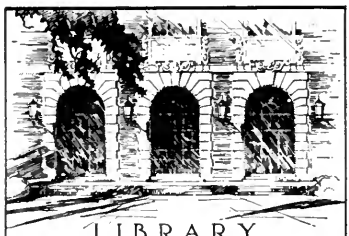

STUDIES OF THE VEGETATION OF MISSOURI—II

PHANEROGAMIC FLORA OF THE FRESH-WATER SPRINGS IN THE OZARKS OF MISSOURI

BY

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JULIAN A. STEYERMARK

INTRODUCTION

The Ozarks of southern Missouri and northern Arkansas are noted for an abundance of springs. From earliest times the Ozark springs have played an important rôle in the historical development of southern Missouri. Their very abundance must necessarily have encouraged many homesteaders to settle and farm in the region. In fact, the majority of farmers in this area have settled on land containing at least one small spring. A fair proportion of Ozark farmers today depend upon pump- or bucket-drawn well water, but a considerable number are still dependent on water from springs.

Aside from their obvious use in yielding water for drinking purposes, springs have played an important rôle in the development of agriculture and stock-raising. Grist mills, for grinding corn and other grains, are usually located by and receive their power from springs. These mills at one time or another have served many a community, and the rise and development of a number of Ozark towns can be traced directly or indirectly to the establishment and use of a grist mill. In recent years a number of spring waters have been developed for the propagation of fish, especially trout. These fish can live only in the cooler temperatures of spring water. By the establishment of these hatcheries, many fish have been propagated and released into spring-fed fishing waters.

In addition to their economic value, Ozark springs are outstandingly beautiful. They are visited by increasing numbers of tourists annually, and are appreciated for their esthetic as well as recreational values. Many of the state parks in the Ozarks possess a large spring as their chief scenic feature; examples are Big Spring State Park, Roaring River State Park, Bennett Spring State Park, Montauk State Park, Chesapeake State Park, Round Spring State Park, and several others. It has been estimated that the Ozarks of Missouri and Arkansas contain a greater number of both large and small springs than any other area of similar size in North America, if not in the world.

EXTENT OF WORK

The Ozark springs are interesting also because of the unique plant life that they contain. Many of the plants found in the springs are

rare species restricted to such a habitat. Furthermore, the vegetation of the springs is conspicuously uniform and appears as a natural, distinct unit in the flora of the state. These considerations suggested that a thorough study of the flora of the springs would prove interesting from the standpoint of isolating a natural vegetational element or unit of the Ozark flora and also in studying relatively simple factors in the isolation and distribution of aquatic plants of springs.

The author began work on the springs in 1928. Since then, all the largest and most of the important springs in the Ozarks have been visited and studied. All the springs described in *Water resources of Missouri*[1] have been investigated, and many others have been visited.

All the species of phanerogams were collected from each spring. Characeae (*Chara* and *Nitella*) were also collected, as were a small number of bryophytes. In the following pages, the statements referring to the vegetation of the springs refer in practically all cases to phanerogams. A complete set of herbarium material of the species collected may be found in the Missouri Botanical Garden Herbarium. A nearly complete set is in the Herbarium of Field Museum.

It will be noted in the following pages that the material on each spring is presented in the following manner: (1) location; (2) description of spring; (3) description and arrangement of the vegetation from the head of the spring to its confluence with another body of water; and, finally (4), a list of the various species found in each spring with the dominant species noted in each case.

SPRINGS: THEIR DEFINITION, OCCURRENCE, NATURE, USES, AND SIZE

The large springs in the Ozark region are considered by Fuller,[2] Shepard,[3] Bridge,[4] and other geologists to be the actual surface outlets of underground streams. Their abundance throughout the Ozarks, therefore, implies a well-developed system of subterranean drainage. The explanation of the origin and nature of Ozark springs has been presented by many geologists, and is here given only in a brief résumé. Water from surface rains sinks into the strata of porous

[1] H. C. Beckman, Water resources of Missouri, Mo. Bur. Geol. and Mines, 20: 341–353. 1927. All quotations in the descriptions of the various springs, appearing in a later part of the paper, have been taken from this publication.

[2] M. L. Fuller, Notes on certain large springs of the Ozark region, Missouri and Arkansas, U. S. Geol. Surv. Water-Supply Paper, 110: 207–210. 1905.

[3] E. M. Shepard, Springs, U. S. Geol. Surv. Water-Supply Paper, 102: 416–440. 1903.

[4] J. Bridge, Geology of the Eminence and Cardareva quadrangles, Mo. Bur. Geol. and Mines, 2nd ser. 24: 39. 1930.

rocks below and eventually meets other water which has similarly found its way through porous substrata. The combined force of the water, from several sources, working its way down along the joints and bedding planes of the rock, gradually dissolves and enlarges passages, until an underground stream is formed. Usually the most porous zone, and the one through which the stream can cut its passage most easily, is dolomite (magnesian limestone). Eventually these streams come to the surface in the form of springs.

The spring is the terminus of this subterranean stream, but the latter may have had its origin many miles away, somewhere within the Ozark dome. The underground stream which emerges in the form of a spring may represent an original single stream without admixture or confluence of other subterranean tributary drainage. However, most of the larger springs appear to be outlets of large subterranean streams comprising a combined volume of several other tributary drainages, the sources of which may be many miles distant. In some cases the outlet of these subterranean streams is near the ground surface. In other instances, the outlet is far below the surface level, and the water is usually very deep. The outlet of most of the large subterranean streams permits free passage of the water, but in some of the smaller springs it is filled with gravel.

The springs generally occur in valleys, canyons, or deep ravines where the streams have cut down into the rock and travel through a water-bearing bed. The springs are larger, as a rule, where erosion has cut more deeply into the valleys. Often they arise at the bases of bluffs where the rock is exposed. Generally, this substratum is a cherty dolomite, mainly of Cambrian or Ordovician age. All the streams in the Ozarks are spring-fed. They are relatively clear because the spring water feeding them is largely a subterranean flow not disturbed or muddied by surface rains or overflows bearing alluvial deposits. The majority of the large springs occur along the Current, Gasconade, Black, Eleven Points, Meramec, White (North Fork), and Niangua rivers. Only a few of them are found along the St. Francis, Osage, White, Pomme de Terre, and Sac rivers and tributaries; these latter streams are generally muddier, and are more subject to floods and less uniformity of flow than the rivers that are more frequently supplied with spring water.

The occurrence of the springs is correlated with the altitude of the region. Bridge[1] found that there were no permanent springs of any size above 900 feet elevation in the Eminence-Cardareva region of

[1] Ibid., p. 36.

Shannon, Carter, and Reynolds counties, and that most of the permanent streams had their sources between the elevations of 760 and 900 feet, this indicating the permanent water table level of the region. Most of the other large springs in the Ozarks arise at an altitude generally above 700 and below 900 feet.

In their relation to the topography it has been found[1] that most of the large Ozark springs occur "close to a large valley which is either dry, or else occupied by a stream which appears much too small for the size of the valley which contains it." This is found, for example, in the case of Round Spring, located close to Spring Valley, which is usually dry.

The chief characteristics of the Ozark springs are the great clearness and cold temperature of their water. Most of them vary between 52° and 58° F. Such constant low temperatures as these are maintained principally because the subterranean streams flow at such a depth that they are not much influenced by atmospheric changes of temperature at the surface. The beauty of many of the springs depends upon their great clarity and bluish color; in general, the deeper the spring the bluer its water. Various theories have been set forth to account for this unusually deep blue color. Presence of certain minerals or particles in suspension in the water and reflection from the sky have been brought forth as arguments to explain the blue water. The most recent and most probable explanation is that of Pettit,[2] who explains it on the basis of the reflection and diffusion of certain light rays. His explanation calculates that light falling on the purest water, with only water molecules to intercept the shorter rays, is scattered in the deepest blue over the widest arc, whereas blues give way to white upon the increase of larger particles, catching the longer rays, in other waters. As successively clearer water samples were tested, Pettit found that the scattered light became blue and then deeper blue over a wider and wider arc, at first above the surface and then extending below, though the scattered light itself became no bluer. Dr. Pettit experimented with water from Crater Lake, settled ocean water, distilled and tap water, and dust-free water. Observation of Ozark springs in general appears to corroborate Dr. Pettit's evidence that depth combined with the purity of the water is largely responsible for the deep blue color. In some of the large Ozark springs the water is so clear that one can see the bottom at depths between 30 and 50 feet. In some of the springs

[1] Ibid., pp. 41–42.

[2] E. Douglass, Why Crater Lake is so blue, Magazine Supplement, St. Louis Post Dispatch, p. 1. July 26, 1936.

the water appears milky or green. This turbidity is probably due to the presence of minute particles of suspended clay matter. On rare occasions, notably after seasons of very heavy rainfall, the water may appear slightly murky and less clear than at other times. Many samples of Ozark spring water measured by H. W. Mundt and W. D. Turner showed no turbidity, while others exhibited varying degrees of turbidity.

The flow of these springs is not constant. During the spring months, corresponding to the period of maximum rainfall, it is greatest, while during the summer and fall months the flow is least. Only a few of the smallest springs in the Ozarks have been known to go dry. All the springs show marked variations of discharge directly correlated with variations in rainfall. The maximum total number of gallons discharged in a day by Big Spring, in Carter County, was 543,000,000, with an average of 242,000,000. Greer Spring, the second largest in Missouri, flowed a maximum of 539,000,000 gallons a day, and an average of 209,000,000.

The flow of the water is very rapid. In some cases, where the outlet of the subterranean stream emerges as a deep pool far below the surface, the water may be quite still. In other springs, where the outlet is nearer the surface or has a very strong discharge, the water rushes forth or boils up violently. The rate of discharge of the water at the outlet appears to be the chief factor in causing a slow or rapid current in the spring branch. However, the fall of the water and the width of the bed are of great importance as well. In the larger springs the current in the spring branch is rapid at first, and occupies the entire width of the branch. Downstream, where the bed is usually wider and the gradient of the branch less, the main current exists in the middle, while slow or still water occurs along the sides.

The following list of the twelve largest springs in Missouri is taken from Beckman's[1] report.

Rank	Spring	County	Rank	Spring	County
1	Big	Carter	7	Blue	Shannon
2	Greer	Oregon	8	Blue	Oregon
3	Welch	Shannon	9	Alley	Shannon
4	Double	Ozark	10	Hahatonka	Camden
5	Meramec	Phelps	11	Montauk	Dent
6	Bennett	Laclede	12	Round	Shannon

Other springs ranking among the largest are Roubidoux Spring and Boiling Spring in Pulaski County, and Pulltight Spring and Cave Spring in Shannon County.

[1] H. C. Beckman, Water resources of Missouri, Mo. Bur. Geol. and Mines, 20: 341–342. 1927.

DISCUSSION OF VEGETATION OF SPRINGS

Drouet[1] is the only previous worker who has carried on any actual detailed investigation of the vegetation of Missouri springs. His work was confined principally to collections of algae, although he mentions the occurrence in a few springs of several species of spermatophytes. Some of the latter mentioned by him, originally taken from notes made by H. W. Rickett, have since been found to be based upon misdeterminations. For example, his record of *Vallisneria spiralis* L. from Howe's Mill Spring is *Sparganium americanum* Nutt., and *Myriophyllum scabratum* Michx., recorded from Yancy Mill Spring, Alley Spring, and Roubidoux Spring, *Myriophyllum heterophyllum.*

Metcalf[2] and Rickett[3] record a few spermatophytes from some of the Ozark springs, but their work was only incidental and comprised a small number of collections from only a few springs. Some of their records are based upon misdeterminations. For example, Metcalf's report of *Potamogeton Friesii* Rupr. in Hahatonka Spring has been found by Fernald to be *Potamogeton foliosus* var. *genuinus.* Rickett's report of *Naias* sp. in Yancy Mill Spring is actually *Callitriche heterophylla,* while the "*Potamogeton* sp. (probably *P. pectinatus* L.)" is *Potamogeton foliosus* var. *macellus.*

SPERMATOPHYTES OF THE OZARK SPRINGS

The following list, including all species which have been found growing in the water of the spring, spring branches, or along the margin of the springs, is based upon carefully studied living and herbarium collections which have been made over a period of ten years from the Missouri Ozark springs. Herbarium specimens of all the species studied and recorded in the following lists may be found in the herbaria of Field Museum of Natural History and the Missouri Botanical Garden.

TYPHACEAE

Typha latifolia L. Common cat-tail

SPARGANIACEAE

Sparganium americanum Nutt. Bur-reed

[1] F. Drouet, Algal vegetation of the large Ozark Springs, Trans. Amer. Micro. Soc. 52: 83–100. 1933.

[2] F. P. Metcalf, Notes on marsh and aquatic plants of Missouri, Journ. Wash. Acad. Sci. 12: 307–312. 1922.

[3] H. W. Rickett, A list of plants from the Missouri Ozarks, Amer. Midl. Nat. 12: 411–419. 1931.

NAJADACEAE

Potamogeton crispus L. Curly-leaved muck-weed
Potamogeton amplifolius Tuckerm. Large-leaved pondweed
Potamogeton lucens L. Shining pondweed
Potamogeton foliosus Raf., var. *genuinus* Fern. Pondweed
Potamogeton foliosus var. *macellus* Fern. Pondweed
Potamogeton panormitanus Bivona-Bernardi, var. *minor* Biv. Pondweed
Potamogeton panormitanus var. *major* G. Fischer. Pondweed
Najas guadalupensis (Spreng.) Morong. Naiad
Zannichellia palustris L., var. *major* Boenningh. Horned pondweed

ALISMACEAE

Sagittaria latifolia Willd. Broad-leaved arrowhead
Alisma subcordatum Raf. Water plantain

HYDROCHARITACEAE

Anacharis occidentalis (Pursh) Victorin. Water-weed

GRAMINEAE

Agrostis perennans (Walt.) Tuckerm. Thin grass
Agrostis stolonifera L. Red top grass
Poa annua L., var. *reptans* Haussknecht. Annual bluegrass
Eragrostis hypnoides (Lam.) BSP. Creeping love grass
Leersia oryzoides (L.) Sw. Rice cut grass
Glyceria striata (Lam.) Hitchc. Fowl meadow grass

CYPERACEAE

Eleocharis acicularis (L.) R. & S., var. *typica* Svenson. Needle spike rush
Eleocharis acicularis var. *gracilescens* Svenson. Needle spike rush
Eleocharis calva Torr. Creeping spike rush

LEMNACEAE

Spirodela polyrhiza (L.) Schleid. Duckweed
Lemna trisulca L. Ivy-leaved duckweed
Lemna minor L. Little duckweed
Lemna valdiviana Philippi. Duckweed
Wolffia punctata L. Least duckweed

PONTEDERIACEAE

Heteranthera dubia (Jacq.) MacM. Water star-grass

JUNCACEAE

Juncus acuminatus Michx. Knotty-leaved rush
Juncus effusus L., var. *solutus* Fern. & Wieg. Rush
Juncus macer S. F. Gray. Slender rush

SAURURACEAE

Saururus cernuus L. Lizard's tail

POLYGONACEAE

Polygonum punctatum Ell. Smartweed, water pepper
Polygonum hydropiperoides Michx. Mild water pepper

CERATOPHYLLACEAE

Ceratophyllum demersum L. Hornwort

NYMPHAEACEAE

Nuphar ozarkanum Miller & Standley. Ozark spatterdock

RANUNCULACEAE

Ranunculus longirostris Godron. White water crowfoot

CRUCIFERAE

Rorippa Nasturtium-aquaticum (L.) Schinz & Thell. Water cress
Cardamine bulbosa (Schreb.) BSP., f. *fontinalis* Palmer & Steyermark. Sprin cress

CALLITRICHACEAE

Callitriche heterophylla Pursh. Water starwort

LYTHRACEAE

Peplis diandra Nutt. Water purslane
Rotala ramosior (L.) Koehne, var. *interior* Fern. & Griscom. Tooth-cup

ONAGRACEAE

Ludvigia palustris (L.) Ell., var. *americana* (DC.) Fernald & Griscom. Wate purslane
Epilobium coloratum Muhl. Willow herb

HALORAGIDACEAE

Myriophyllum proserpinacoides Gill. Water feather
Myriophyllum scabratum Michx. Water milfoil
Myriophyllum heterophyllum Michx. Water milfoil

LABIATAE

Mentha piperita L. Peppermint

SCROPHULARIACEAE

Lindernia dubia (L.) Pennell, var. *typica* Pennell. False pimpernel
Gratiola neglecta Torr. Clammy hedge hyssop
Veronica connata Raf. Water speedwell
Veronica connata var. *glaberrima* (Pennell) Fassett. Water speedwell

LENTIBULARIACEAE

Utricularia gibba L. Bladderwort

Of this list only the following species are found submerged in th spring water:

Sparganium americanum Nutt.
Potamogeton crispus L.
Potamogeton amplifolius Tuckerm.
Potamogeton lucens L.
Potamogeton foliosus Raf., var. *genuinus* Fern.
Potamogeton foliosus var. *macellus* Fern.
Potamogeton panormitanus Bivona-Bernardi, var. *minor* Biv.
Najas guadalupensis (Spreng.) Morong
Zannichellia palustris L., var. *major* Boenningh.
Anacharis occidentalis (Pursh) Victorin
Poa annua L., var. *reptans* Haussknecht
Glyceria striata (Lam.) Hitchc.
Agrostis stolonifera L.
Eleocharis acicularis (L.) R. & S., var. *typica* Svenson
Spirodela polyrhiza (L.) Schleid.
Lemna trisulca L.
Lemna valdiviana Philippi
Wolffia punctata L.
Heteranthera dubia (Jacq.) MacM.
Polygonum hydropiperoides Michx.
Ceratophyllum demersum L.
Ranunculus longirostris Godron
Rorippa Nasturtium-aquaticum (L.) Schinz & Thell.

