138. Jackson Co., Hanover-Pulaski Twp. line; T4S,R2W(Hanover)R3W(Pulaski),Sec.31(R2W)Sec.36(R3W); along NYCRR at Grover Rd. 1 species.
140. Hillsdale Co., Scorpio Twp.; T5S,R3W,Sec.2; along NYCRR at Mosherville Station Rd. 2 species.
141. Hillsdale Co., Scorpio Twp.; T5S,R3W,Sec.10,15; along NYCRR at Litchfield Rd. 3 species.
142. Hillsdale Co., Scorpio Twp.; T5S,R3W,Sec.15,22; along NYCRR at Hastings Lake Rd. 4 species.
143. Hillsdale Co., Scorpio Twp.; T5S,R3W,Sec.22; an old cemetery along Concord Rd. between Hastings Lake and Sterling Rds. 6 species.

144. Hillsdale Co., Scorpio Twp.; T5S,R3W,Sec.22,27; along NYCRR at Sterling Rd. 2 species.
145. Hillsdale Co., Scorpio Twp.; T5S,R3W,Sec.27,28; along NYCRR at Concord Rd. 4 species.
146. Hillsdale Co., Fayette Twp.; T6S,R3W,Sec.33; along NYCRR at Wright Rd. 4 species.
147. Hillsdale Co., Fayette Twp.; T6S,R3W,Sec.33; along NYCRR at M-99. 1 species.
148. Hillsdale Co., Fayette Twp.; T6S,R3W,Sec.5; along NYCRR and Murphy Rd.(Wilson Rd.) 11 species.
149. Hillsdale Co., Fayette Twp.; T6S,R3W,Sec.31,32; along NYCRR at Bunn Rd. 2 species.
150. Hillsdale Co., Fayette Twp.; T6S,R3W,Sec.5,6; along NYCRR at Bunn Rd. 12 species.
151. Hillsdale Co., Fayette Twp.; T6S,R3W,Sec.6; along NYCRR at Wise Rd. 7 species.
153. Hillsdale Co., Litchfield Twp.; T5S,R4W,Sec.25,26; along NYCRR at Cronk Rd. 2 species.
154. Hillsdale Co., Litchfield Twp.; T5S,R4W,Sec.23,26; along NYCRR at Sterling Rd. 2 species.
156. Hillsdale Co., Allen Twp.; T6S,R4W,Sec.1,2; along NYCRR at Cronk Rd. 3 species.
157. Hillsdale Co., Allen Twp.; T6S,R4W,Sec.2; along NYCRR at Beulow Rd. 5 species.
160. Hillsdale Co., Allen Twp.; T6S,R4W,Sec.4; along NYCRR at South Allen Rd. 1 species.
166. Branch Co., Quincy Twp.; T6S,R5W,Sec.15; along NYCRR at Claredon Rd. 5 species.
167. Branch Co., Quincy Twp.; T6S,R5W,Sec.21; along NYCRR at U.S. 12 (112). 8 species.
168. Branch Co., Quincy Twp.; T6S,R5W,Sec.20; along NYCRR at Ridge Rd. 4 species.
169. Branch Co., Quincy Twp.; T6S,R5W,Sec.19; along NYCRR at Fremont Rd. 1 species.
170. Branch Co., Quincy-Coldwater Twp. line; T6S,R5W(Quincy)R6W(Coldwater), Sec.19(R5W)Sec.24(R6W); along NYCRR at Fox Rd. 4 species.

171. Branch Co., Coldwater Twp.; T6S,R6W,Sec.24; along NYCRR at Lott Rd. 2 species.
172. Branch Co., Coldwater Twp.; T6S,R6W,Sec.23,24; along NYCRR at Fisk Rd. 6 species.
173. Branch Co., Coldwater Twp.; T6S,R6W,Sec.23; along NYCRR at Willowbrook Rd. 3 species.
174. Branch Co., Coldwater Twp.; T6S,R6W,Sec.23; along NYCRR and South Michigan Rd. 5 species.
176. Branch Co., Coldwater Twp.; T6S,R6W,Sec.19; along NYCRR at Sprague St. 4 species.
177. Branch Co., Coldwater Twp.; T6S,R6W,Sec.19; along NYCRR at Branch Rd. 1 species.
179. Branch Co., Batavia Twp.; T6S,R7W,Sec.26; along NYCRR at Wheeler Rd. 7 species.
180. Branch Co., Batavia Twp.; T6S,R7W,Sec.26,27; along NYCRR at Batavia Rd. 1 species.
181. Branch Co., Batavia Twp.; T6S,R7W,Sec.27; along stream at Batavia Rd. 3 species.
182. Branch Co., Batavia Twp.; T6S,R7W,Sec.34; along NYCRR at U.S. 12. 3 species.
183. Branch Co., Batavia Twp.; T6S,R7W,Sec.33; along NYCRR at Snow Prairie Rd. 3 species.
184. Branch Co., Batavia Twp.; T6S,R7W,Sec.33; along NYCRR at Cavanaugh Rd. 15 species.
185. Branch Co., Bethel Twp.; T7S,R7W,Sec.5; along NYCRR at U.S. 12. 2 species.
186. Branch Co., Bethel Twp.; T7S,R7W,Sec.5; along NYCRR at U.S. 12. 2 species.
187. Branch Co., Bethel-Bronson Twp. line; T7S,R7W(Bethel)R8W(Bronson), Sec.6(R7W)Sec.1(R8W); along NYCRR at Parnan Rd. 2 species.
188. Branch Co., Bronson Twp.; T7S,R8W,Sec.11; along NYCRR at Mill St. 4 species.
191. Branch Co., Bronson Twp.; T7S,R8W,Sec.17,18; along NYCRR and Holmes Rd. 4 species.
192. St. Joseph Co., Burr Oak Twp.; T7S,R9W,Sec.24; along NYCRR at Deer Park Rd. 6 species.