Cardamine bulbosa (Schreb.) BSP., f. *fontinalis* Palmer & Steyermark
Callitriche heterophylla Pursh
Peplis diandra Nutt.
Ludvigia palustris (L.) Ell., var. *americana* (DC.) Fernald & Griscom
Myriophyllum prosperpinacoides Gill.
Myriophyllum scabratum Michx.
Myriophyllum heterophyllum Michx.
Veronica connata Raf.
Veronica connata var. *glaberrima* (Pennell) Fassett
Utricularia gibba L.

However, some of the plants included in the above list are very rarely found. The following list includes the most commonly encountered species of springs, or those more or less characteristic of all Ozark springs:

Eleocharis acicularis (L.) R. & S., var. *typica* Svenson, and var. *gracilescens* Svenson
Poa annua L., var. *reptans* Haussknecht
Sparganium americanum Nutt.
Potamogeton amplifolius Tuckerm.
Potamogeton lucens L.
Potamogeton foliosus Raf., var. *genuinus* Fern.
Potamogeton foliosus Raf., var. *macellus* Fern.
Zannichellia palustris L., var. *major* Boenningh.
Anacharis occidentalis (Pursh) Victorin
Ceratophyllum demersum L.
Rorippa Nasturtium-aquaticum (L.) Schinz & Thell.
Callitriche heterophylla Pursh
Ludvigia palustris (L.) Ell., var. *americana* (DC.) Fern. & Griscom
Myriophyllum heterophyllum Michx.
Veronica connata Raf.
Polygonum hydropiperoides Michx.
Cardamine bulbosa f. *fontinalis* Palmer & Steyermark

Of an original list of 60 species occurring in and along the water of springs, we find only 16 actually common to most of the springs. Of these 16 the three commonly found are water milfoil (*Myriophyllum heterophyllum* Nutt.), water cress (*Rorippa Nasturtium-aquaticum* (L.) Schinz & Thell.), and water starwort (*Callitriche heterophylla* Pursh).

Since the above species are the commonest ones found, it is of interest to note from which of the following springs two of them are absent:

WATER CRESS (*Rorippa Nasturtium-aquaticum*)

Amsden Mill Spring
Aspley Spring
Blue Spring, Ozark County
Boiling Spring, Pulaski County
Davidson's Blue Spring
Falling Spring
Gravel Spring
Mabrey Spring
Markham Spring
Mill Spring
Mill Pond
Old Pond
Roaring Spring
Sands Spring
Silver Lake
Tucker Bay Spring
Turner Mill Spring
Warner Bay Spring

WATER MILFOIL (*Myriophyllum heterophyllum*)

Amsden Mill Spring
Aspley Spring
Beaver Spring
Big Spring, Newton County
Bliss Spring
Blue Spring, Carter County
Blue Spring, Crawford County
Boiling Spring, Texas County
Boylers Mill Spring
Cave Spring, Greene County
Chesapeake Spring
Cold Spring
Coppedge Spring
Davidson's Blue Spring
Elm Spring
Evans Spring
Howe's Mill Spring
Kratz Spring
Mill Creek Spring
Mill Spring
Miller Spring
Montauk Spring
Mossy Spring
Piney Spring
Prewett Spring
Randolph Spring
Roaring River Spring
Roaring Spring
Schlicht Spring
Shanghai Spring
Slabtown Spring
Steelville Spring
Turner Mill Spring
Wilkins Spring
Williams Spring

In 18 cases water cress is absent, while in 35 cases water milfoil is not recorded. Water cress, therefore, is the species which occurs the greatest number of times in the springs. In the present paper only the larger Ozark springs are described. However, it may be stated in passing that in most of the smaller Ozark springs not included in this paper water cress was found to be the dominant and commonest species. In many of these springs, in fact, it was the only aquatic spermatophyte found. Although water cress was recorded as of more frequent occurrence in the springs than any other species, it must not be inferred that it was also the dominant species. In many cases, its occurrence in the larger Ozark springs is exceeded in abundance by a number of other species. This is especially true as regards its rivals, water milfoil and water starwort, the species next most frequently occurring. These latter two species are often the most abundant and dominant ones present. Where several species are represented in a given spring, they often grow so abundantly, especially water milfoil, as to minimize the occurrence of the others in comparison.

It is of interest to note the conditions under which the two commonest species found in the springs thrive. In the case of water cress, shallow water with a gravelly substratum and a slow- to medium-flowing current appear to suit this species best. For these reasons it is the dominant and common species in all the small Ozark springs and spring branches where the water is shallow, the stream bed is gravelly, and the current not too fast. For the same reasons, water cress is absent around the heads of some of the large and deep springs where the banks slope off steeply into deeper water or where the current is too fast. For example, at Blue Spring in Ozark County,

Silver Lake, Boiling Spring in Pulaski County, and Sands Spring, to mention a few examples, the water at the head of the spring is deep, the sides of the banks are steep, and, in the case of Boiling Spring, the water boils up forcefully. No foothold is afforded for water cress in such cases.

However, where water cress does not exist around the heads of some springs, it often is found farther down along the course of the spring branch where the conditions of shallower water, less rapid stream flow, and more gravelly substrata exist. Of all the factors enumerated, shallow water appears to be the most important for the occurrence of the species.

In the case of water milfoil almost the reverse conditions seem to be necessary. It grows best where the water is rather deep, the substratum muddy, and the current slow to medium. It grows in the deepest waters, if necessary. It prefers muddy substrata. If the water is too swift and at the same time shallow, with a gravel substratum, it is likely to be absent. It, therefore, does not appear in such springs as Big Spring in Newton County, Bliss Spring, Cave Spring in Greene County, Chesapeake Spring, Kratz Spring, Mill Creek Spring, Mossy Spring, Steelville Spring, and Wilkins Spring.

The following chart shows the relative frequency of occurrence of the commonest species in the springs:

FREQUENCY OF OCCURRENCE OF SPECIES WITHIN OZARK SPRINGS

Name of plant	Rank	No. of times found
Rorippa Nasturtium-aquaticum	1	72
Callitriche heterophylla	2	54
Myriophyllum heterophyllum	3	53
Sparganium americanum	4	41
Anacharis occidentalis	5	38
Veronica connata	6	35
Potamogeton foliosus var. *genuinus* *Zannichellia palustris* var. *major*	7	34
Ludvigia palustris var. *americana*	8	32
Ceratophyllum demersum	9	22
Potamogeton foliosus var. *macellus* *Potamogeton lucens*	10	18
Ranunculus longirostris	11	17
Poa annua var. *reptans* *Eleocharis acicularis* var. *typica* and var. *gracilescens* *Polygonum hydropiperoides*	12	15
Cardamine bulbosa f. *fontinalis*	13	14
Potamogeton amplifolius *Mentha piperita* *Heteranthera dubia*	14	9
Alisma subcordatum	15	8
Nuphar ozarkanum *Eleocharis calva* *Juncus acuminatus*	16	6
Sagittaria latifolia	17	5

Najas guadalupensis, *Glyceria striata*, *Agrostis stolonifera*, *Spirodela polyrhiza*, *Lindernia dubia* var. *typica*	18	4
Penthorum sedoides, *Leersia oryzoides*, *Saururus cernuus*, *Lemna minor*	19	3
Lemna trisulca, *Utricularia gibba*, *Mentha arvensis* var. *glabrata*, *Rumex obtusifolius*, *Samolus parviflorus*	20	2
All others mentioned in descriptions of springs	21	1

In an exceptional number of cases, only one or two species of spermatophytes occur in the springs. The following springs are examples of such a paucity of higher vegetation:

Spring	Species found
Big Spring, Newton County	*Rorippa Nasturtium-aquaticum*
Big Spring, Lawrence County	*Rorippa Nasturtium-aquaticum* *Myriophyllum heterophyllum*
Bliss Spring	*Rorippa Nasturtium-aquaticum* *Callitriche heterophylla*
Blue Spring, Ozark County	*Callitriche heterophylla*
Cave Spring, Greene County	*Rorippa Nasturtium-aquaticum*
Creasy Spring	*Rorippa Nasturtium-aquaticum* *Myriophyllum heterophyllum*
Davidson's Blue Spring	*Zannichellia palustris* var. *major*
Falling Spring	*Myriophyllum heterophyllum*
Mill Creek Spring	*Rorippa Nasturtium-aquaticum* *Potamogeton foliosus* var. *genuinus*
Mossy Spring	*Rorippa Nasturtium-aquaticum*
Roaring Spring	*Callitriche heterophylla*

Of the 11 springs above enumerated, it will be noted that in only four cases was water cress absent. In two instances water starwort was the only species recorded, and in a third case it was the only other species to occur. In one spring, horned pondweed was the sole species of higher plant represented, and in one spring pondweed (*Potamogeton foliosus* var. *genuinus*) was the only other plant to occur with water cress. In other words, five species of plants were found in the 11 instances in which only one or two kinds of spermatophytes existed in the springs. Of these five which occurred, water cress was most common, with water milfoil, water starwort, horned pondweed, and pondweed named in successive order of occurrence.

From what has already been stated concerning water cress and water milfoil, it will be observed that the relative abundance and distribution of the different species occurring in the springs is affected by various factors. The following factors appear to be the most significant: (1) velocity of current, (2) depth of water, and (3) type

of substratum. These factors are probably most important because they are the most variable, thereby causing a greater differentiation within a given environment. Other factors, such as temperature of the water, volume of water, amount of light, clarity, and alkalinity of the water, do not vary enough to have a marked effect on distribution and arrangement of the various species.

Most of the Ozark spring waters are decidedly alkaline in reaction as they emerge from their outlets. As shown in the analyses of spring waters in Beckman's report,[1] they are highly charged with dissolved bicarbonates and calcium carbonates. Considerable calcium and magnesium are present, as would be expected in waters coming from porous dolomitic limestone strata.

The effects of the several environmental factors in the springs react upon the species in different ways. The most noticeable factor is that of swiftness of the current and its effect upon the flowering of the species. In rapid-running water or in swift currents water milfoil, bur-reed, white water crowfoot, water speedwell, mild water pepper, and water star-grass vegetate prolifically, but nearly always are sterile. The same species growing in quiet water or rooting near the margin of the spring usually flower abundantly. This condition holds more or less true with most other species of the springs. Shining pondweed often has a different appearance in quiet and in rapid water. In quiet water the leaves are erect, wavy on the margins, and ascending, while in rapid-running water they are less wavy on the margins, and less curved. Running water appears to have a marked effect on water purslane and water speedwell, both of which grow in larger and more compact clusters and have smaller leaves under such conditions.

Deep water frequently has the same effect on plants as that produced by swift currents, namely, a tendency toward the production of vegetative or sterile shoots only. This is especially conspicuous in the case of water milfoil, bur-reed, water starwort, shining pondweed, and broad-leaved pondweed. These species often grow in the deeper waters of the spring, where they vegetate freely, but rarely, if ever, produce flowers.

In general, the main factors which appear to be associated constantly with the flowering condition of the plants are, in order of importance, (1) quiet water or remoteness from main current, (2) shallow water or lowering of water level, and (3) increased exposure

[1] H. C. Beckman, Water resources of Missouri, Mo. Bur. of Geol. and Mines, 20: 402–407. 1927.

to sunlight or desiccation. Either one or all of these conditions usually result in production of flowers.

Each of the characteristic aquatic species of the spring, i.e., those which actually grow in the water throughout the entire year, remains green and alive, at least in vegetative condition, during winter, spring, summer, and autumn. During the winter, as a rule, many of the species are in vegetative condition only. This is especially true in the case of the various pondweeds (*Potamogeton*), water purslane, water speedwell, water milfoil, bur-reed, water-weed, and white water crowfoot. Sometimes horned pondweed, water starwort, and annual bluegrass flower in winter as well as at other times of the year. Most of the aquatics mentioned, however, do not flower until late spring and summer.

Those species which usually occur along the shore and grow partly in and partly out of the water, such as lizard's tail, broad-leaved arrowhead, common cat-tail, water plantain, rice cut grass, creeping spike rush, various species of rush (*Juncus acuminatus*, *J. effusus* var. *solutus*, and *J. macer*), and others, drop their leaves and remain dormant over most of the winter and spring, renewing growth in early or late spring. As early as February some of these amphibious species, such as lizard's tail, may begin to produce a few new leaves. Water purslane, which is more nearly amphibious than any of the other truly aquatic species of the springs, often loses many of its leaves during winter, or most of them in the lower and middle portions of the plant may turn black, leaving only the uppermost leaves and tips green or flushed with orange, red, or purple.

Throughout the years of observation devoted to the study of the vegetation of the Ozark springs, the author has kept records for each spring, noting the various environmental conditions under which each species occurs. From a comparative study of these records, it has been found that some species occur most frequently under one set of conditions, while other species appeared most often when other types of environmental factors were prominent. Of course, some overlapping exists in which one species or another may tolerate or occur despite various types of conditions, which is to be expected. But, generally, it may be stated that certain types of environment favor the abundance or occurrence of one species over another. As has been stated before, the most variable factors in the springs are those of (1) depth of water, (2) velocity of current, and (3) type of substratum (mud, sand, gravel, rocks, or combinations of these).

First, there is the consideration of deep or shallow water. In order that this may be considered more conveniently, those species which favor such waters have been arranged as two classes in the following columns:

SPECIES FAVORING DEEP WATER	SPECIES FAVORING SHALLOW WATER
Phanerogams	
Myriophyllum heterophyllum	*Rorippa Nasturtium-aquaticum*
Sparganium americanum	*Zannichellia palustris* var. *major*
Potamogeton amplifolius	*Veronica connata* and var. *glaberrima*
Potamogeton lucens	*Eleocharis acicularis* and varieties
Potamogeton foliosus and varieties	*Eleocharis calva*
Potamogeton panormitanus and varieties	*Callitriche heterophylla*
Ceratophyllum demersum	*Potamogeton foliosus* and varieties
Callitriche heterophylla	*Ceratophyllum demersum*
Anacharis occidentalis	*Ranunculus longirostris*
Nuphar ozarkanum	
Cryptogams	
Chara spp.	
Nitella spp.	
Porella sp.	

These lists indicate that the species included in them occur most frequently in one or the other type of water. It does not signify that the species invariably lives in shallow or in deep water, but merely that it has been found most often growing under those conditions. The same is true for the other lists which follow in which other categories are used. When the same species is listed under both classes, it is evident that it is more or less ubiquitous and can exist under both conditions.

From an examination of the above lists, it will be seen that *Callitriche heterophylla, Potamogeton foliosus* and varieties, and *Ceratophyllum demersum* are found frequently in both deep and shallow water. It may be stated, however, that while these are equally common in one or the other, at least one, namely, *Callitriche heterophylla,* is commoner in shallow water.

Myriophyllum heterophyllum and *Potamogeton amplifolius* occur most frequently in the deepest parts of the springs, the former often frequenting the sides and bottom of the outlets of the deepest springs, and forming vegetative strands several feet in length. *Ceratophyllum demersum, Sparganium americanum, Nuphar ozarkanum, Potamogeton lucens, Chara* spp., and *Nitella* spp. are the other species that often inhabit the deeper portions of springs.

Second, there is the consideration of fast or quiet water. The following lists indicate the frequency and tolerance of the species under such conditions:

SPECIES FAVORING SWIFT WATER	SPECIES FAVORING QUIET WATER
Phanerogams	
Zannichellia palustris var. *major*	*Ceratophyllum demersum*
Veronica connata and var. *glaberrima*	*Myriophyllum heterophyllum*
Potamogeton foliosus and varieties	*Ranunculus longirostris*
Poa annua var. *reptans*	*Sparganium americanum*
Ranunculus longirostris	*Anacharis occidentalis*
Polygonum hydropiperoides	*Callitriche heterophylla*
Eleocharis acicularis and varieties	*Ludvigia palustris* var. *americana*
Callitriche heterophylla	*Saururus cernuus*
	Potamogeton foliosus and varieties
Cryptogams	*Potamogeton amplifolius*
Various mosses	*Potamogeton lucens*
Various hepatics	*Polygonum hydropiperoides*
Various algae	*Nuphar ozarkanum*
	Eleocharis acicularis and varieties
	Zannichellia palustris var. *major*
	Veronica connata and var. *glaberrima*
	Cryptogams
	Chara spp.
	Nitella spp.
	Porella sp.

It will be noted from the above lists that many species of swift waters are listed as occurring also in quiet waters. Such species are *Zannichellia palustris* var. *major*, *Veronica connata* and var. *glaberrima*, *Potamogeton foliosus* and varieties, *Polygonum hydropiperoides*, *Ranunculus longirostris*, *Callitriche heterophylla*, and *Eleocharis acicularis* and varieties. However, the species occurring the greatest number of times in and most characteristic of the swiftest waters are *Zannichellia palustris* var. *major*, *Potamogeton foliosus* and varieties, *Poa annua* var. *reptans*, and *Veronica connata* and var. *glaberrima*. *Zannichellia palustris* var. *major* is especially common in the swifter waters. Particularly *Myriophyllum heterophyllum*, *Ceratophyllum demersum*, *Sparganium americanum*, *Callitriche heterophylla*, *Ludvigia palustris* var. *americana*, *Anacharis occidentalis*, and *Saururus cernuus* are characteristically quiet-water plants.

Other conditions being equal, a spring with quiet waters and slow currents usually harbors a greater variety and luxuriance of aquatic plants than one with swifter waters.