193. St. Joseph Co., Burr Oak Twp.; T7S,R9W,Sec.23; along NYCRR at Half-way Rd. 1 species.
194. St. Joseph Co., Burr Oak Twp.; T7S,R9W,Sec.27; along NYCRR at Robinson Rd. 13 species.
195. St. Joseph Co., Burr Oak Twp.; T7S,R9W,Sec.28,33; along NYCRR at Witt Lake Rd. 1 species.
196. St. Joseph Co., Burr Oak-Fawn River Twp. line; T7S(Burr Oak)T8S (Fawn River),R9W,Sec.32(T7S)Sec.5(T8S); along NYCRR at Airline Rd. 7 species.
197. St. Joseph Co., Fawn River Twp.; T8S,R9W,Sec.5,6; along NYCRR at Big Hill Rd. 8 species.
198. St. Joseph Co., Fawn River Twp.; T8S,R9W,Sec.6; along NYCRR. 3 species.
199. St. Joseph Co., Sturgis Twp.; T8S,R10W,Sec.1; along NYCRR at LaFayette St. 1 species.
201. St. Joseph Co., Sherman Twp.; T7S,R10W,Sec.26; along PCRR at Yoder Rd. 1 species.
202. St. Joseph Co., Sherman Twp.; T7S,R10W,Sec.14,22; along PCRR at Wenzel Rd. 2 species.
203. St. Joseph Co., Sherman Twp.; T7S,R10W,Sec.12; along NYCRR at Banker Rd. 5 species.
205. St. Joseph Co., Nottawa Twp.; T6S,R10W,Sec.14,15; along NYCRR at Nottawa Rd. 9 species.
206. St. Joseph Co., Nottawa Twp.; T6S,R10W,Sec.13,14; along NYCRR at Walterspaugh Rd. 3 species.
207. St. Joseph Co., Colon Twp.; T6S,R9W,Sec.18; along NYCRR and M86. 27 species.
208. Kalamazoo Co., Kalamazoo Twp.; T2S,R11W,Sec.20; along NYCRR and Stadium Dr. 3 species.
209. Kalamazoo Co., Kalamazoo Twp.; T2S,R11W,Sec.19; along NYCRR near West Michigan Ave. 1 species.
210. Kalamazoo Co., Oshtemo Twp.; T2S,R12W,Sec.24; along NYCRR and Kalamazoo Ave. 6 species.
211. Kalamazoo Co., Oshtemo Twp.; T2S,R12W,Sec.24; along NYCRR and Kalamazoo Ave. at 11th St. 7 species.
212. Kalamazoo Co., Oshtemo Twp.; T2S,R12W,Sec.23; along NYCRR at 9th St. 1 species.

214. Kalamazoo Co., Oshtemo Twp.; T2S,R12W,Sec.28; along NYCRR at Miller Ave. 3 species.
215. Kalamazoo Co., Oshtemo Twp.; T2S,R12W,Sec.32,33; along NYCRR at 4th Ave. 10 species.
219. Van Buren Co., Antwerp Twp.; T3S,R13W,Sec.12,13; along NYCRR at McDillan(56th Ave.). 8 species.
220. Van Buren Co., Antwerp Twp.; T3S,R13W,Sec.13,14; along NYCRR at 24th (Main St.). 1 species.
221. Van Buren Co., Antwerp Twp.; T3S,R13W,Sec.14; along NYCRR and 26th Rd. 18 species.
222. Van Buren Co., Antwerp Twp.; T3S,R13W,Sec.23; along NYCRR and 26th Rd. 11 species.
223. Van Buren Co., Antwerp Twp.; T3S,R13W,Sec.22; along NYCRR at Drape Rd. 2 species.
224. Van Buren Co., Antwerp Twp.; T3S,R13W,Sec.27,28; along NYCRR at 28th Ave. 8 species.
226. Van Buren Co., Antwerp Twp.; T3S,R13W,Sec.31; along NYCRR and Ewing Rd. 3 species.
227. Van Buren Co., Decatur Twp.; T4S,R14W,Sec.1; along NYCRR at 556 Rd. 1 species.
228. Van Buren Co., Decatur Twp.; T4S,R14W,Sec.11; along NYCRR and Burgess Rd. 16 species.
229. Van Buren Co., Decatur Twp.; T4S,R14W,Sec.10,11; along NYCRR at 38th St. 12 species.
230. Van Buren Co., Decatur Twp.; T4S,R14W,Sec.10; along NYCRR at 39th St. 27 species.
231. Van Buren Co., Decatur Twp.; T4S,R14W,Sec.9,10,15,16; along NYCRR at 40th St. 11 species.
232. Van Buren Co., Decatur Twp.; T4S,R14W,Sec.16; along NYCRR and Burgess Rd. between 40 and 42nd Sts. 15 species.
233. Van Buren Co., Decatur Twp.; T4S,R14W,Sec.16,17; along NYCRR at 42nd St. 13 species.
234. Van Buren Co., Decatur Twp.; T4S,R14W,Sec.19; along NYCRR at 45th St. 7 species.
235. Van Buren Co., Decatur-Hamilton Twp. line; T4S,R14W(Decatur)R15W(Hamilton),Sec.30(R14W)Sec.25(R15W); along NYCRR at 46th St. 7 species.

236. Cass Co., Wayne Twp.; T5S,R15W,Sec.2,3; along NYCRR at Rd. 3 species.
238. Cass Co., Wayne Twp.; T5S,R15W,Sec.9,10,16; along NYCRR at Twin Lakes Rd. 9 species.
239. Cass Co., Wayne Twp.; T5S,R15W,Sec.16; along NYCRR at Rd. 10 species.
240. Cass Co., Wayne Twp.; T5S,R15W,Sec.20,21; along NYCRR at Atwood Rd. 4 species.
241. Cass Co., Wayne Twp.; T5S,R15W,Sec.20,29; along NYCRR near Gage Rd. 15 species.
242. Cass Co., Wayne Twp.; T5S,R15W,Sec.30; along NYCRR and Colby Rd. 5 species.
243. Cass Co., Pokagon Twp.; T6S,R16W,Sec.11,14; along NYCRR at Peavine Rd. 3 species.
244. Cass Co., Pokagon Twp.; T6S,R16W,Sec.15,22; along NYCRR at Beeson Rd. 1 species.
245. Cass Co., Pokagon Twp.; T6S,R16W,Sec.22; along NYCRR and Klumbus Rd. 10 species.
246. Cass Co., Pokagon Twp.; T6S,R16W,Sec.28; along NYCRR at Wells Rd. 17 species.
247. Cass Co., Howard Twp.; T7S,R16W,Sec.5; along NYCRR and Wells Rd. 28 species.
248. Cass Co., Howard Twp.; T7S,R16W,Sec.5,8; along NYCRR at White Rd. 6 species.
252. Berrien Co., Chikaming Twp.; T7S,R20W,Sec.2,11; along CORR at Sawyer Rd. 1 species.
257. Berrien Co., Chikaming Twp.; T7S,R20W,Sec.20; along CORR and U.S. 12. 6 species.
259. Berrien Co., New Buffalo Twp.; T8S,R21W,Sec.10; along CORR and Stomer St. 1 species.
260. Berrien Co., New Buffalo Twp.; T8S,R21W,Sec.16; along CORR and Lubke Rd. 1 species.
261. Berrien Co., New Buffalo Twp.; T8S,R21W,Sec.16; along CORR at Sand Rd. 1 species.
263. Berrien Co., New Buffalo Twp.; T8S,R21W,Sec.17,20; along CORR at Wilson Rd. 2 species.

264. Berrien Co., New Buffalo Twp.; T8S,R21W,Sec.20; at Shedd Rd. 2 species.
265. Berrien Co., New Buffalo Twp.; T8S,R21W,Sec.19; along NYCRR and U.S. 12. 1 species.
266. Berrien Co., New Buffalo Twp.; T8S,R21W,Sec.18; along NYCRR at Wilson Rd. 3 species.
270. Berrien Co., Three Oaks Twp.; T8S,R20W,Sec.4,3; along NYCRR at Schwark Rd. 6 species.
271. Berrien Co., Three Oaks Twp.; T8S,R20W,Sec.3; along NYCRR at St. 3 species.
272. Berrien Co., Three Oaks Twp.; T8S,R20W,Sec.2,1; along NYCRR at Flynn Rd. 4 species.
273. Berrien Co., Three Oaks-Galien Twp. line; T8S,R20W(Three Oaks)R19W (Galien),Sec.1(R20W)Sec.6(R19W); along NYCRR at Avery Rd. 3 species.
276. Berrien Co., Galien Twp.; T8S,R19W,Sec.1,2; along NYCRR at Rd. 1 species.
277. Berrien Co., Galien Twp.; T8S,R19W,Sec.1; along NYCRR at Rd. 2 species.
279. Berrien Co., Bertrand Twp.; T8S,R18W,Sec.4; at northeast corner of Highbridge Rd. and U.S.12 (Pulaski Hwy.). 5 species.
280. Berrien Co., Buchanan Twp.; T7S,R18W,Sec.34; along NYCRR at Bakertown Rd. 7 species.
282. Berrien Co., Buchanan-Bertrand Twp. line; T7S(Buchanan)T8S(Bertrand), R18W,Sec.36(T7S)Sec.1(T8S); along NYCRR at Chamberlain Rd. 1 species.
283. Berrien Co., Bertrand Twp.; T8S,R17W,Sec.5,6; along NYCRR at Onagflower Rd. (?). 4 species.
284. Berrien Co., Bertrand Twp.; T8S,R17W,Sec.4E $\frac{1}{2}$; along NYCRR at Portage Rd. 1 species.
286. Berrien Co., Niles Twp.; T7S,R17W,Sec.33,34; along NYCRR at Philip Rd. 1 species.
288. Berrien Co., Niles Twp.; T7S,R17W,Sec.27,26; along NYCRR at Lincoln St. 10 species.
289. Berrien Co., Niles Twp.; T8S,R17W,Sec.2,11; along NYCRR at Rd. 1 species.
290. Berrien Co., Niles Twp.; T8S,R17W,Sec.11,14; along NYCRR at Fulkerson Rd. 2 species.

291. Berrien Co., Niles Twp.; T8S,R17W,Sec.14; along NYCRR at Bertrand Rd. 1 species.
292. Berrien Co., Niles Twp.; T8S,R17S,Sec.24; along Bertrand Rd. 4 species.
293. Berrien Co., Niles Twp.; T8S,R17W,Sec.23; along NYCRR at Ontario Rd. 1 species.
295. Cass Co., Ontwa Twp.; T8S,R15W,Sec.7,18; along GTWRR at May Rd. 1 species.
298. Cass Co., Ontwa Twp.; T8S,R15W,Sec.4,5; along M-62 at Hess Rd. 1 species.
299. Cass Co., Jefferson Twp.; T7S,R15W,Sec.32; along GTWRR at Yankee Rd. 1 species.
300. Cass Co., Jefferson Twp.; T7S,R15W,Sec.32,33; along GTWRR at Hess Rd. 3 species.
301. Cass Co., Jefferson Twp.; T7S,R15W,Sec.28,33; along GTWRR at Harris Rd. 1 species.
303. Cass Co., Jefferson Twp.; T7S,R15W,Sec.21,22; along GTWRR at Muller Rd. 1 species.
304. Cass Co., Jefferson Twp.; T7S,R15W,Sec.15,22; along GTWRR at Jefferson Center Rd. 6 species.
308. Cass Co., Penn Twp.; T6S,R14W,Sec.20,21; along GTWRR at Gard's Prairie Rd. 11 species.
310. Cass Co., Penn Twp.; T6S,R14W,Sec.15,16; along GTWRR at Penn Rd. 1 species.
313. Cass Co., Penn Twp.; T6S,R14W,Sec.2; along GTWRR at White Temple Rd. 3 species.
317. Cass Co., Marcellus Twp.; T5S,R13W,Sec.29; along GTWRR at Pioneer Rd. 2 species.
318. Cass Co., Marcellus Twp.; T5S,R13W,Sec.21,28; along GTWRR at Pioneer Rd. 1 species.
319. Cass Co., Marcellus Twp.; T5S,R13W,Sec.22; along GTWRR at 119 Rd. 1 species.
324. St. Joseph Co., Flowerfield Twp.; T5S,R12W,Sec.6,7; along GTWRR at Flowerfield Rd. 1 species.
325. Kalamazoo Co., Portage Twp.; T3S,R11W,Sec.3,10; along NYCRR at O Ave. 9 species.

326. Kalamazoo Co., Portage Twp.; T3S,R11W,Sec.3,10; along stream (Portage Creek) at O Ave. 1 species.
327. Kalamazoo Co., Portage Twp.; T3S,R11W,Sec.21,28; along NYCRR and Shaver Rd.(U.S. 131). 10 species.
329. Kalamazoo Co., Portage Twp.; T3S,R11W,Sec.32; along NYCRR at Oakland Rd. 1 species.
330. Kalamazoo Co., Schoolcraft Twp.; T4S,R11W,Sec.6,7; along NYCRR at U Ave. 3 species.
332. Kalamazoo Co., Schoolcraft Twp.; T4S,R11W,Sec.19,20; along GTWRR at 14th Ave. 4 species.
333. Kalamazoo Co., Schoolcraft Twp.; T4S,R11W,Sec.30; along NYCRR at XY Rd. 4 species.
334. Kalamazoo Co., Schoolcraft Twp.; T4S,R11W,Sec.31; along NYCRR at YZ Rd. 1 species.
336. St. Joseph Co., Park Twp.; T5S,R11W,Sec.7; along NYCRR at Spring Creek between Muskrat and Catherman Lake Rds. 4 species.
337. St. Joseph Co., Park Twp.; T5S,R11W,Sec.7; along NYCRR at Catherman Lake Rd. 8 species.
338. St. Joseph Co., Park Twp.; T5S,R11W,Sec.7,18; along NYCRR at Michigan Rd. 3 species.
339. St. Joseph Co., Park Twp.; T5S,R11W,Sec.18,19; along NYCRR at Marcellus Rd. 3 species.
340. St. Joseph Co., Park Twp.; T5S,R11W,Sec.19,30; along NYCRR at Moore Park Rd. 7 species.
341. St. Joseph Co., Park Twp.; T5S,R11W,Sec.30,31; along NYCRR at Hiembach Rd. 1 species.
342. St. Joseph Co., Mottville Twp.; T8S,R11W,Sec.11; along NYCRR between Eagley(US 131) and Indian Prairie Rds. 20 species.
343. St. Joseph Co., Mottville Twp.; T8S,R11W,Sec.14; along NYCRR between Indian Prairie and Harrison Rds. 13 species.
344. St. Joseph Co., Mottville Twp.; T8S,R11W,Sec.14; along NYCRR between Harrison and Blue School Rds. 24 species.
345. St. Joseph Co., Mottville Twp.; T8S,R11W,Sec.15; along NYCRR between Blue School and Roy Rds. 23 species.
346. St. Joseph Co., Mottville Twp.; T8S,R11W,Sec.22; along NYCRR along Roy Rd. 5 species.