The third most important consideration is that of substratum. The main types of substrata in springs may be classified as mud, sand-gravel, and rock. Of these types, the mud and sand-gravel or a combination of these is the most common. Only mosses, hepatics, and algae have been recorded as growing on the loose rocks in springs. Of the other types the following lists are available:

Species Favoring Mud Substratum	Species Favoring Sand-Gravel Substratum
Phanerogams	
Saururus cernuus	*Zannichellia palustris* var. *major*
Callitriche heterophylla	*Veronica connata* and var. *glaberrima*
Sparganium americanum	*Potamogeton lucens*
Ludvigia palustris var. *americana*	*Potamogeton foliosus* and varieties
Sagittaria latifolia	*Heteranthera dubia*
Ceratophyllum demersum	*Rorippa Nasturtium-aquaticum*
Heteranthera dubia	*Ranunculus longirostris*
Ranunculus longirostris	*Eleocharis acicularis* and varieties
Nuphar ozarkanum	*Callitriche heterophylla*
Potamogeton foliosus and varieties	*Sparganium americanum*
Potamogeton lucens	*Poa annua* var. *reptans*
Potamogeton amplifolius	
Alisma subcordatum	
Eleocharis acicularis and varieties	
Rorippa Nasturtium-aquaticum	
Veronica connata and var. *glaberrima*	
Zannichellia palustris var. *major*	
Cryptogams	
Chara spp.	
Nitella spp.	

The exceptions to the above lists are *Veronica connata* and var. *glaberrima*, and *Rorippa Nasturtium-aquaticum*, which are characteristic of sand-gravel substrata, but sometimes grow upon mud. On the other hand, an exception of a species occurring on the sand-gravel substratum which is most frequent and otherwise characteristic of mud is *Sparganium americanum*. *Ceratophyllum demersum*, *Sparganium americanum*, *Ludvigia palustris* var. *americana*, *Chara* spp., and *Nitella* spp. are rarely found away from mud, while *Zannichellia palustris* var. *major* is so characteristic of sand or gravel that it invariably appears on the newly deposited or small stretch of sandy or gravelly substratum occurring in a spring possessing otherwise a muddy substratum. Usually *Sparganium americanum* appears along the muddy margins of the spring, but rarely takes to pure gravel as it does where it is abundant on the gravel at the head of one of the sources of Paydown Spring, Maries County.

The species which appear on both mud and sand-gravel substrata are *Zannichellia palustris* var. *major*, *Veronica connata* and var. *glaberrima*, *Potamogeton lucens*, *Potamogeton foliosus* and varieties, *Callitriche heterophylla*, *Heteranthera dubia*, *Rorippa Nasturtium-aquaticum*, *Sparganium americanum*, *Ranunculus longirostris*, and *Eleocharis acicularis* and varieties. The preferences and exceptions of most of these species have already been discussed above.

Water cress is, as has previously been mentioned, the species occurring the greatest number of times in the springs. It also occurs most commonly on the sand-gravel type of substratum, where it is a

pioneer species and usually remains dominant. Its preference is for the sand-gravel type of substratum, but it also appears sometimes on mud substratum as a result of a filling in of mud or alluvium in the spring branch deposited over the original sand-gravel bed. This muddy or alluvial deposit may also occur as a result of the dominant growth of water cress itself. This may happen when the water cress becomes so common and luxuriant along the margin or bed of the spring branch that huge beds or colonies are formed. Then the perennial growth adds yearly deposits of particles of decomposed matter to the soil, while the latter becomes deeper and is deposited around the base of the plants. Eventually, the current is slowed, the water becomes relatively shallower around the water cress, and a deeper deposit of alluvium and mud is built up around the plants.

In the previous discussions, species have been grouped according to their preference for one or another of certain factors. Thus, where only one factor has been considered, it was found that frequent overlapping was the result and the same species was often found in either category; but when a combination of factors is considered, it is found that a much more definite preference occurs and that a certain association of species usually is present.

Thus in a combination of *deep* and *quiet* water, the following species almost invariably occur:

Myriophyllum heterophyllum
Ceratophyllum demersum
Nuphar ozarkanum
Saururus cernuus
Potamogeton amplifolius
Sparganium americanum
Potamogeton panormitanus and varieties
Chara spp.
Nitella spp.

In water which has a *swift* current and a *sand-gravel* substratum the usual plants are:

Poa annua var. *reptans*
Potamogeton foliosus var. *genuinus* and var. *macellus*
Zannichellia palustris var. *major*

Water which has a *shallow* current and a *muddy* substratum generally contains:

Ludvigia palustris var. *americana*
Sagittaria latifolia
Alisma subcordatum
Callitriche heterophylla
Eleocharis acicularis and varieties
Ceratophyllum demersum
Anacharis occidentalis

From what has already been stated concerning species growing under different conditions, it is obvious that various combinations of certain environmental conditions favor the occurrence of some species, or an assemblage of species, more so than they do others.

The combination of factors least conducive to the growth of aquatic spermatophytes is very swift and deep water at the head of a large spring. In such outlets of subterranean streams, water rushes out by the gallon, and the plants usually can not get a foothold in such swiftly rushing water. Passing through various stages of more favorable habitats, the one apparently best suited to a luxuriant production of aquatic plant life is that containing a combination of water which is slightly deep, having a slow to medium current, or at least with some current producing a visible motion, together with a sandy-mud or muddy gravel substratum. Too much sand or too much mud eliminates the occurrence of either mud-loving or sand-loving species, while sand-mud or mud-sand-gravel mixtures appear to be favorable media for the growth of all the species.

Sometimes it is hard to explain why some springs, apparently with the necessary qualifications of favorable environmental factors, appear to be unsuited for the growth of a variety or luxuriance of plants. Some of the springs most favorable for a rich development of aquatic plants are Boze Mill Spring in Oregon County, Big Spring in Carter County, Double or Rainbow Spring in Ozark County, and Bennett Spring in Laclede County.

Some of the species found in the springs are those which require a cool temperature of 54°–60° F.; they are not found in waters with warmer temperatures. The following species are exclusively restricted to spring waters or waters in the vicinity of outlets of springs:

Sparganium americanum
Potamogeton amplifolius
Potamogeton foliosus var. *genuinus*
Potamogeton foliosus var. *macellus*
Potamogeton lucens
Lemna trisulca
Ranunculus longirostris
Rorippa Nasturtium-aquaticum
Myriophyllum heterophyllum
Veronica connata and var. *glaberrima*

Other species which are found in springs are far more tolerant of a range in temperature, for these occur not only in the cooler waters of the springs, but even in the warmer waters of ponds or rivers. Some of the water in these ponds reaches temperatures above 80° F. The species tolerant of this range in temperature are:

Najas guadalupensis
Eleocharis acicularis var. *typica*
Spirodela polyrhiza
Lemna valdiviana
Wolffia punctata
Polygonum hydropiperoides
Callitriche heterophylla
Peplis diandra
Ludvigia palustris var. *americana*
Myriophyllum scabratum
Myriophyllum proserpinacoides
Utricularia gibba

Of these, the ones that occur most commonly in the springs and in the warmer ponds are *Eleocharis acicularis* var. *typica*, *Callitriche heterophylla*, and *Ludvigia palustris* var. *americana*. It is interesting

to note that all three of these species root in shallow water along the margins of the ponds where the water may reach over 80° F., as well as along the shallow margins of the colder water of the spring heads and spring branches.

DIFFERENTIATION AND DISTINGUISHING CHARACTERS OF SPECIES

The purpose of the present section is to give some of the characteristics of each species occurring in or marginal to the water of the various Ozark springs. Technical descriptions of all these species are found in manuals and monographs, so that in the present case only the most obvious field marks for identification are given.

Differences in the habitats of these species have already been discussed, and it is obvious that some species prefer fast to still water, deep to shallow water, and sand to mud substratum.

Aside from differences in habitat, there remain for discussion differences in habit, color, and general appearance due to such factors as leaf arrangement and leaf position. As regards the habit of the plant, some species grow with erect stems, while others have a decumbent, procumbent, or even prostrate habit. Also, some species grow more or less as solitary individuals, while others generally occur in colonies.

The following species usually occur as solitary plants:

Alisma subcordatum
Poa annua var. *reptans*
Juncus macer
Juncus effusus var. *solutus*
Ceratophyllum demersum
Callitriche heterophylla
Peplis diandra
Rotala ramosior var. *interior*
Ludvigia palustris var. *americana*
Epilobium coloratum
Myriophyllum scabratum
Lindernia dubia var. *typica*

The following grow generally in colonies or mats of several plants close together:

Typha latifolia
Sparganium americanum
Potamogeton crispus
Potamogeton amplifolius
Potamogeton lucens
Potamogeton foliosus var. *genuinus*
Potamogeton foliosus var. *macellus*
Potamogeton panormitanus var. *major*
Potamogeton panormitanus var. *minor*
Najas guadalupensis
Zannichellia palustris var. *major*
Anacharis occidentalis
Eragrostis hypnoides
Leersia oryzoides
Eleocharis acicularis var. *typica*
Eleocharis acicularis var. *gracilescens*
Eleocharis calva
Spirodela polyrhiza
Lemna trisulca
Lemna valdiviana
Wolffia punctata
Heteranthera dubia
Juncus acuminatus
Saururus cernuus
Polygonum hydropiperoides
Nuphar ozarkanum
Ranunculus longirostris
Rorippa Nasturtium-aquaticum
Cardamine bulbosa f. *fontinalis*
Myriophyllum heterophyllum
Mentha piperita
Veronica connata
Utricularia gibba

Most of the species in the above list have creeping rootstocks.

The following species usually have a prostrate or procumbent habit of growth:

Zannichellia palustris var. *major*
Anacharis occidentalis
Poa annua var. *reptans*
Eragrostis hypnoides
Heteranthera dubia
Ludvigia palustris var. *americana*
Myriophyllum scabratum
Myriophyllum proserpinacoides
Veronica connata

The species in the above list generally grow with a procumbent or prostrate habit. One factor responsible for this habit is the swift, shallow water in which some of them, such as *Poa annua* var. *reptans*, *Zannichellia palustris* var. *major*, and *Veronica connata* grow. Also, the tendency of some species to creep along wet, muddy places at the edge of the spring accounts for the prostrate habit often found in *Ludvigia palustris* var. *americana*, *Heteranthera dubia*, *Anacharis occidentalis*, *Eragrostis hypnoides*, *Myriophyllum proserpinacoides*, and *Myriophyllum scabratum*.

Fast, shallow water usually causes normally erect-growing plants to become prostrate or procumbent, and this is quite marked in the case of several species of *Potamogeton*, *Polygonum hydropiperoides*, *Ranunculus longirostris*, and *Eleocharis acicularis* var. *typica*. These species grow in both still and swift waters, and their habits of growth vary according to their toleration of one or the other type of current.

While some species occur in definite colonies of several to many stems or plants growing together, their appearance differs considerably as a result of the manner of growth. Some of them, such as species of *Chara* and *Nitella*, grow in large, hemispherical masses, the shape a result of the regular growth in all directions. *Ranunculus longirostris* generally occurs in circular or subcircular masses, because of its branching and growth in all directions. *Rorippa Nasturtium-aquaticum*, likewise, forms dense, evenly grown clumps of foliage.

On the other hand, some species have the habit of elongating the stem-axes in one direction and producing leaves mostly in two planes. This type of vegetative growth, especially when the main stem produces few branches, results in long strands of foliage. Such is the case in *Potamogeton lucens* and *P. foliosus* var. *genuinus*, whose elongate, mostly simple stems grow to three and four feet in length. *Najas guadalupensis*, with a similar growth habit, produces long, dense mats, sometimes five or even ten feet long. *Zannichellia palustris* var. *major*, *Heteranthera dubia*, and *Anacharis occidentalis* sometimes form long, vegetative strands. Under certain conditions, where the water is shallower or swifter, these same species may produce

much shorter stems with shorter internodes, thus becoming less elongated, and, consequently, forming denser and more circular patches.

Both *Eleocharis acicularis* var. *typica* and *E. calva* form large beds or colonies because of their creeping rootstocks, and the same result is found in the case of *Sparganium americanum*, *Mentha piperita*, and many other plants. Some species, such as *Mentha piperita* and *Eleocharis acicularis*, form dense colonies along the shallow stretches of spring water, but can not tolerate too great a depth, and eventually their colonizing and rooting tendencies become lost in direct proportion to the increasing depth of the water.

Differences between the various species in color is well marked and in general is a good specific character for field identification. Of course, some of the species have a slight change in color according to the season of the year, but in general the color for any one species remains a fairly constant and reliable character. Thus, *Callitriche heterophylla* is usually a shade of light green, or rarely assumes a bronze or coppery appearance with a light green tint, but the light green color is quite characteristic. *Rorippa Nasturtium-aquaticum* remains constant in color throughout the year; it is usually of a light green or rich grass-green shade. *Sparganium americanum* always has pale to light green leaves. *Zannichellia palustris* var. *major* usually has leaves of a light green color, but is also of a bright green, rich or dark grass-green color, and sometimes appears blue-green. *Eleocharis acicularis* and varieties are usually of a light or grass-green shade similar to the usual color of *Zannichellia palustris* var. *major*. *Eleocharis calva*, on the other hand, together with *Juncus acuminatus* and *Juncus effusus* var. *solutus*, has dark or dull green leaves and stems. *Cardamine bulbosa* has leaves of a light green color on the upper surface, and either purplish or pale green on the lower surface. *Veronica connata* and variety are fairly uniform, most constantly appearing in shades of olive-green. These shades may vary at times from a dull olive or pastel-olive to olive-green, light green, or sometimes, in late fall and winter, to an olive-green tinged with a brick color. *Najas guadalupensis* varies from a rich grass-green to dull green or brownish green, and even to brownish. Its usual color is a dull grass-green.

The various species of pondweeds found in springs and spring branches are usually in shades of dark green. *Potamogeton crispus* is the darkest green of any of the species, and often is green-brown in color. *Potamogeton amplifolius* is either dark blackish green, dull,

dark green, or dull green. *Potamogeton lucens* is usually dull olive-green, but varies from light green to an olive-green, grass-green, dark olive, or even buff-brown color. The varieties of *Potamogeton foliosus* are quite variable in color. In his key to the varieties of *Potamogeton foliosus*, Fernald[1] distinguishes var. *genuinus* from var. *macellus* partly on the basis of color. *Potamogeton foliosus* var. *genuinus* is characterized by "leaves deep-green to bronze," while *P. foliosus* var. *macellus* is distinguished by "leaves bright green." After having made many collections in Missouri of both these varieties, I find that these color differences are not constant. For example, I have found *Potamogeton foliosus* var. *genuinus* in Missouri with the following colors: bright green, dark green, bright olive-green, dark bronze-green, and brown-black-green, while *P. foliosus* var. *macellus* has the following variations: dark bronze, olive-green and bronze, bronze-green, dark green and bronze, and dull green. In the majority of cases it was found that *P. foliosus* var. *genuinus* was usually a bright green color, while *P. foliosus* var. *macellus* was either dark green, bronze-green, or a combination of dark green and bronze. In many instances it was found that both varieties occurred near each other, and sometimes side by side. In fact, while *Potamogeton foliosus* var. *genuinus* is more frequently found in deeper or fast-flowing water, and *P. foliosus* var. *macellus* oftener in shallower and slower water, the habitats of the two types merge, and at times it is difficult to determine material which agrees absolutely with the characters assigned by Fernald to one or the other variety. In one spring *P. foliosus* var. *genuinus* assumes the "deep-green to bronze" color by which Fernald characterizes it, while in other springs the same variety may be found with leaves "bright green," which is supposed to distinguish the other variety, *P. foliosus* var. *macellus*.

Of the aquatic grasses found in spring waters *Poa annua* var. *reptans* and *Agrostis stolonifera* usually have blue-green or silvery green leaves. These are the most common of the more frequent aquatic grasses.

Ranunculus longirostris is usually of a grass- or dark green color, but varies from an olive-green to a dark blackish green color. The aquatic, submerged states of *Polygonum hydropiperoides*, which grow in dense mats similar to those of *Veronica connata*, often resemble that species in color, usually possessing an olive-green color, but they are usually flushed with purple and red shades. It often has leaves of a bronze-purple color on the lower surface and an olive-green on the

[1] M. L. Fernald, The linear-leaved North American species of *Potamogeton*. Mem. Amer. Acad. 17: 43. 1932.

upper surface. The leaves may be mostly tinged with reddish or copper in some specimens and orange and green in others.

The thin, submerged leaves of *Nuphar ozarkanum* are usually olive- or light green tinged with pink-reddish or bronze color, while the floating leaves are leathery and dark green. *Heteranthera dubia* also usually has leaves of an olive-green color. In *Ludvigia palustris* var. *americana*, while the ordinary color scheme is a combination of various reds or coppery-reds and greens, as in *Polygonum hydropiperoides*, other shades also are found, such as olive-green with rose or copper color, brownish red and green, and olive-green with the tips of the shoots red and orange or tinged with bronze and orange. Rarely is the entire plant of a reddish purple color. Sometimes the leaves are all dark green in shade, but usually some reddish, purplish, or orange color is suffused with the olive-green. At times, in winter, many leaves of some of the plants become darker, or most of them become black, with only the tips remaining colored.