348. Kalamazoo Co., Kalamazoo Twp.; T2S,R11W,Sec.7,8; along NYCRR at 14th St. (Nichols Rd.). 1 species.
350. Kalamazoo Co., Oshtemo Twp.; T2S,R12W,Sec.1,2; along NYCRR at 10th Ave. 1 species.
353. Kalamazoo Co., Alamo Twp.; T1S,R12W,Sec.26; along NYCRR at corner of Hart and 8th St. 7 species.
354. Kalamazoo Co., Alamo Twp.; T1S,R12W,Sec.27; along NYCRR and Hart Rd. at Owen Rd. 5 species.
357. Kalamazoo Co., Alamo Twp.; T1S,R12W,Sec.21,20; along NYCRR at DE Ave. 1 species.
360. Van Buren Co., Pine Grove Twp.; T1S,R13W,Sec.26; along NYCRR at 25th St. 2 species.
363. Van Buren Co., Pine Grove Twp.; T1S,R13W,Sec.29,30; along NYCRR at 32nd St. 1 species.
377. Van Buren Co., South Haven Twp.; T1S,R17W,Sec.15; along CORR at Blue Star Highway. 1 species.
381. Van Buren Co., South Haven Twp.; T1S,R17W,Sec.27; along 76th St. between 16th and 20th Sts. 2 species.
382. Van Buren Co., South Haven Twp.; T1S,R17W,Sec.27,34; along CORR at 20th St. 2 species.
383. Van Buren Co., South Haven Twp.; T1S,R17W,Sec.32; along Ruggles Rd. - entrance to Van Buren State Park. 3 species.
384. Van Buren Co., South Haven Twp.; T1S,R17W,Sec.34; along Blue Star Highway. 1 species.
385. Van Buren Co., Covert Twp.; T2S,R17W,Sec.10,15; along CORR at 32nd St. 2 species.
386. Van Buren Co., Covert Twp.; T2S,R17W,Sec.3,10; along CORR at 28th St. 2 species.
387. Van Buren Co., Covert Twp.; T2S,R17W,Sec.3; along CORR at 75th St. 3 species.
395. Van Buren Co., Hartford Twp.; T3S,R16W,Sec.20; along CORR at 66th St. 2 species.
398. Berrien Co., Coloma Twp.; T3S,R17W,Sec.19; along CORR at Coloma Rd. 3 species.
402. Berrien Co., Hager Twp.; T3S,R18W,Sec.27,28; along CORR at Piper Rd. 3 species.

403. Berrien Co., Hager Twp.; T3S,R18W,Sec.28,33; along CORR at Lynch Rd. 1 species.
408. Berrien Co., Lake Twp.; T6S,R19W,Sec.19,30; along CORR at Baldwin Rd. 1 species.
409. Berrien Co., Lake Twp.; T6S,R19W,Sec.19; along CORR at Rambo Rd. 1 species.
412. Berrien Co., Lake Twp.; T6S,R19W,Sec.8; along CORR at Livingston Rd. 1 species.
413. Berrien Co., Lake-Lincoln Twp. line; T6S(Lake)T5S(Lincoln),R19W, Sec.32(T6S)Sec.5(T5S); along CORR at Lincoln Rd. 1 species.
415. Berrien Co., Lincoln Twp.; T5S,R19W,Sec.28; along CORR between Johnson and John Beers Rds. 2 species.
417. Berrien Co., Niles Twp.; T7S,R17W,Sec.15; along NYCRR at M-140. 5 species.
418. Berrien Co., Niles Twp.; T7S,R17W,Sec.15; along NYCRR at Ullery Rd. 2 species.
420. Berrien Co., Niles Twp.; T7S,R17W,Sec.3; along NYCRR at Stafford Rd. 1 species.
422. Berrien Co., Berrien Twp.; T6S,R17W,Sec.34; along NYCRR at Steinbauer Rd. 4 species.
423. Berrien Co., Berrien Twp.; T6S,R17W,Sec.27,28; along NYCRR at Lake Chapin Rd. (?) 6 species.
424. Berrien Co., Berrien Twp.; T6S,R17W,Sec.22; cemetery at corner of Pokagon Rd. and M-140. 1 species.
427. Berrien Co., Berrien Twp.; T6S,R17W,Sec.9,16; along NYCRR at Hill Rd. 1 species.
429. Berrien Co., Berrien Twp.; T6S,R17W,Sec.4; along NYCRR at Eau Claire Rd. 2 species.
435. Berrien Co., Sodus Twp.; T5S,R18W,Sec.24; along NYCRR at Oxbow Rd. 1 species.
440. Van Buren Co., Hartford Twp.; T3S,R16W,Sec.10; along NYCRR at 64th St. 1 species.
441. Van Buren Co., Hartford Twp.; T3S,R16W,Sec.3,10; along CORR at 52nd Ave. 1 species.
442. Van Buren Co., Bangor Twp.; T2S,R16W,Sec.27; along CORR at 42nd Ave. 1 species.

452. Kalamazoo Co., Oshtemo Twp.; T2S,R12W,Sec.27; at ML Rd. between 5th and 8th St. 3 species.
453. Kalamazoo Co., Oshtemo Twp.; T2S,R12W,Sec.27; along NYCRR between ML and 8th St. 2 species.
454. Kalamazoo Co., Texas Twp.; T3S,R12W,Sec.8SE $\frac{1}{4}$; along 3rd Ave. 7 species.
456. Jackson-Ingham Co. Line, Rives Twp.(Jackson Co.); T1S,R1W,Sec.4; along Base Line Rd. at Churchill Rd. 2 species.
457. Kalamazoo Co., Portage Twp.; T3S,R11W,Sec.28; along Shaver Rd. 4 species.
458. St. Joseph Co., Flowerfield Twp.; T5S,R12W,Sec.5,6; along GTWRR at Chamberlain Rd. 1 species.
460. Kalamazoo Co., Prairie Ronde Twp.; T4S,R12W,Sec.33; along GTWRR at YZ Ave. 1 species.
463. Kalamazoo Co., Prairie Ronde Twp.; T4S,R12W,Sec.25,26; along GTWRR at 10th Ave. 3 species.
464. Kalamazoo Co., Schoolcraft Twp.; T4S,R11W,Sec.20,21; along GTWRR at 16th St. 7 species.
466. Kalamazoo Co., Brady Twp.; T4S,R10W,Sec.19; along PCRR and 24th St. 2 species.
467. Kalamazoo Co., Brady Twp.; T4S,R10W,Sec.30,31; along PCRR at Y Ave. 5 species.
468. Kalamazoo Co., Brady Twp.; T4S,R10W,Sec.32; along PCRR at Z Ave. 2 species.
469. St. Joseph Co., Mendon Twp.; T5S,R10W,Sec.8; along PCRR at Hallumm Rd. 1 species.
470. St. Joseph Co., Mendon Twp.; T5S,R10W,Sec.9,16; along PCRR at E. Michigan Ave. 4 species.
471. Jackson Co., Blackman Twp.; T2S,R1W,Sec.31; along NYCRR and E. Michigan Ave. just west of BL I-94,M-60. 19 species.
472. Jackson Co., Sandstone Twp.; T2S,R2W,Sec.36; along NYCRR at Glasgow Rd. 6 species.
473. Jackson Co., Sandstone Twp.; T2S,R2W,Sec.32,33,34; along NYCRR between Harrington and Dearing Rds. 15 species.
474. Jackson Co., Sandstone Twp.; T2S,R2W,Sec.32,29; along NYCRR between Harrington and Hender Rds. 4 species.

475. Jackson Co., Parma Twp.; T2S,R3W,Sec.36; along NYCRR at Parma Village St. 3 species.
476. Jackson Co., Parma-Concord Twp. line; T2S(Parma)T3S(Concord),R3W, Sec.35(T2S),Sec.2(T3S); along NYCRR at Erie Rd. 6 species.
477. Jackson Co., Concord Twp.; T3S,R3W,Sec.2; along NYCRR between Erie and Concord Rds. 7 species.
478. Jackson Co., Concord Twp.; T3S,R3W,Sec.5,8,9,10; along NYCRR between Concord and Bath Mills Rds. 10 species.
479. Jackson Co., Parma Twp.; T2S,R3W,Sec.31; along NYCRR and Erie Rd. 2 species.
480. Calhoun Co., Albion Twp.; T3S,R4W,Sec.1; along NYCRR at 29½ Mile Rd. 5 species.
481. Calhoun Co., Marshall Twp.; T2S,R6W,Sec.27,28,29,30; along NYCRR between 15 Mile and 12 Mile Rds. 15 species.
483. Calhoun Co., Battle Creek Twp.; T2S,R8W,Sec.19,20; along GTWRR at 1 Mile Rd. 2 species.
484. St. Joseph Co., Mendon Twp.; T5S,R10W,Sec.34,27; along PCRR at Simpson Rd. 1 species.
485. St. Joseph Co., Mendon-Nottawa Twp. line; T5S(Mendon)T6S(Nottawa), R10W,Sec.34(T5S),Sec.3(T6S); along PCRR at Prairie Corner Rd. 26 species.
486. St. Joseph Co., Nottawa Twp.; T6S,R10W,Sec.3,10; along PCRR at Butler Rd. 7 species.
487. St. Joseph Co., Nottawa Twp.; T6S,R10W,Sec.10,15; along PCRR at Spring Creek Rd. 11 species.
488. Jackson Co., Spring Arbor Twp.; T3S,R2W,Sec.25; along NYCRR at Mathews Rd.(Horton Rd.). 3 species.
489. Jackson Co., Hanover Twp.; T4S,R2W,Sec.31,32; along Strait Rd. 3 species.
491. Hillsdale Co., Scorpio Twp.; T5S,R3W,Sec.22; along NYCRR near Hastings Lake Rd. 13 species.
492. Kalamazoo Co., Ross Twp.; T1S,R9W,Sec.16; along C Ave. between 40 and 42nd Ave. 1 species.
493. Kalamazoo Co., Charleston Twp.; T2S,R9W,Sec.18; along M-96. 2 species.
494. Kalamazoo Co., Ross Twp.; T1S,R9W,Sec.35; along NYCRR and Custer Rd. 2 species.

495. Branch Co., Sherwood Twp.; T5S,R8W,Sec.28,33; along NYCRR at Division Rd. 1 species.
496. Calhoun Co., Convis Twp.; T1S,R6W,Sec.36; along U.S. 27 just north of L Dr. 1 species.
497. Van Buren Co., Antwerp Twp.; T3S,R13W,Sec.22NE $\frac{1}{4}$; along 60th Ave. 10 species.
498. Cass Co., Pokagon Twp.; T6S,R16W,Sec.2; along M-40; 1 species.
499. St. Joseph Co., Lockport Twp.; T6S,R11W,Sec.7; along NYCRR and Business 131. 9 species.
500. St. Joseph Co., Lockport Twp.; T6S,R11W,Sec.29; along NYCRR and Lutz Rd. 14 species.
501. St. Joseph Co., Lockport Twp.; T6S,R11W,Sec.23; along NYCRR and Schrader Rd. 19 species.
502. St. Joseph Co., Nottawa Twp.; T6S,R10W,Sec.20; along NYCRR between Rambrandt and Corner Rds. 4 species.
503. St. Joseph Co., Nottawa Twp.; T6S,R10W,Sec.21; along NYCRR between Bucknell and Rambrandt Rds. 7 species.
504. St. Joseph Co., Nottawa Twp.; T6S,R10W,Sec.13; along NYCRR between Walterspaugh and N. Sturgis (78/86) Rds. 12 species.
505. St. Joseph Co., Mendon Twp.; T5S,R10W,Sec.28,29,30; along M-60. 4 species.
507. St. Joseph Co., Lockport Twp.; T6S,R11W,Sec.30,31; along NYCRR between Fairchild and Lutz Rds. 23 species.
508. St. Joseph Co., Lockport Twp.; T6S,R11W,Sec.29; along NYCRR at corner of Lutz and Hoshal Rds. 14 species.
509. St. Joseph Co., Florence Twp.; T7S,R11W,Sec.6; along NYCRR between Fairchild and Constantine Rds. 7 species.
511. St. Joseph Co., Constantine Twp.; T7S,R12W,Sec.25; along NYCRR between Stears and Constantine Rds. 15 species.
512. St. Joseph Co., White Pigeon Twp.; T8S,R11W,Sec.8; along NYCRR at Sevison Rd. 21 species.
513. St. Joseph Co., White Pigeon Twp.; T8S,R11W,Sec.8; along NYCRR at Apa Gravel Rd. 7 species.
514. St. Joseph Co., White Pigeon Twp.; T8S,R11W,Sec.7; along NYCRR at Lima Rd. 12 species.

515. Jackson Co., Pulaski Twp.; T4S,R3W,Sec.22,27; along Pulaski Hwy. 1 species.
517. St. Joseph Co., Sturgis Twp.; T8S,R10W,Sec.3,4; along NYCRR at Balk Rd. 17 species.
518. St. Joseph Co., Sturgis Twp.; T8S,R10W,Sec.2,3; along NYCRR at White School Rd. 12 species.
519. Van Buren Co., Antwerp Twp.; T3S,R13W,Sec.19; along M-119. 6 species.
520. Cass Co., Pokagon Twp.; T6S,R16W,Sec.28,29,30,31; along NYCRR and Baron Lake Rd. 1 species.
521. St. Joseph Co., White Pigeon Twp.; T8S,R12W,Sec.12; along NYCRR at U.S.-131. 16 species.
522. St. Joseph Co., Sturgis Twp.; T8S,R10W,Sec.13,24; along NYCRR at Bogen Rd. 10 species.
523. St. Joseph Co., Fawn River Twp.; T8S,R9W,Sec.7,8; along Big Hill (Lakeview) Rd. 7 species.
524. St. Joseph Co., Colon Twp.; T6S,R9W,Sec.17; along NYCRR and M-86 (78). 25 species.
525. St. Joseph Co., Colon Twp.; T6S,R9W,Sec.10; along NYCRR at Farrand Rd. 10 species.
526. St. Joseph Co., Colon Twp.; T6S,R9W,Sec.12; along NYCRR at Lowland Rd. 7 species.
527. Calhoun Co., Homer Twp.; T4S,R4W,Sec.17,20; along R Dr. 1 species.
528. Calhoun Co., Homer Twp.; T4S,R4W,Sec.11; along NYCRR at N Dr. 6 species.