Passing to the darker shades of green found among the species inhabiting springs, we find that the commoner ones having a dark green color are *Ceratophyllum demersum*, *Anacharis occidentalis*, and *Myriophyllum heterophyllum*. In *M. heterophyllum* the plants are usually dark green, but vary greatly according to the season of the year and depth of the water. Sometimes plants of this species are of a bronze-red, or purple-red color. In winter they are often brown-red or even brown, but this is not always the case, for in some springs in winter the plants may be more green than brown. A bronze tinge is characteristic of many plants of this species at certain times of the year. In spring the plants are often dark green. In great depths of water, such as at Markham Spring in Wayne County, the stems of *M. heterophyllum* may be entirely purple-red. *M. scabratum*, a rarer species, usually has dark green or grass-green leaves, while a tropical species, *M. proserpinacoides*, introduced and established around Blue Spring in Crawford County, has leaves of a blue-green or gray-green color. Another common species with a dark color is *Ceratophyllum demersum*. It usually is dark green, but varies from dark bronze-green to bronze and purple and even dark brown with blackish green. *Anacharis occidentalis* is most frequently dark grass-green. It often gives a black appearance to the water when it occurs in large masses. It is often found with *Myriophyllum heterophyllum*, and where the two are close together, with a similar dark green or blackish green color, the differentiation of the two plants may be made at some distance by the smaller, more terete or pencil-shaped, smoother masses of

Anacharis, compared with the broader, more worm-like or bushy-tailed appearance of *Myriophyllum heterophyllum*. The latter is sometimes called coon's-tail, in allusion to the bushy-tailed appearance of its large strands. *Anacharis* also appears in other colors, such as coppery, dark coppery green, dull green mixed with red, and russet-brown and green. The latter color combination was observed in some places during the spring season. *Alisma subcordatum* usually has dark green leaves, as has also *Peplis diandra*, and *Saururus cernuus*. *Peplis diandra* may assume shades of rose or orange when exposed to bright, steady sunlight. *Chara* and *Nitella* species are frequently dark green, but also vary considerably. In some species of *Chara* the color may usually be dull olive-green or it may be dark green or dark grass-green. In species of *Nitella* the color is usually dark green, but may vary from light green to olive- and gray-green.

Among the Lemnaceae of spring waters, most species of *Lemna*, *Wolffia*, and *Spirodela* are of light to grass-green shades. The exception is *Lemna trisulca*, which is usually dark blue-green.

Utricularia gibba most often occurs in light to olive- or grass-green mats, but *Mentha piperita* is characteristically grass-green.

The various types of leaf arrangement serve to distinguish many of the species occurring in the spring and give them their characteristic appearance.

GEOGRAPHICAL DISTRIBUTION OF SPECIES

The species discussed below are those which are either characteristic of the spring, that is, they are the ones found the greatest number of times among the species occurring in the spring water, or they are species usually found in springs. This list includes the following species:

Sparganium americanum
Potamogeton amplifolius
Potamogeton lucens
Potamogeton crispus
Potamogeton foliosus var. *genuinus*
Potamogeton foliosus var. *macellus*
Potamogeton panormitanus var. *major*
Potamogeton panormitanus var. *minor*
Zannichellia palustris var. *major*
Anacharis occidentalis
Poa annua var. *reptans*
Eleocharis acicularis var. *typica*
Eleocharis acicularis var. *gracilescens*
Lemna trisulca
Wolffia punctata
Polygonum hydropiperoides
Rorippa Nasturtium-aquaticum
Cardamine bulbosa f. *fontinalis*
Ceratophyllum demersum
Ranunculus longirostris
Callitriche heterophylla
Ludvigia palustris var. *americana*
Myriophyllum heterophyllum
Veronica connata and var. *glaberrima*

Species not included in the above list are ones which either are not found typically in springs or spring water but occur in many

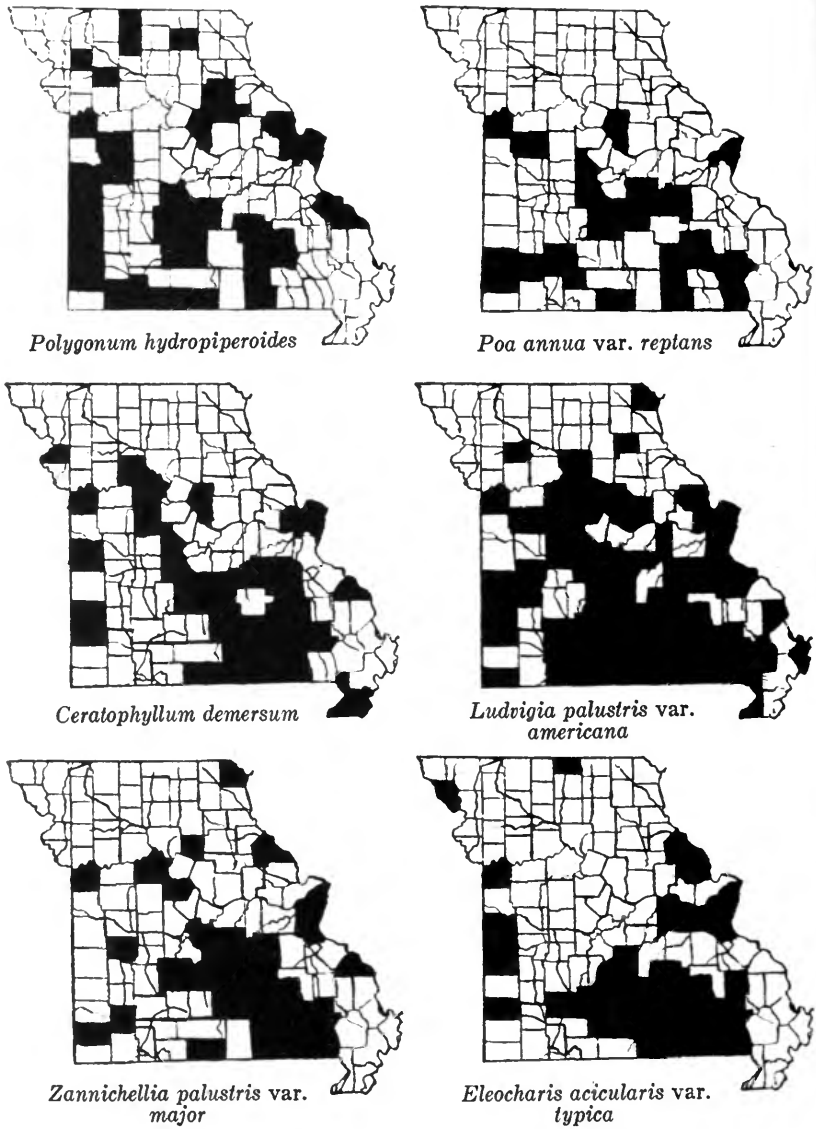


FIG. 46. Distribution in Missouri of the species of the fresh-water springs.

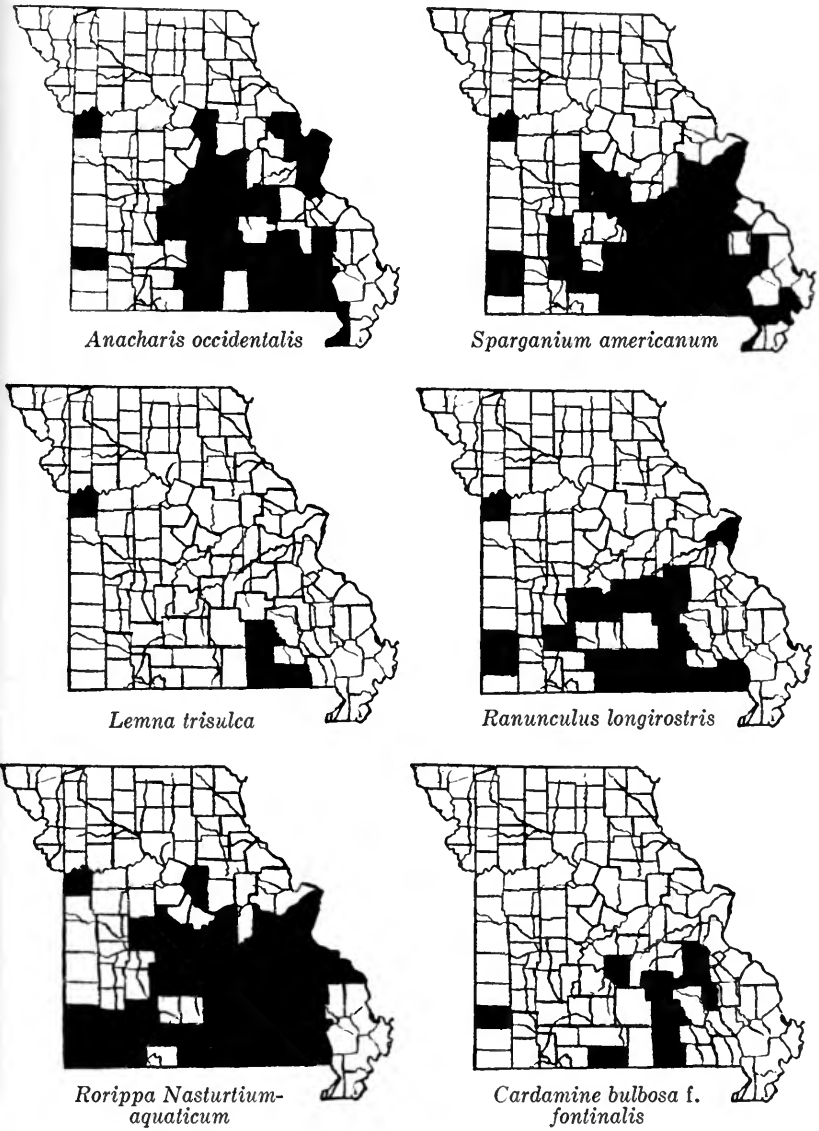


FIG. 47. Distribution in Missouri of the species of the fresh-water springs.

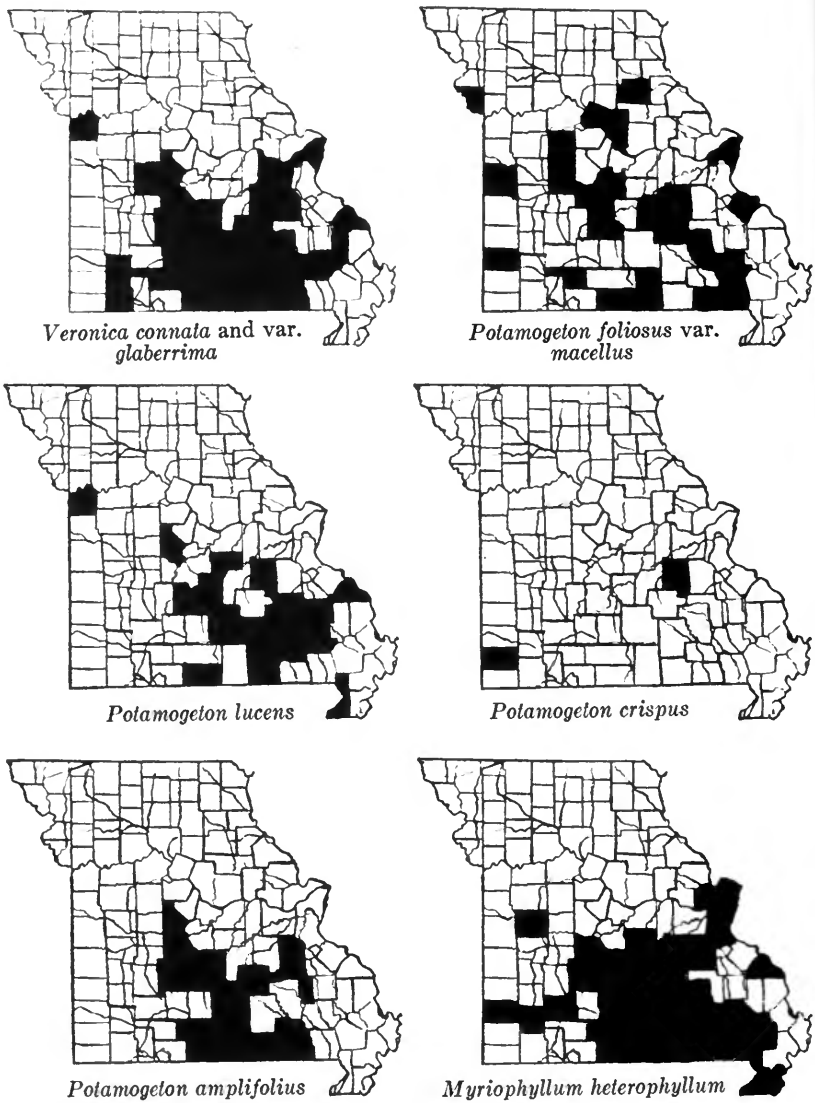


FIG. 48. Distribution in Missouri of the species of the fresh-water springs.

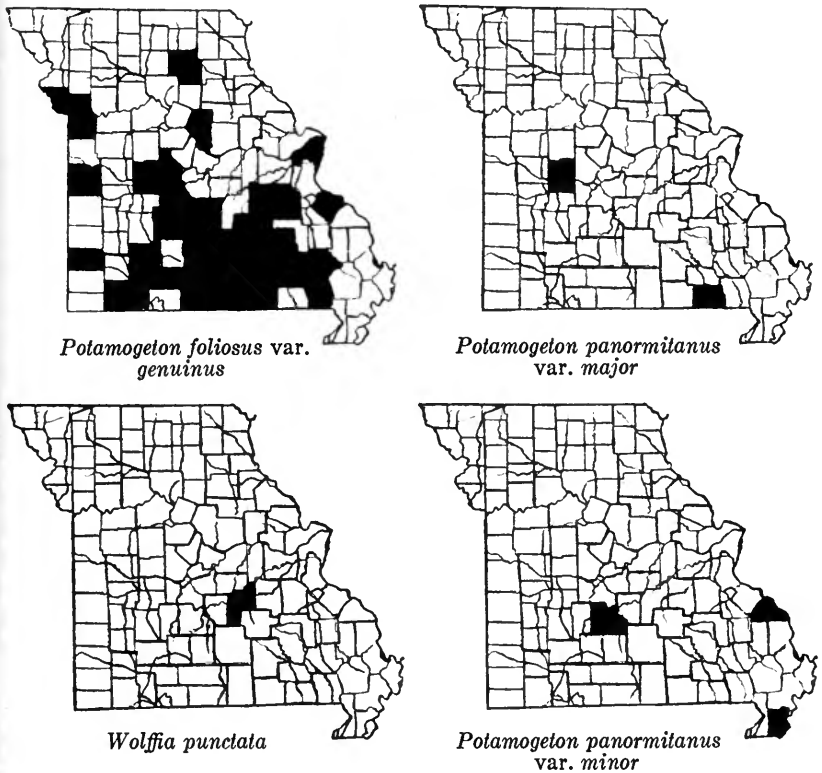


FIG. 49. Distribution in Missouri of the species of the fresh-water springs.

other types of habitat, or else are species which occur only casually in or around spring water. On the other hand, all the species listed above are typically found in spring water in Missouri or are found for the most part inhabiting this kind of water.

It is interesting to note the distribution in Missouri of the species mentioned above which occur in the springs. The distribution of these species by counties as shown in figures 46–49 reveals the fact that more than half of them (59 per cent) are limited to the Ozarks, and one-third of them are mostly general throughout Missouri, although three of these, namely, *Eleocharis acicularis* var. *typica*, *Ceratophyllum demersum*, and *Zannichellia palustris* var. *major*, are predominantly Ozarkian in distribution, and the others are chiefly Ozarkian, while two of the species in the list, or 9 per cent, are extremely local and both occur within the Ozark region. The following table analyzes these differences:

DISTRIBUTION OF SPECIES IN MISSOURI CHARACTERISTIC OF OZARK SPRINGS

Limited to Ozarks in Missouri	General in Missouri
Potamogeton foliosus var. *macellus*	*Polygonum hydropiperoides*
Potamogeton amplifolius	*Poa annua* var. *reptans*
Potamogeton crispus	*Ludvigia palustris* var. *americana*
Potamogeton lucens	*Zannichellia palustris* var. *major* (mainly Ozarkian)
Veronica connata and var. *glaberrima*	*Ceratophyllum demersum* (mainly Ozarkian)
Myriophyllum heterophyllum	*Eleocharis acicularis* (mainly Ozarkian)
Anacharis occidentalis	*Potamogeton foliosus* var. *genuinus* (mainly Ozarkian)
Sparganium americanum	
Lemna trisulca	Local in Missouri
Ranunculus longirostris	*Potamogeton panormitanus* var. *major*
Rorippa Nasturtium-aquaticum	*Potamogeton panormitanus* var. *minor*
Cardamine bulbosa f. *fontinalis*	*Wolffia punctata*

When the distribution within the United States of most of the species in the above list is studied (see figs. 50–66),[1] it will be noticed that the ranges fall within three main categories: (1) Those species that have a range more or less general throughout the United States; (2) those species that are distributed in the northern half of the United States and in Canada; and (3) those species that are predominantly in the eastern half or northeastern part of the United States. The first group includes *Ludvigia palustris* var. *americana*, *Zannichellia palustris* var. *major*, *Ceratophyllum demersum*, and *Potamogeton foliosus* var. *genuinus*. The second group of more northern types includes *Ranunculus longirostris*, *Lemna trisulca*, *P. lucens*, *P. foliosus* var. *macellus*, *P. panormitanus* var. *major* and var. *minor*, *Eleocharis acicularis* var. *typica*, *Rorippa Nasturtium-aquaticum*, and *Veronica connata*. The third group, the range of which is concentrated mainly in the eastern half or northeastern part of the United States, includes *Sparganium americanum*, *Anacharis occidentalis*, *Potamogeton amplifolius*, and *Myriophyllum heterophyllum*.

About half of these species are of northern distribution and about one-third of general distribution, while only one-fourth or one-fifth show an eastern or northeastern type of range.

It is interesting to observe that some species whose general distribution is mainly in the northern half of the United States, have their distribution in Missouri confined to the Ozark region. One would naturally expect that species found in Iowa, Minnesota, Wisconsin, Indiana, and other states to the north would occur as

[1] The data on these maps were provided by the examination of specimens from the herbaria of the following institutions: Field Museum of Natural History, Gray Herbarium, Missouri Botanical Garden, New York Botanical Garden, United States National Museum, and the University of Minnesota. To the curators of these herbaria the author is deeply grateful for the opportunity of examining specimens from the collections in their charge.