APPENDIX C

Frequency of prairie and non-prairie species found in a composition study of 19 prairie sites. Sites are ordered according to decreasing percentages of prairie species. Site numbers are defined in Appendix B. An asterisk indicates prairie species. Species found in the sample area, but not in the sample quadrats are marked with a plus sign.

APPENDIX C

Frequency of species found in a composition study of 19 prairie sites. Sites are ordered according to decreasing number of prairie species. Site numbers are defined in Appendix B. An asterisk indicates prairie species. Species found in the sample design, but not in the sample quadrats are marked with a plus sign.

SPECIES	247	485	12a	221	30	31	471	501	512	15	496	12c	96	491	270	143	1	12b	327	463
<i>Acer negundo</i>							1													
<i>Achillea millefolium</i>		3	18	2	+		10		12			5		12	10	10		+		
<i>Agropyron repens</i>		13					38	12						2				20	50	
<i>Agrostis alba</i>																30				
<i>Allium cernuum*</i>	8																			
<i>Amorpha canescens*</i>		3						16	2										50	
<i>Ambrosia artemesifolia</i>		2	2		4	48		4	4	2	3	20		2		6		50	40	
<i>Andropogon gerardii*</i>		1	4	20	46	3	27	6	96	82		85	+	+	100					
<i>Andropogon scoparius*</i>	12			75	3	83		40	28	14	96		76	52						
<i>Anemone cylindrica*</i>	4	3		1	1		5	16	2					6						
<i>Antennaria spp.</i>								2					16	20	11	16				
<i>Apocynum androsaemifolium</i>	6	1		6			14	2	6	+		+	+					100		
<i>Arctium minus</i>							4													
<i>Aristida oligantha</i>															12					
<i>Aristida purpurascens</i>		1		3										46						
<i>Artemisia caudata</i>				1							6									
<i>Asclepias amplexicaulis*</i>		1						5												
<i>Asclepias syriaca</i>	4	2	1	+	+		26	14	+	4		+		+	+	2		70		
<i>Asclepias tuberosa*</i>	1			+	+				+	2		4		+				10		
<i>Asclepias viridiflora*</i>																				
<i>Aster sp.</i>				11	2			8							40	46		20	20	
<i>Aster ericoides*</i>		22		1			3					12				14				
<i>Aster laevis*</i>	14								2											
<i>Aster novae-angliae</i>							2								20					
<i>Aster pilosus</i>		9	22	4						14	2	34								
<i>Aster sagittifolius</i>	8								6											

SPECIES

[illegible]

SPECIES

247 485 12a 221 30 31 471 501 512 15 496 12c 96 491 270 143 1 12b 327 463

Eupatorium altissimum
*Euphorbia corollata**
Festuca sp.
Fragaria virginiana
Galium sp.
Gentiana flavida
Geranium maculatum
Gnaphalium obtusifolium
Helianthemum canadense
Helianthus divaricatus
Helianthus giganteus
*Helianthus occidentalis**
*Heuchera richardsonii**
*Hieracium longipilum**
Hypericum perforatum
Juniperus virginiana
*Kuhnia eupatorioides**
Labiatae
Lactuca canadensis
Lepidium sp.
*Lespedeza capitata**
Lespedeza hirta
*Liatris aspera**
*Liatris cylindracea**
Liatris novae-angliae
Lilium philadelphicum
Linaria vulgaris
*Lithospermum canescens**
Lupinus perennis
Lychnis alba
Lysimachia ciliata
Lysimachia lanceolata
Melilotus alba
Monarda fistulosa

50 43 20 10 10 83 22 16 54 54 29 65 26 10 21 90 +
 4 6
 50 5 1 2 10 6 2 12 100 70
 20
 2
 2 8 12 4 10
 4 2 2 4 12 10 6 2 +
 14 30 16 16
 10 34 10
 6 2 2 6 8 12 4 64 2 2 +
 1 2 15
 49 56 2 2 14 4 50
 2 7 3 + 1 2 4 2 1 8 6
 1
 3 4 9 2 40 4 39 6 36
 3
 10 3 5 3 53 4 14 2
 1
 1 19
 2 16 1 25 2 1 10
 1
 12
 3 1 2 2 12 23 + 50
 2 1 6 3 3 10 11 14 70 7 2 10
 8

[illegible]

[illegible]

[illegible]

APPENDIX D

Distribution maps of five prairie species found in southwestern Michigan.

Legend: Large circle -- Scharrer 1969

Medium circle -- Herbaria 1910-1969

Small circle -- Herbaria pre-1910

Large triangle -- Literature 1910-1969

Medium triangle -- Literature pre-1910

Irregular shapes -- original prairies
(Veatch 1928, Kenoyer 1930, 1934,
1940).

Figure 16. Distribution of Coreopsis palmata
Nutt. in southwestern Michigan.

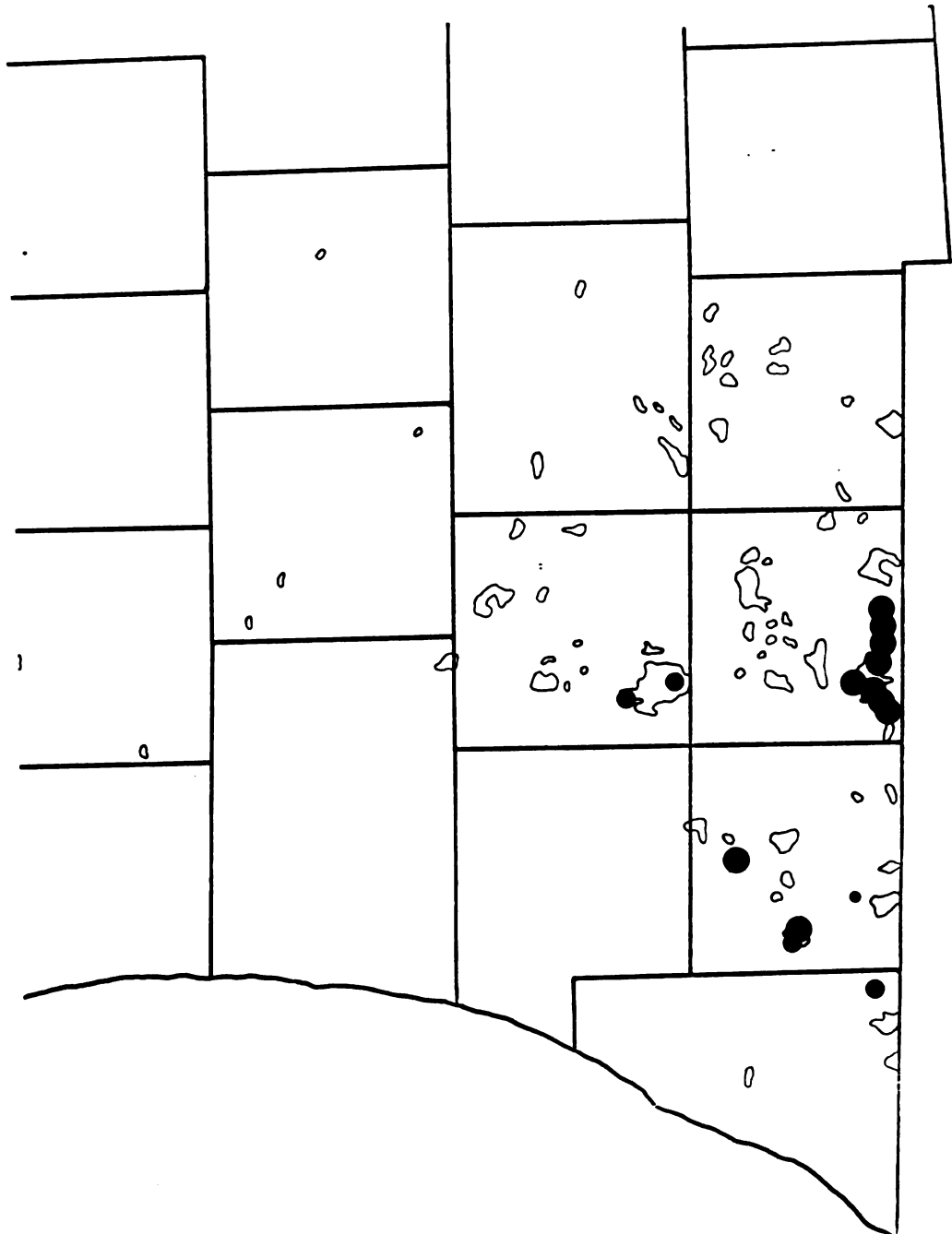


Figure 17. Distribution of *Panicum virgatum* L
in southwestern Michigan.

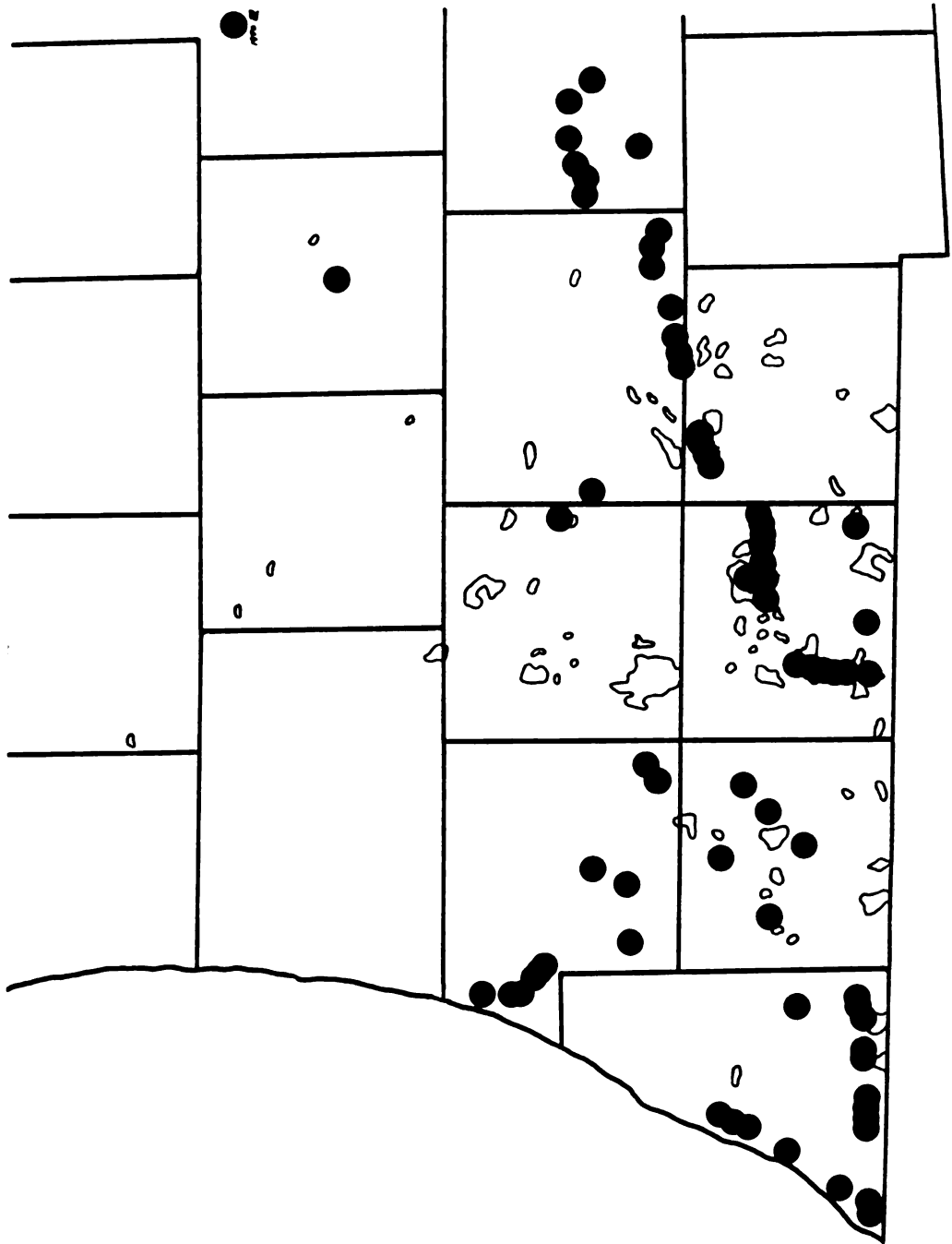


Figure 18. Distribution of Ruellia humilis Nutt.
in southwestern Michigan.