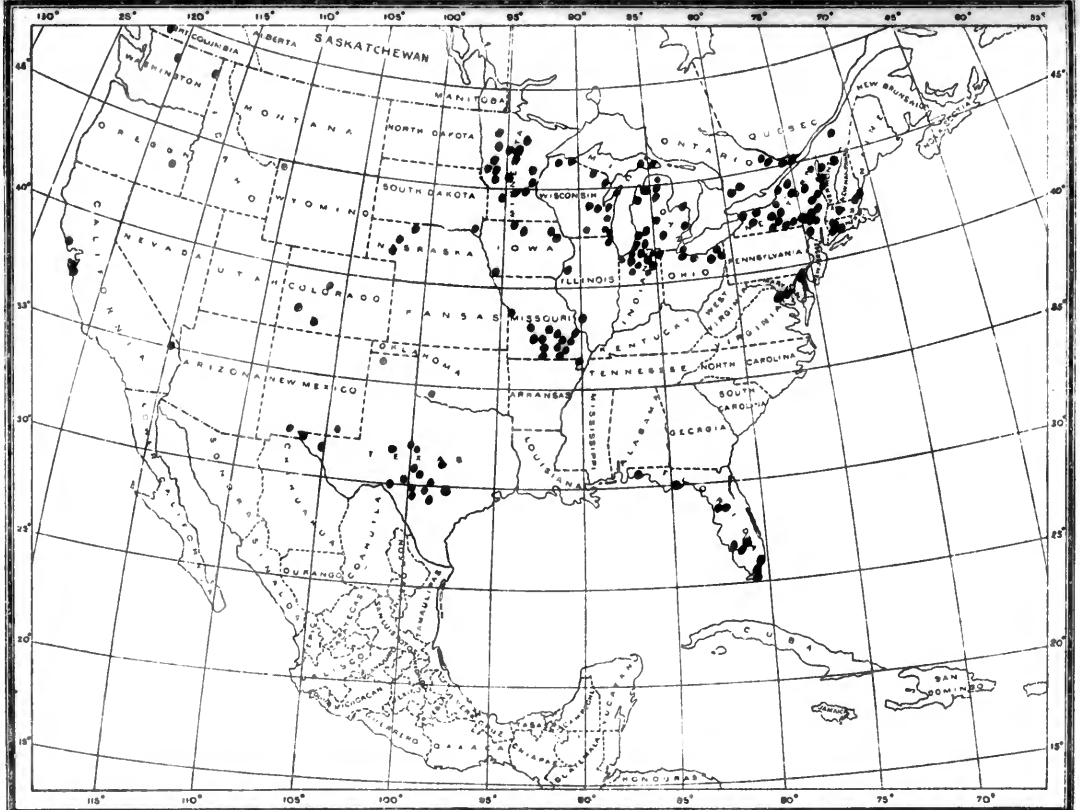


FIG. 50. Distribution of *Potamogeton lucens*. The author is deeply indebted to Dr. E. C. Ogden, of the University of Maine, who is monographing this group, for the data used in the preparation of this map.

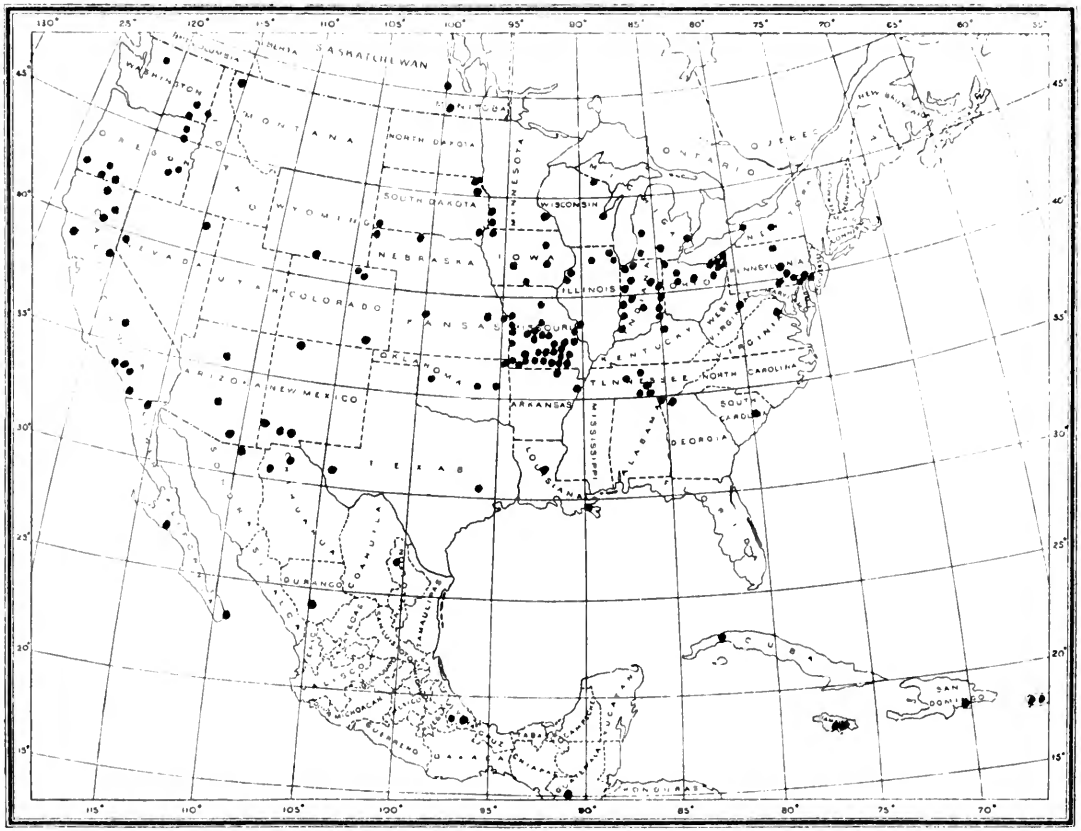


FIG. 51. Distribution of *Potamogeton foliosus* var. *genuinus*. The author is indebted to Dr. M. L. Fernald's monograph of the linear-leaved North American species of *Potamogeton* for the data used in the preparation of this map.

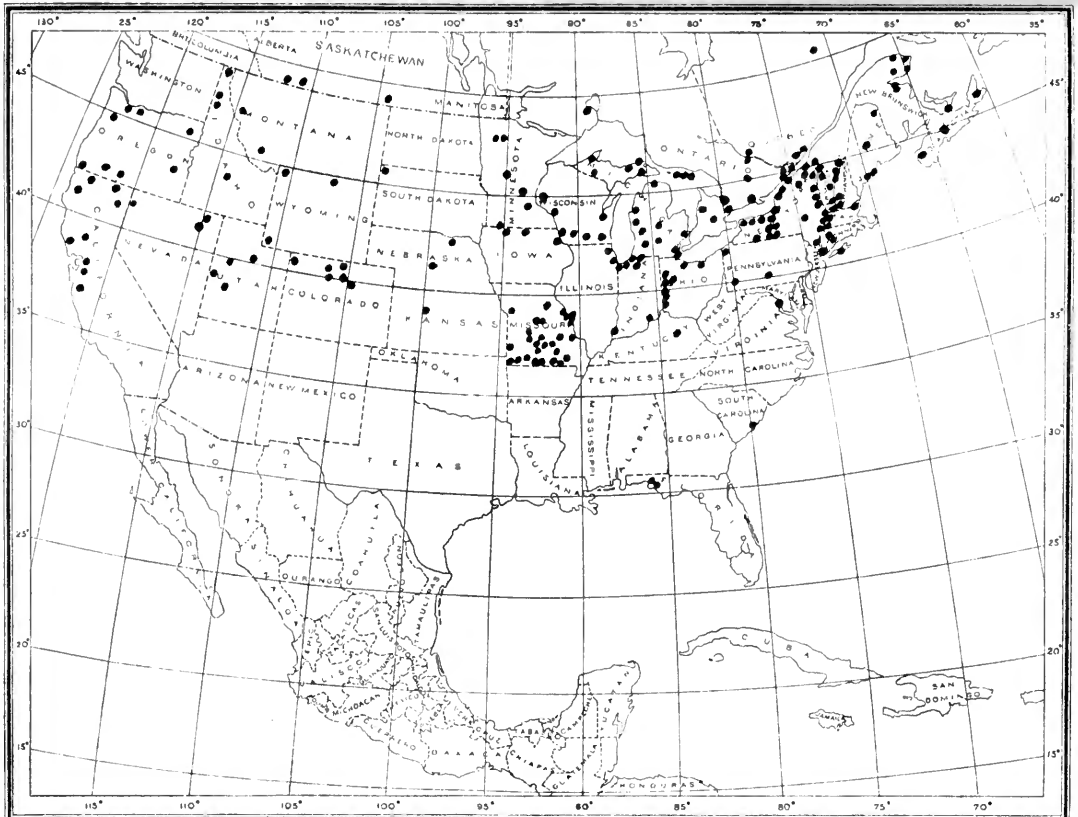


FIG. 52. Distribution of *Potamogeton foliosus* var. *macellus*. The author is indebted to Dr. M. L. Fernald's monograph of the linear-leaved North American species of *Potamogeton* for the data used in the preparation of this map.

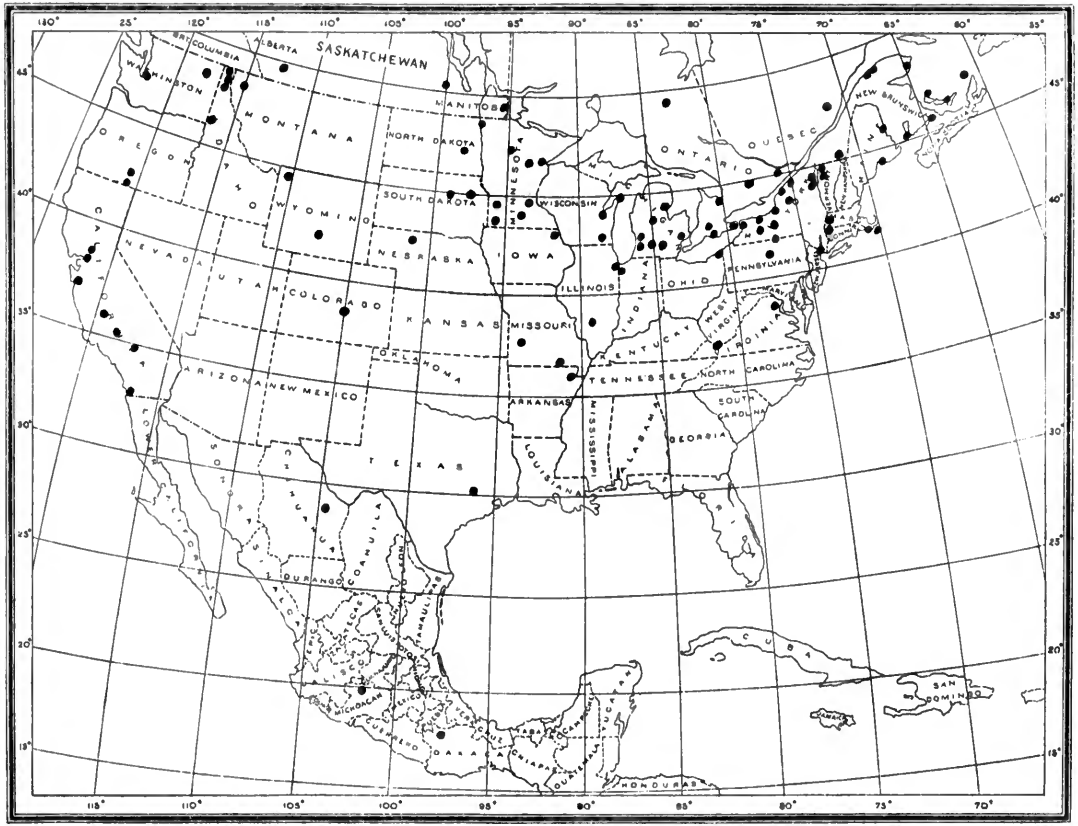


FIG. 53. Distribution of *Potamogeton panormitanus* var. *major*. The author is indebted to Dr. M. L. Fernald's monograph of the linear-leaved North American species of *Potamogeton* for the data used in the preparation of this map.

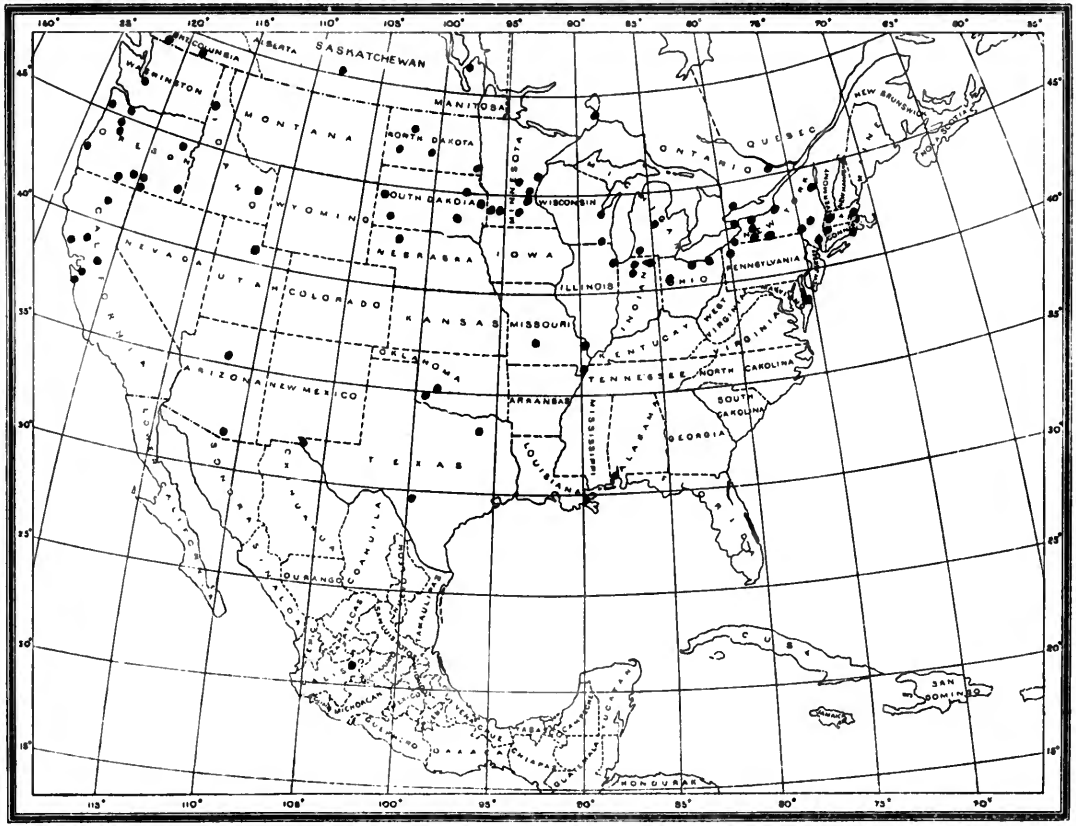


FIG. 54. Distribution of *Potamogeton panormitanus* var. *minor*. The author is indebted to Dr. M. L. Fernald's monograph of the linear-leaved North American species of *Potamogeton* for the data used in the preparation of this map.

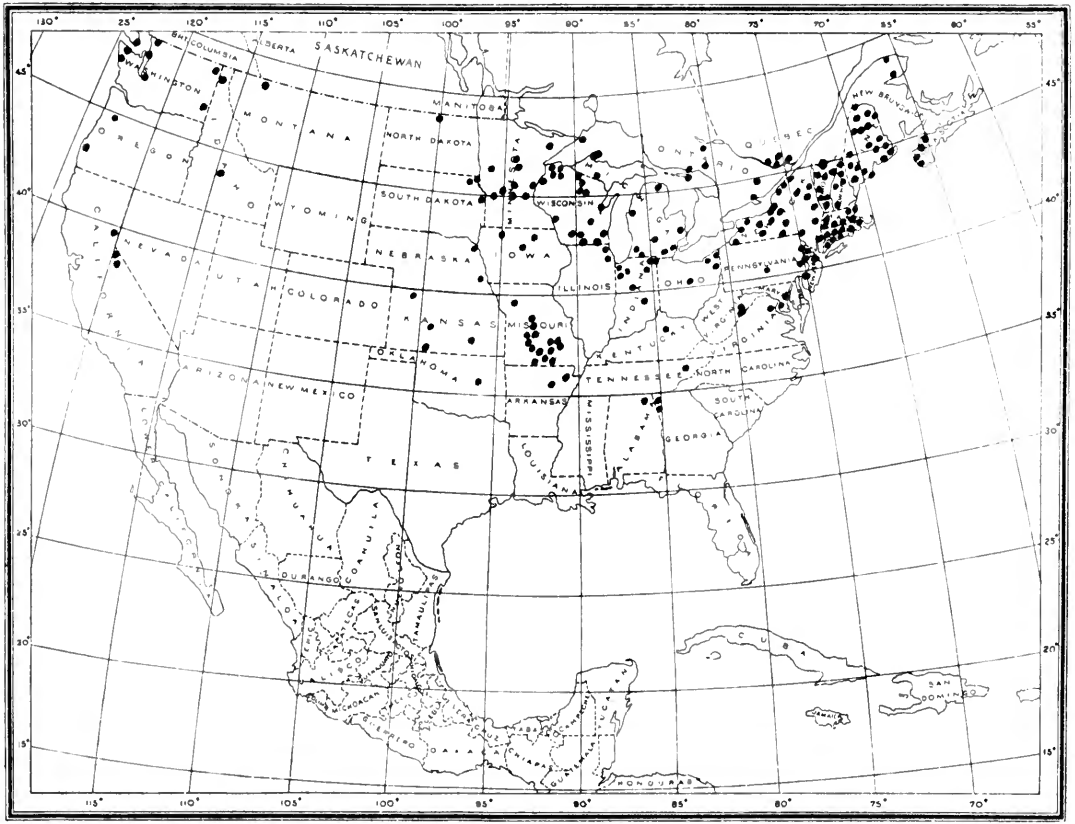


FIG. 55. Distribution of *Potamogeton amplifolius*. The author is deeply indebted to Dr. E. C. Ogden, of the University of Maine, who is monographing this group, for the data used in the preparation of this map.