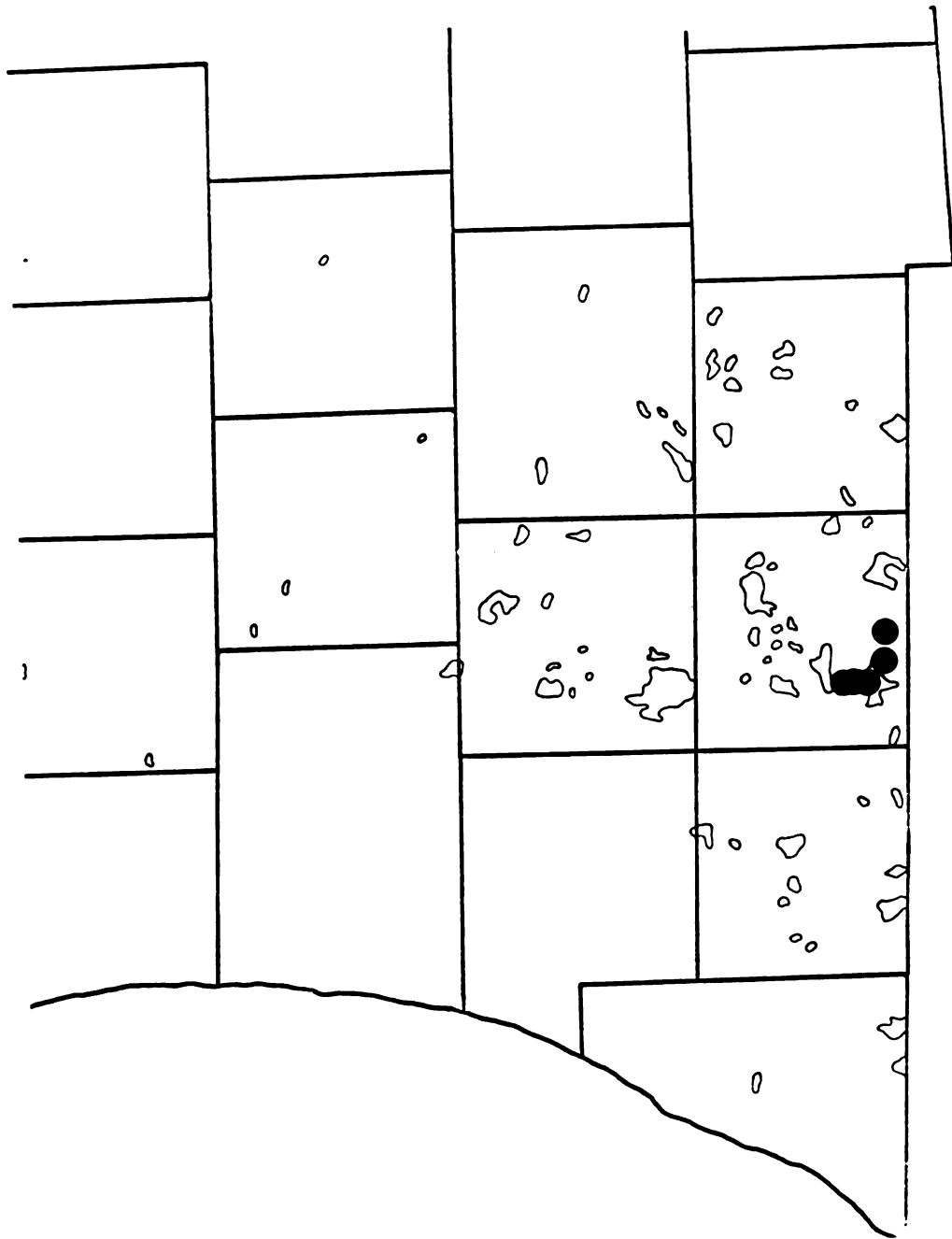


Figure 19. Distribution of Silphium integrifolium
Michx in southwestern Michigan.

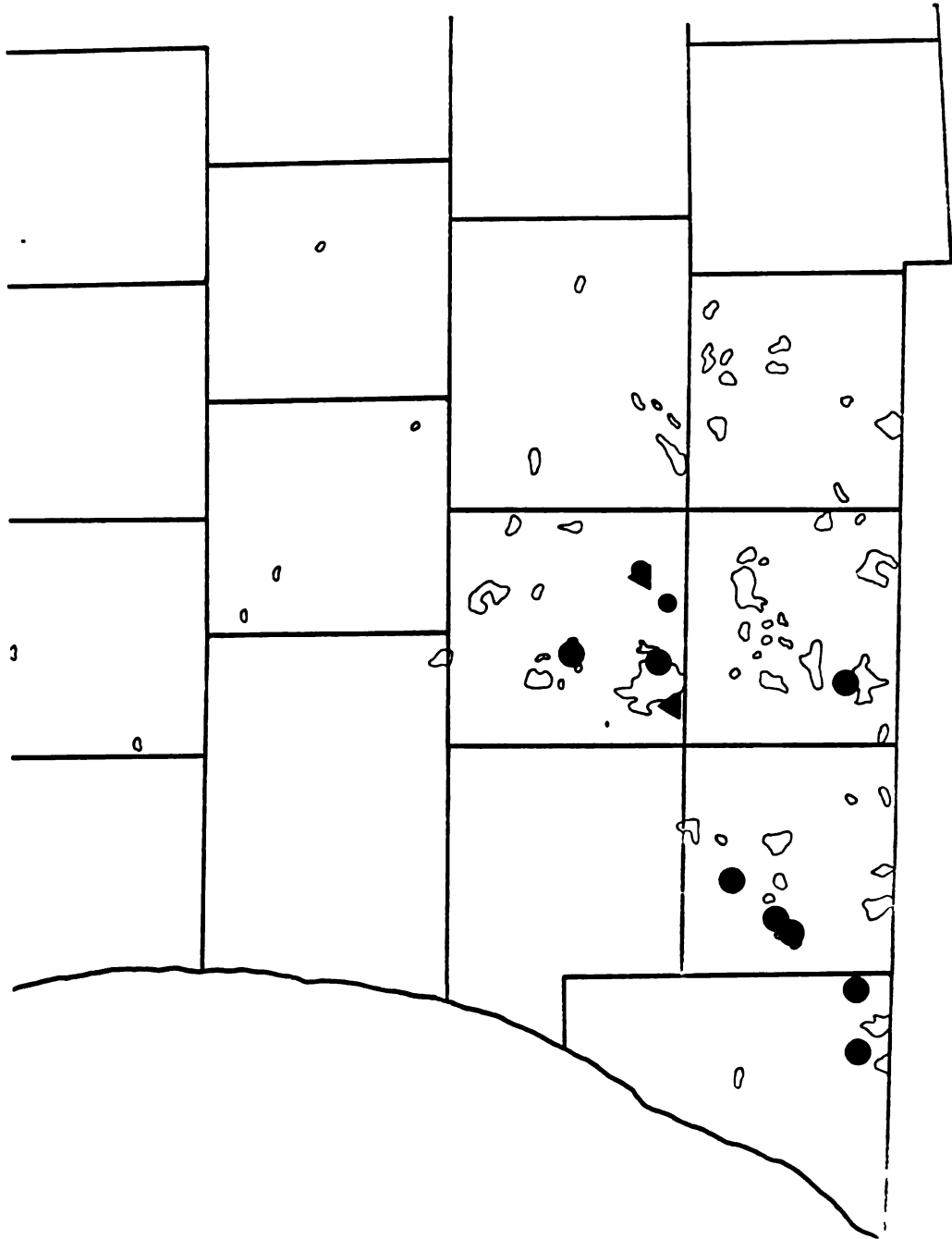


Figure 20. Distribution of Silphium
terebinthinaceum Jacq. in southwestern
Michigan.

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