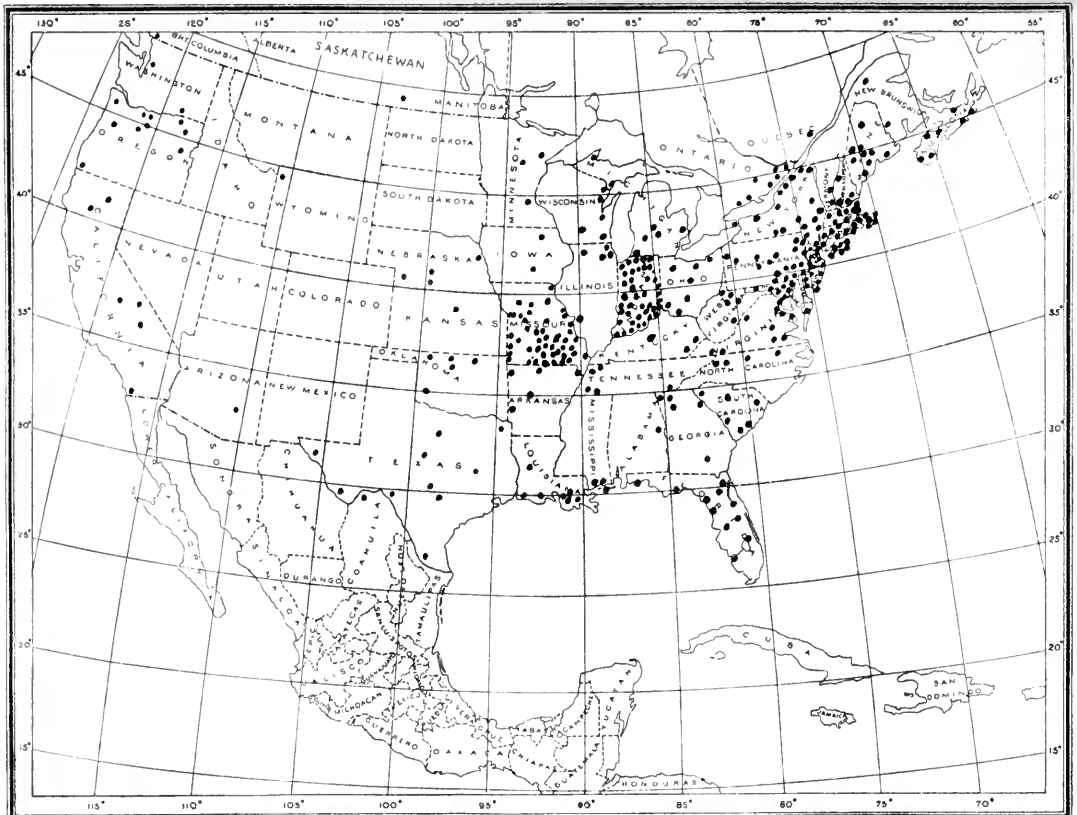


FIG. 56. Distribution of *Ludvigia palustris* var. *americana*.

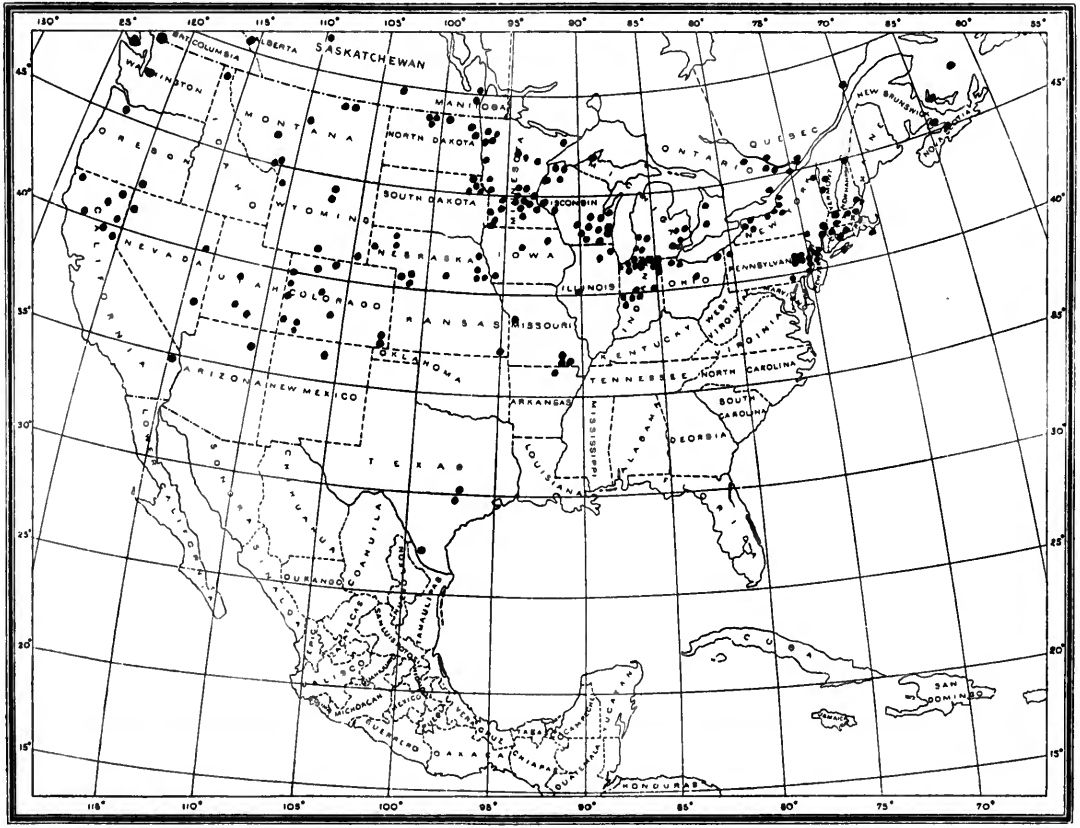


FIG. 57. Distribution of *Lemna trisulca*.

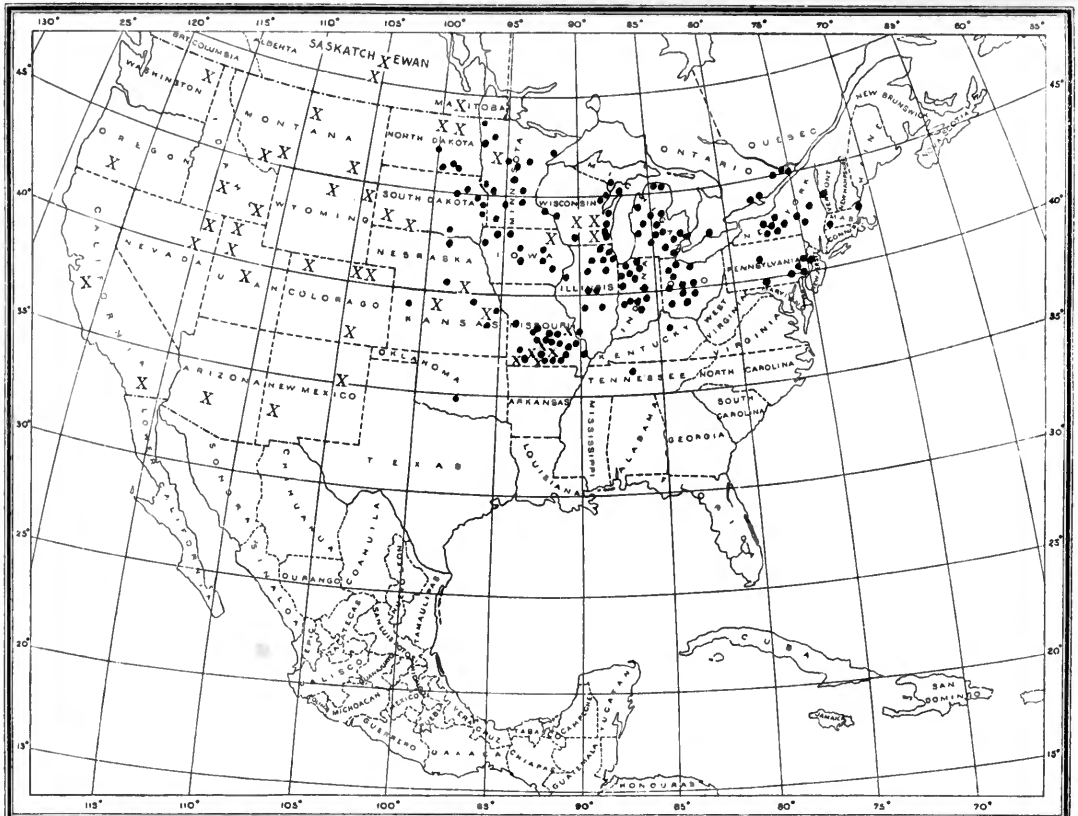


FIG. 58. Distribution of *Veronica connata* (●) and var. *glaberrima* (X).

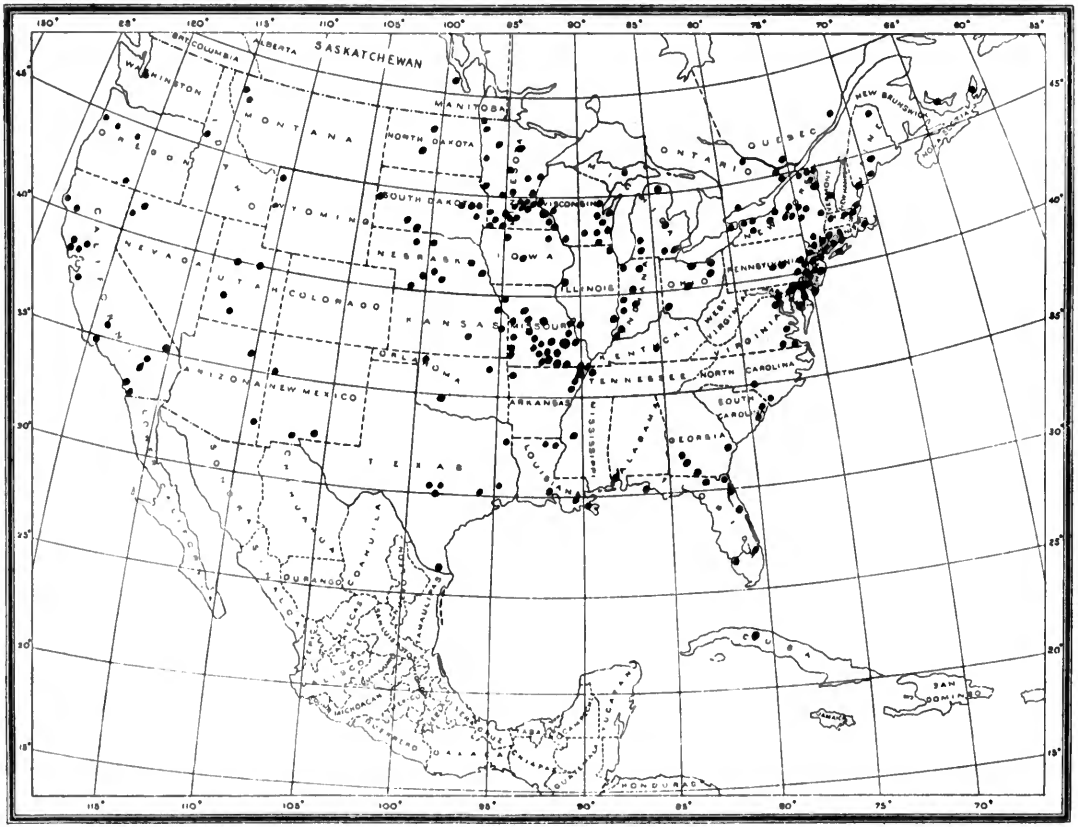


FIG. 59. Distribution of *Ceratophyllum demersum*.

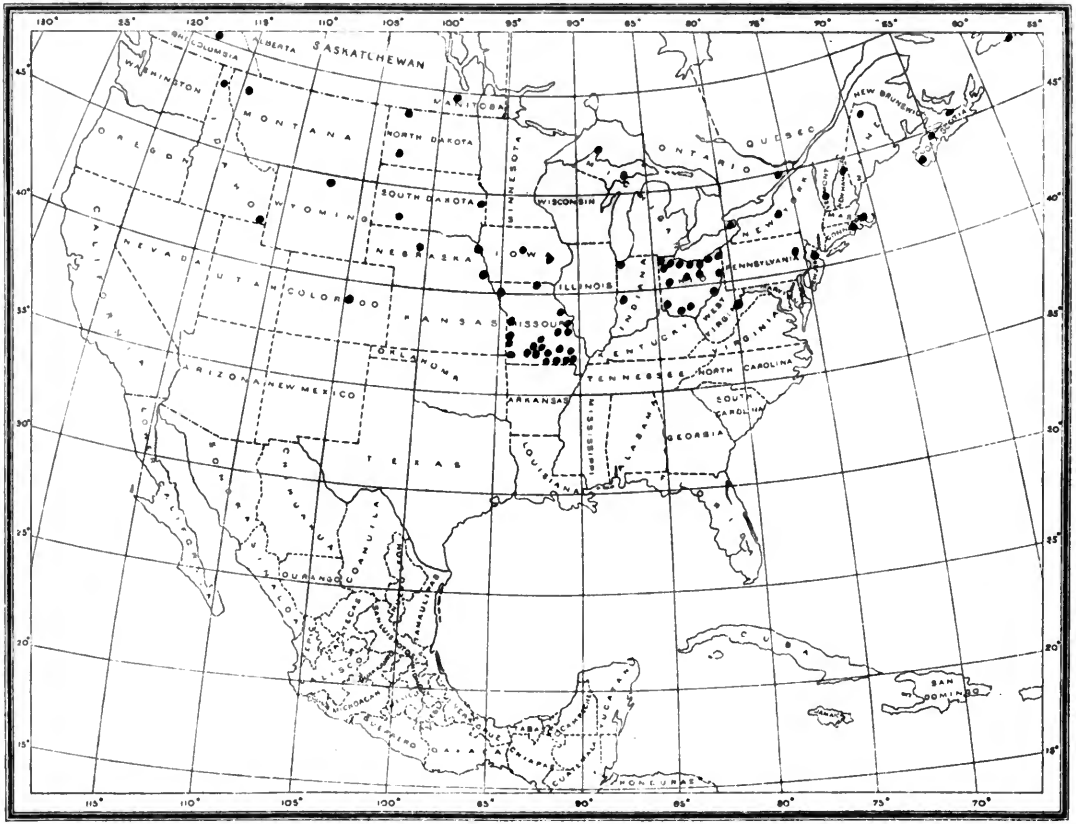


FIG. 60. Distribution of *Eleocharis acicularis* var. *typica*.

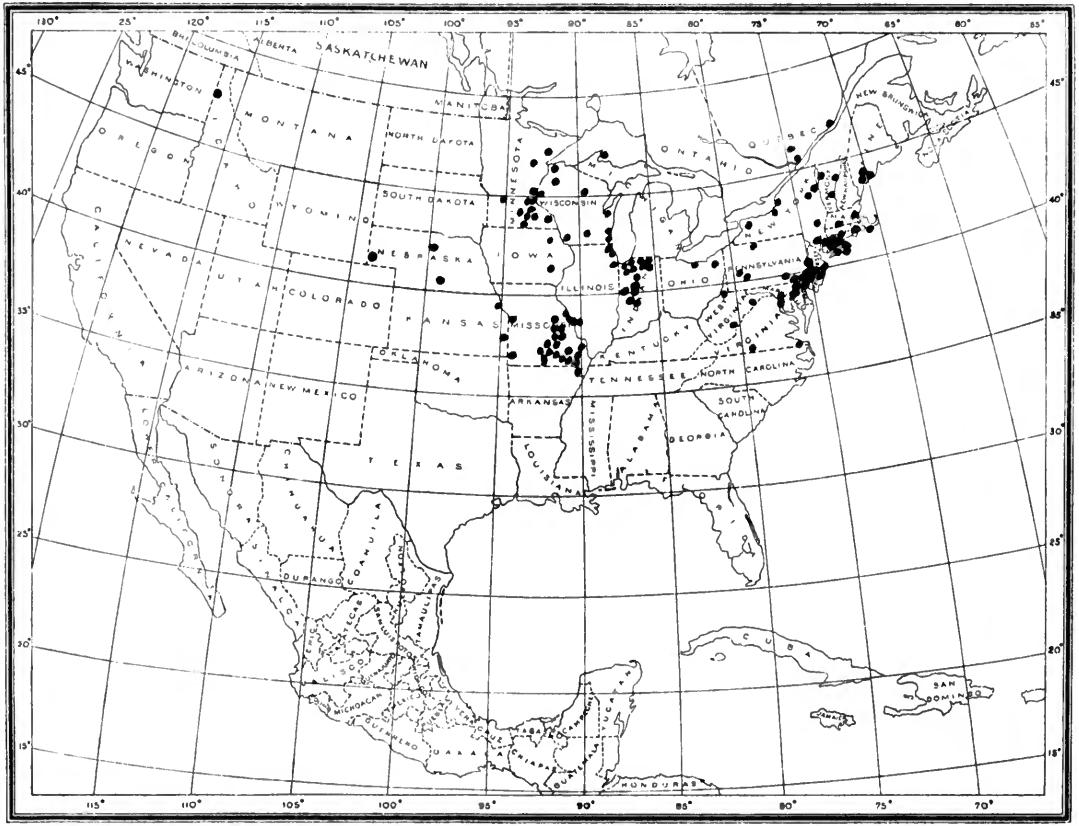


FIG. 61. Distribution of *Anacharis occidentalis*.

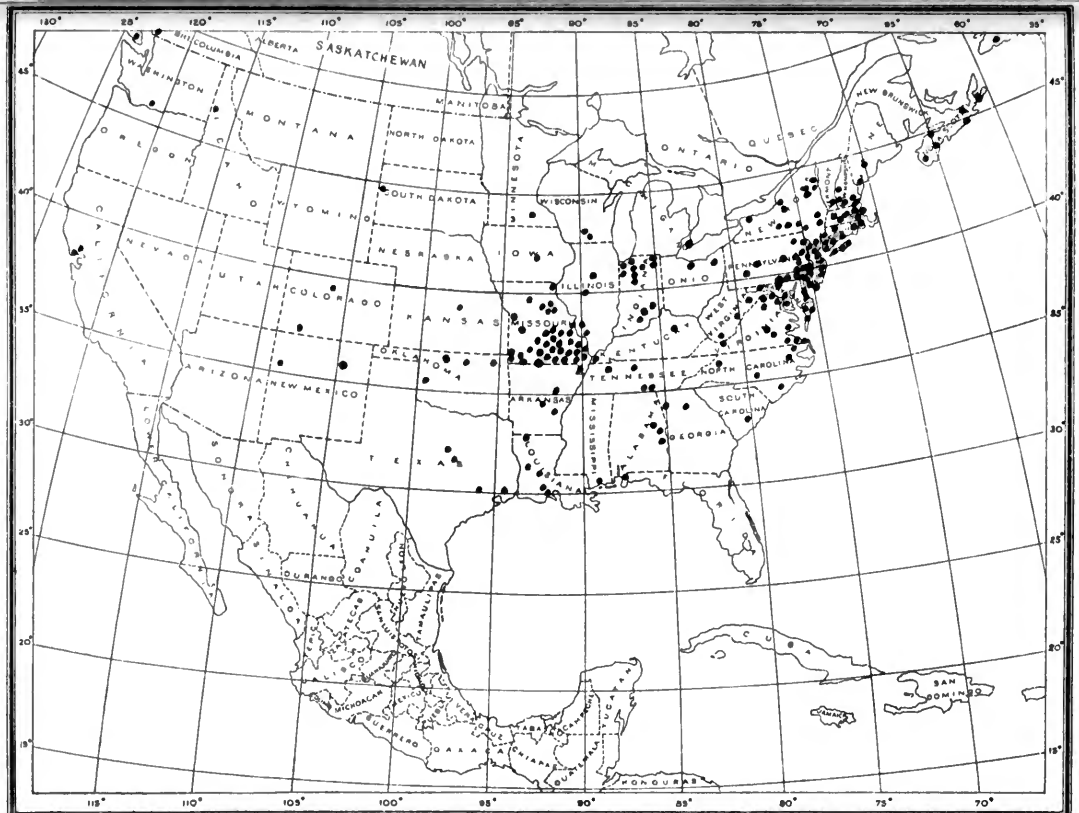


FIG. 62. Distribution of *Callitriche heterophylla*.

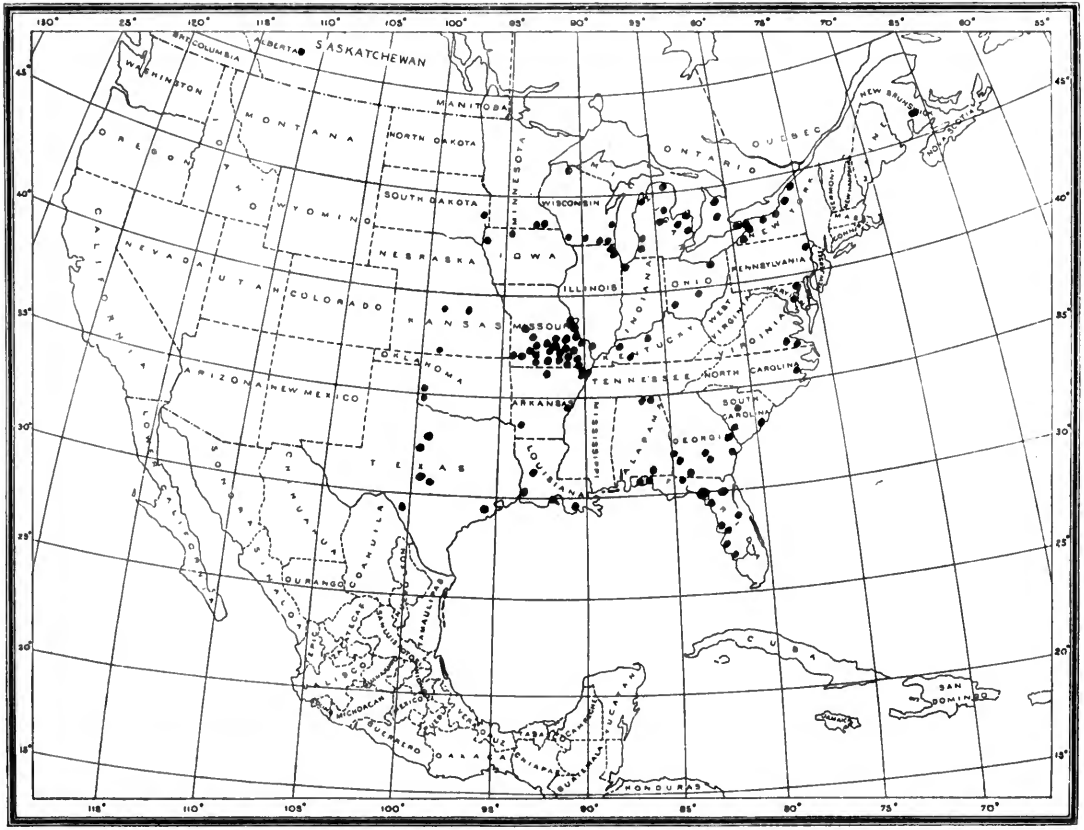


FIG. 63. Distribution of *Myriophyllum heterophyllum*.

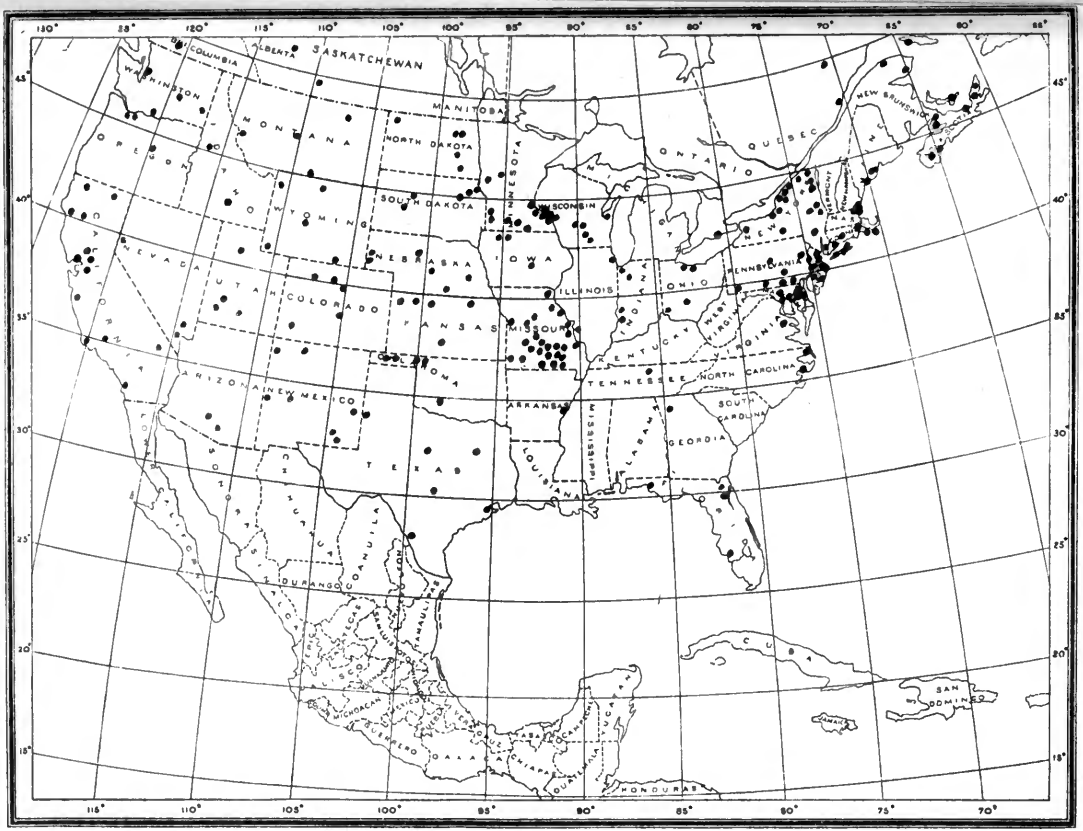


FIG. 64. Distribution of *Zannichellia palustris* var. *major*.

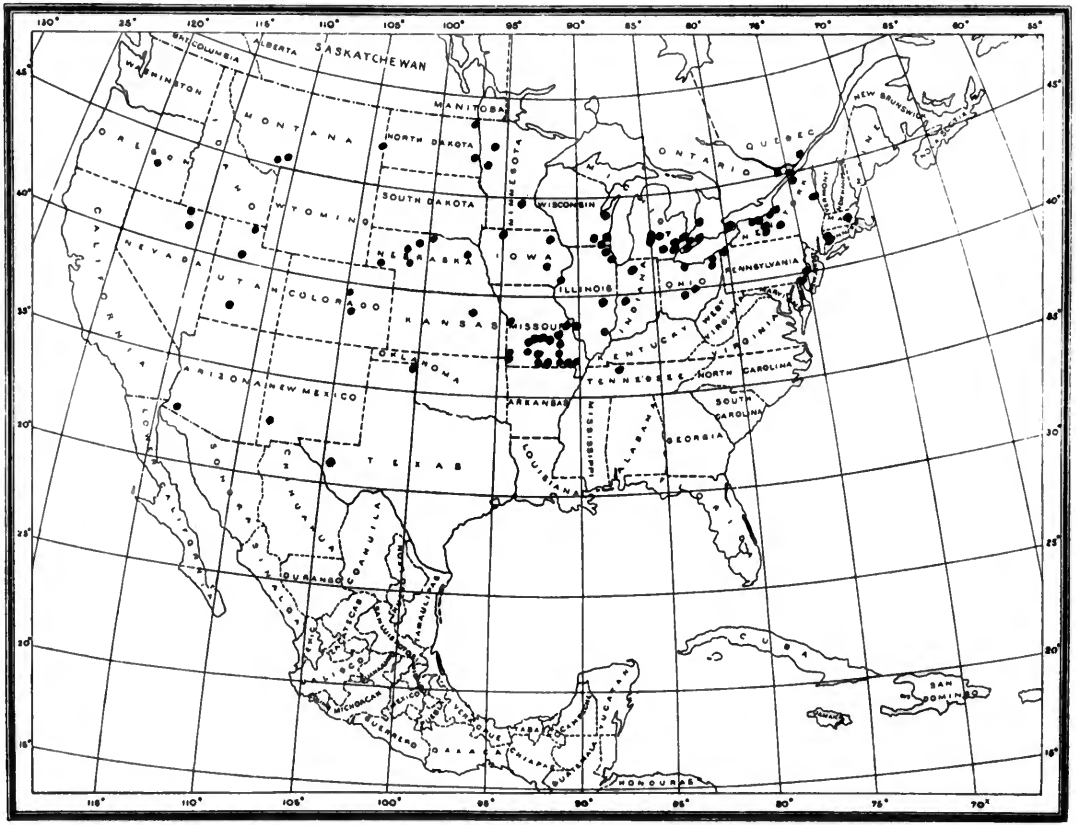


FIG. 65. Distribution of *Ranunculus longirostris*.

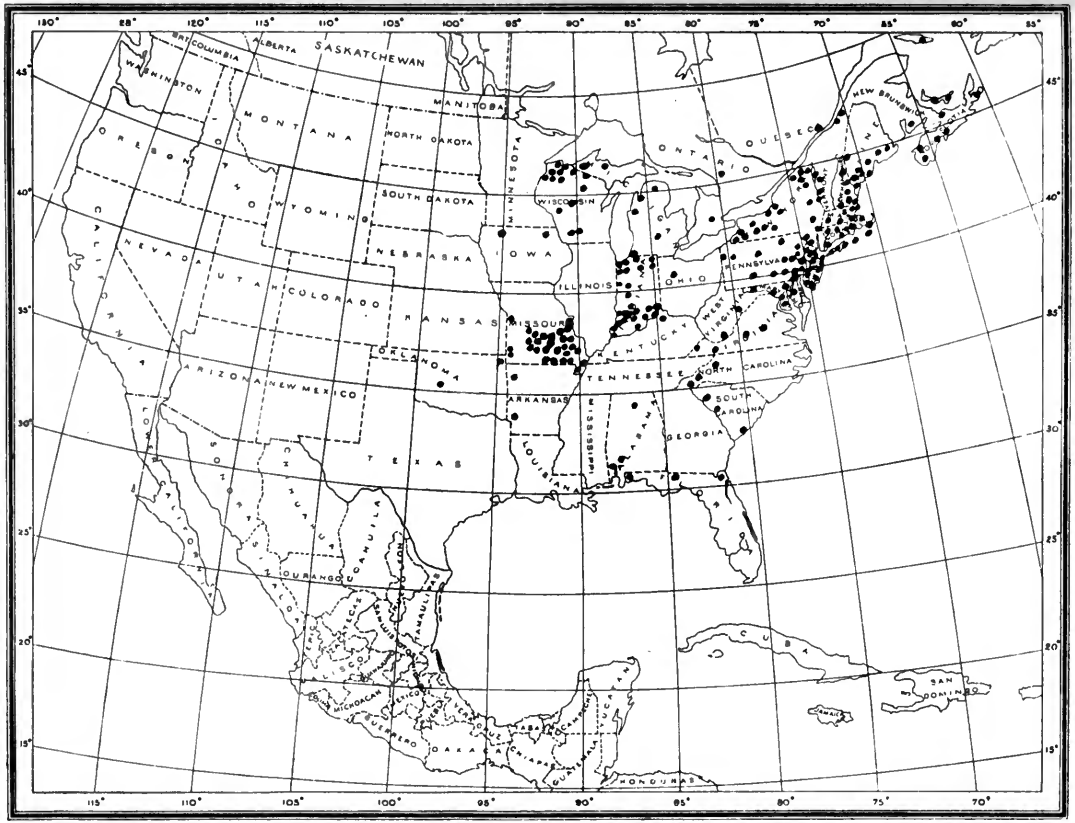


FIG. 66. Distribution of *Sparganium americanum*.

well normally in northern Missouri. Such is not the case, as may be observed from the maps which show distribution. Many of them, in fact, more than half of the species of springs, are confined to the Ozarks. This type of distribution—species which range to the north and east of Missouri but which in Missouri occur chiefly or only in the Ozark region—is not only limited to some of the species occurring within the Ozark springs; it is more or less characteristic of the distributions of many Missouri species of Ozarkian range.

In the case of the species occurring in the springs whose distribution in Missouri is confined to the Ozark region, the limiting factor appears to be the suitable habitat of cooler waters found in the Ozark springs as compared to the temperatures found in rivers, lakes, sloughs, and other types of aquatic environment in other parts of the state. All the species which in Missouri are confined, or practically confined, to the springs in the Ozarks, and yet are found north and northeast of Missouri, appear to find in the springs a suitable habitat. The only property possessed by Ozark Springs which is not duplicated in streams, lakes, sloughs, and other bodies of water in Missouri, is cold water. Other properties, such as rapid current, *pH* concentration, gravel, sand, or mud substratum, and clarity of the water, are all duplicated in other bodies of water in Missouri. Yet, as we have seen, species may be found abundantly in spring water, but are totally lacking in the slightly warmer but otherwise similar waters of the Ozark streams into which the spring water empties. This is well demonstrated in the case of Blue Spring, Shannon County. At this place *Potamogeton americanus* is found in the Current River only five feet away from the confluence of Blue Spring branch with Current River, and yet is not found in Blue Spring proper. *Potamogeton americanus* never occurs in the cool waters of the Ozark springs, but is common in the somewhat warmer waters of the Ozark streams. Conversely, species which are abundant in the cooler waters of the Ozark springs fail to reappear in the slightly warmer waters of the Ozark streams. Sometimes the cooler spring water persists for a few hundred feet down the main stream into which it empties, and as long as the influence of the cooler temperature of its water persists, so does the vegetation characteristic of the spring water. However, just as soon as this influence is lost and the water becomes warmer, the species typical of the springs likewise disappear. Water cress is so characteristic of spring water in the Missouri Ozarks that as soon as one sees this species, one knows that the water in which this plant appears is spring-fed. Such is the case also for water milfoil (*Myriophyllum*

heterophyllum), ivy-leaved duckweed (*Lemna trisulca*), water speedwell (*Veronica connata*), shining pondweed (*Potamogeton lucens*), and the others which have been listed as limited to the Ozarks.

It may be hypothesized that the species of the springs which are confined to the Ozarks illustrate by this limited distribution their relict nature or their persistence in unglaciated regions. In other words, some may argue that northern and central Missouri, having been glaciated, lost these species through destruction and elimination of their habitats, and that these species found an area in which they could survive, south of the Missouri River. Against this hypothesis, however, it should be argued that all these species which do *not* occur in the glaciated area of northern and central Missouri, *do* occur in the glaciated areas of states to the north and northeast of Missouri in habitats many of which have nothing to do with spring water, and just as surely as they can occur in the glaciated regions of these other states in non-spring habitats, so too could they occur in the glaciated sections of northern and central Missouri in non-spring habitats. The main factor for the absence of these species in northern and central glaciated Missouri appears to be lack of a suitable habitat, i.e., lack of cool spring water. The large springs in Missouri are all confined to the Ozark region, and this is related to topography and past geological history of the state. If large, cool springs were found in northern and central Missouri, then no doubt these same species would appear in the glaciated portions of Missouri as well. In the states north and northeast of Missouri these same species occur in the cool waters of lakes, streams, and sloughs, as well as in springs.

In the many cases of other species in the Missouri flora, discussing now those not found in spring water, there are many which, unlike those confined to the springs in the Ozarks, seem restricted to the Ozarks because they have persisted in an unglaciated region; in the Ozark region they have remained in such suitable restricted habitats as were left to them after similar ones had been destroyed in the now glaciated areas of northern and central Missouri. No doubt, suitable types of habitats related to a certain topography, or rock substratum or geological structure, are exceedingly important, and are involved in many cases where the species is now restricted to an unglaciated region because the habitats it seeks have been destroyed or eliminated or have become inaccessible in glaciated areas where presumably they may previously have occurred before glaciation took place.

Even though the Kansan and Iowan glaciations in Missouri were old ones, preceding the recent Illinoian and Wisconsin ice sheets

(which did not come into Missouri), and would have allowed sufficient time for Ozark spring-inhabiting and other types of Ozark species to spread into and invade habitats to the northward in Missouri, the fact remains that throughout all the time since the last glaciation in Missouri, few of these Ozark-confined species have ever spread into this glaciated area. In the case of many of these species the habitat can no longer be duplicated or it may have been destroyed and never regained. In the case of the spring-inhabiting species there seem to be no cool spring waters available in northern and central Missouri, and this appears to be the chief if not the only reason for their absence from that area.

THE INFLUENCE OF SPRINGS ON THE MISSOURI FLORA

As has been brought out in the preceding section of this report, the water of the springs averages much cooler (52°–58° F.) than that of rivers, lakes, or other bodies of water. This cooler water is the habitat of a limited number of species which are not found, or very rarely found, outside of spring water. Mention of species confined to springs or spring water in Missouri includes *Sparganium americanum*, *Potamogeton amplifolius*, *P. lucens*, *P. crispus* (introduced from Europe), *P. panormitanus* var. *major* and var. *minor*, *Anacharis occidentalis*, *Lemna trisulca*, *Rorippa Nasturtium-aquaticum*, *Ranunculus longirostris*, *Myriophyllum heterophyllum*, *Veronica connata*, and *Cardamine bulbosa* f. *fontinalis*. Their affinity for spring water is best shown by the fact that these same species suddenly disappear immediately or shortly after the influence of the cooler spring water has been lost in the river water into which the spring has emptied. These species are, for the most part, an index or guide to the occurrence of spring water or spring-fed water. Even though the waters of most Ozark streams are spring-fed, the amount of spring water in them is not sufficient to keep their temperature down to as low an average as that found in spring water. Consequently, waters of streams average higher temperatures than those of springs and harbor species most of which are never found in spring water. Examples of species found in running water of spring-fed Ozark streams and not found in cooler springs and spring branches include eel grass (*Vallisneria americana*), fennel-leaved pondweed (*Potamogeton pectinatus*), long-leaved pondweed (*Potamogeton americanus*), yellow water crowfoot (*Ranunculus flabellaris*), and large bladderwort (*Utricularia vulgaris* var. *americana*).

A number of species found in the springs are of very limited distribution in Missouri. The isolation and rarity of ivy-leaved duckweed is a good example. It is found in a few widely separated places: in Greer Spring, Oregon County; Blue Spring, Shannon County, in southeastern Missouri; Tucker Bay Spring, Ripley County; and in a spring-fed pond in Jackson County, west-central Missouri. Shining pondweed is confined to approximately fifteen springs located in the eastern and central portions of the Ozarks. Water speedwell is found in a small number of counties in the Missouri Ozarks and reaches in this region one of its southern limits of range in the United States.

The waters from springs naturally test higher in alkalinity, since nearly all the Ozark springs flow underground through water-soluble rocks which dissolve and carry with them calcium carbonate, and the outlets of nearly all the springs are from limestone rock horizons. This alkalinity may play some rôle in the delimitation of certain species to spring waters, but it would not seem to carry much weight, inasmuch as the same species are found in other portions of their range in acid or neutral waters.

A number of spring-inhabiting species also adapt themselves to warmer waters of ponds, sloughs, and slow streams. For example, water purslane inhabits the shores of slow streams, ponds, and other bodies of water. Needle spike rush and water starwort are often found around muddy margins in quiet water of upland sink-hole ponds. Water-weed, hornwort, water milfoil, white water crowfoot, and bur-reed frequently inhabit the quiet waters of spring-fed sloughs of deep standing water. Horned pondweed is often found in warm waters of salt- or sulphur-fed springs.

KEY TO SPECIES FOUND IN OR ALONG THE WATER OF THE SPRINGS AND SPRING BRANCHES

Plants with what appear to be slender, green stems and whorls of small, linear or setaceous, leaf-like parts, but which actually are only elongate cells, belong to the non-vascular, higher algae Characeae, chiefly of the genera *Nitella* and *Chara*, and are not included in this key.

1. Minute, floating plants, of a circular or oblong shape, each plant less than 8 mm. long ..... 2.
1. Plants not as above ..... 4.
2. Plants rootless ..... *Wolffia punctata.*
2. Plants with roots ..... 3.
3. Plants with 1 root ..... *Lemna.*

3. Plants with 2–16 roots ..... *Spirodela.*
4. Plants in chain-like groups, each plant very small and 10 mm. long or less ..... *Lemna trisulca.*
4. Plants not as above ..... 5.
5. Leaves provided with tiny bladders or half-moon-shaped structures; flowers yellow ..... *Utricularia gibba.*
5. Leaves not as above ..... 6.
6. Leaves arising only at the base of the plant (basal) ..... 7.
6. Leaves alternate, opposite, or whorled on the stem ..... 13.
7. Leaves at their base with a broad, triangular or arrow-shaped lobe on each side ..... 8.
7. Leaves not as above ..... 9.
8. Most of the stems and leaves growing out of water; lobes of the leaves acute or acuminate ..... *Sagittaria latifolia.*
8. Most of the stems and leaves growing in the water; lobes of the leaves rounded or obtuse ..... *Nuphar ozarkanum.*
9. Stems and leaves filiform, delicate, less than 0.5 mm. broad. *Eleocharis acicularis* and var. *gracilescens.*
9. Stems and leaves broader, or at least without the above combination of characters ..... 10.
10. Stems and leaves wiry, stiff, narrowly linear or setaceous, or at most 3 mm. broad in middle and upper portions. 11.
10. Stems and leaves much broader and not as above .... 12.
11. Stems creeping, usually leafless; stems mostly supporting a solitary flower spikelet; sheaths at base of stems truncate at the apex, and encircling the stem. *Eleocharis calva.*
11. Stems tufted, with leaves usually present; stems supporting several to many clusters of flowers; sheaths at base of stems not truncate, open along one side. *Juncus.*
12. Leaves light or grass-green; plants 3–10.5 dm. tall; flowers in white or green, rounded masses. *Sparganium americanum.*
12. Leaves bluish or silvery green; plants 9–15 dm. tall; flowers in brown, club-shaped masses. *Typha latifolia.*
13. Leaves alternate ..... 14.
13. Leaves opposite or whorled ..... 27.
14. Leaves deeply lobed, deeply dissected, or divided ..... 15.
14. Leaves simple, not deeply lobed or divided ... 16.
15. Leaves finely dissected into filiform divisions. *Ranunculus longirostris.*
15. Leaves divided into 3–11 round, oblong, or ovate leaflets .. *Rorippa Nasturtium-aquaticum.*
16. Leaves linear and grass-like (includes *Poa annua* var. *reptans*, *Glyceria striata*, and *Agrostis stolonifera*) ..... 17.
16. Leaves not linear or grass-like ..... 21.
17. Leaves blue-green, most of them occurring on the lower half or third of the stem. *Poa annua* var. *reptans.*
17. Leaves yellow- or grass-green, more or less equally distributed along the stem .... 18.

18. Leaves mostly 2–6 mm. broad, without any conspicuous midrib; flowers yellow. *Heteranthera dubia.*

18. Leaves 0.4–2 mm. broad, with a conspicuous midrib or, if the midrib is inconspicuous, then the leaves are 1 mm. wide or less; flowers greenish.....19.

19. Leaves 0.4–1 mm. broad, the midrib mostly not conspicuous; flowers occurring along the sides of the stem. *Zannichellia palustris* var. *major.*

19. Leaves 1–2 mm. broad, the midrib conspicuous; flowers occurring at the ends of the stem.....20.

20. Peduncles 0.4–1 cm. long, usually thickened in the upper part; stems either unbranched or with short branches or not much branched. *Potamogeton foliosus* and varieties.

20. Peduncles usually 1.5–8 cm. long, thread-like, scarcely thickened in the upper part; stems usually long and much branched. *Potamogeton panormitanus* and varieties.

21. No sheathing stipules present at the base of the leaves.....22.

21. Sheathing stipules present at the base of the leaves.....23.

22. Leaves light or grass-green; basal and lowest leaves rounded or obtuse at the apex; main cauline leaves not deeply cordate at the base; small tubers occurring on rootstock; no creeping rootstocks present. *Cardamine bulbosa* f. *fontinalis.*

22. Leaves dark green; basal and lowest leaves acute or acuminate at the apex; cauline leaves deeply cordate at the base; no small tubers present on the rootstock; long, creeping rootstocks present...*Saururus cernuus.*

23. Leaves with only 1 nerve running lengthwise; sheathing stipules with a fringe of bristles or long hairs around the border.....24.

23. Leaves with at least 3 nerves running lengthwise; sheathing stipules not fringed nor with long hairs.....25.

24. Perennial plants, often completely submerged in spring water. *Polygonum hydropiperoides.*

24. Annual plants, rooting on land, never submerged in spring water. *Polygonum punctatum.*

25. Leaves with finely toothed margins; only 3 main longitudinal nerves present; none of the leaves petioled..*Potamogeton crispus.*

25. Leaves with entire margins; 11–50 longitudinal nerves present; at least the lower leaves petioled.....26.

26. Leaves with 11–13 longitudinal nerves, submerged leaves not strongly wavy or recurved.....*Potamogeton lucens.*

26. Leaves, at least the floating ones, with 17–50 longitudinal nerves, submerged leaves strongly wavy or recurved. *Potamogeton amplifolius.*

27. Leaves usually in whorls of 3–6.....28.

27. Leaves in pairs always opposite on the stem.....32.

28. Leaves in whorls of usually 3 narrow, undivided and undissected leaves.....*Anacharis occidentalis.*

28. Leaves in whorls of 4, 5, or 6, filiform or capillary, divided and dissected leaves.....29.

29. Leaves forked and branched; leaf segments with teeth or irregularities on margins..*Ceratophyllum demersum.*

29. Leaves pinnately parted; leaf segments without teeth or other irregularities on the margins.....30.

30. Leaves bluish or grayish green; all the leaves similar in appearance..... *Myriophyllum proserpinacoides.*

30. Leaves dark or grass-green, brown, or brownish green; upper emersed leaves different in appearance from the lower immersed ones.....31.

31. Rare; some of the leaves on the plant not whorled; stems mostly creeping and prostrate, slender, usually less than 1 dm. tall; emersed and floral leaves linear, deeply toothed or cut.
Myriophyllum scabratum.

31. Common; all the leaves whorled; stems usually upright and elongate, stout, usually more than 3 dm. tall; emersed and floral leaves ovate to oblanceolate, entire or slightly toothed.
Myriophyllum heterophyllum.

32. Leaves, when crushed, with a mint odor; leaves serrate..... *Mentha piperita.*

32. Leaves without this combination of characters. 33.

33. Most or all of plant growing on land.....34.

33. Most or all of plant submerged in water..36.

34. At least some of the leaves faintly toothed or with irregular margins; leaves mostly 8–30 mm. broad.
Veronica connata and var. *glaberrima.*

34. All the leaves with entire margins; leaves 1–8 mm. broad.....35.

35. Leaves noticeably tapering at the base, subpetiolate, 3–8 mm. broad, broadest near the middle.
Rotala ramosior var. *interior.*

35. Leaves only slightly tapering at the base or sessile, not subpetiolate, 1–3 mm. broad, mostly of about the same width from base to apex..... *Peplis diandra.*

36. At least some of the leaves faintly toothed or with irregular margins; leaves mostly 8–30 mm. broad.
Veronica connata and var. *glaberrima.*

36. Without the above combination of characters.....37.

37. Submerged leaves mostly spreading upward or ascending; leaves with very minute teeth on each margin (use magnifying lens).
Najas guadalupensis.

37. Submerged leaves mostly wide-spreading; leaves with entire margins (use magnifying lens).....38.

38. Leaves light or pale green; leaves with usually 2 different shapes present on the same plant, the linear leaves 1–1.5 mm. broad.
Callitriche heterophylla.

38. Leaves dark or dull green, all similar in shape on same plant, 1.5–2.5 mm. broad.... *Peplis diandra.*

DESCRIPTION OF SPRINGS, AND THE OCCURRENCE AND ENUMERATION OF THEIR FLORA

In the following pages are described the occurrences and habitats of the flora of each major spring in Missouri:

ALTHEA SPRING (Plate I)

Located in sec. 25, T. 23 N., R. 12 W., at Althea, Ozark County. The water rises in a circular basin about three and one-half feet deep and 20 to 25 feet in diameter, and comes out of limestone boulders bordered above by ledges of Roubidoux sandstone. In the water occur mostly rocks that are covered with mosses and a liverwort (*Porella pinnata*). A slight amount of milfoil and water starwort grows with the mosses.

The water plunges rapidly from the circular basin into a spring branch about two feet in depth. This branch curves about, and along the sides contains many algae associated with water cress. Going downstream the branch is about 30 feet wide and the main current flows over quantities of milfoil, which is the dominant plant in the branch. Along the sides of the branch are strands of water starwort, bur-reed, and horned pondweed.

Just before coming to its first rock dam, the branch for 25 to 30 feet is loaded with sandy mud and has a swift current. Here occur flowing mats of milfoil, light green plants of horned pondweed, bur-reed, needle spike rush, light green in color, and large, robust strands of water-weed. The milfoil is the commonest species here.

Between here and the second dam of the branch, the water flows rapidly, the dominant plant being horned pondweed. Scattered with it are milfoil and water starwort. Then water starwort and horned pondweed predominate in the swift flow of the water to the third dam.

From the third dam to the North Fork of White River the water tumbles over rocks covered with moss and algae, with water cress scattered here and there. Just below the third dam and growing along the side and away from the current is an occasional plant of hornwort. The substratum of this portion of the branch is loose and has clear-colored sand and gravel.

Near its confluence with the North Fork of White River the spring branch contains water milfoil, water cress, and horned pondweed as its chief components. Occasional clumps of dark, bright, grass-green pondweed (*Potamogeton foliosus* var. *macellus*) also occur.

The total distance of flow of the branch from its outlet to the North Fork of White River is 600 feet.

LIST OF SPECIES

Liverwort (*Porella pinnata*)
Water milfoil (*Myriophyllum heterophyllum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water starwort (*Callitriche heterophylla*)
Bur-reed (*Sparganium americanum*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Needle spike rush (*Eleocharis acicularis* var. *typica*)
Water-weed (*Anacharis occidentalis*)
Hornwort (*Ceratophyllum demersum*)
Pondweed (*Potamogeton foliosus* var. *macellus*)

ALLEY SPRING

Located in sec. 25, T. 29 N., R. 5 W., at Alley Spring State Park, five miles west of Eminence, Shannon County. The water "issues from the base of a rocky cliff, flows over a dam which develops power for a grist mill, and empties into Jacks Fork at a distance of a half-mile." The water is of a slightly lighter blue color than that of Round Spring. The basin or lake portion of the spring is 150 to 200 feet wide. The water here is deep and the banks are steeply sloping. Along the margin of the basin occur water milfoil and water cress. Water starwort occurs in places within the basin.

From the basin the water of the spring pours down over rocks at two places, and these branches join about 50 feet farther down. The water here is rapid and shallow, flowing over a gravel bottom. Along the left branch as one goes downstream, where the water rushes out, occur light grass-green mats of spring cress submerged in the water or sending up flower stalks above the surface, and surrounded by rocks covered with mosses and green algae. The right branch has quantities of mosses and algae. Farther down its course there is much water cress.

The main spring branch continues downstream and makes a slight turn. At this point a little overflow from the branch is filled with still water and on its shallow side has bur-reed and water cress.

Thus far in the main branch there have appeared only water cress, peppermint, and an occasional clump of water speedwell. Farther down, however, on the gravel substratum occur a little water starwort and spring cress, but water cress continues to be the chief species. As a whole, the vegetation is really scattered, with green and blue-green algae and mosses occurring plentifully.

Farther down, a portion of the branch winds about and, before meeting the main branch again, forms a small backwater or slough

with mud bottom and quiet water away from the main current. Here occur bronze-colored pondweed (*Potamogeton foliosus* var. *genuinus*), bur-reed, and water speedwell. The last, a dull olive-green in color, occurs in close mats with small leaves, along the side of the water. From here on down and in the lower half of the branch, these latter two species become commoner.

In the lower half of the spring branch the water speedwell is common. With it is a clump of water-weed (*Anacharis occidentalis*), a slight amount of milfoil, water starwort, and a large quantity of water cress. About halfway down this branch submerged plants of annual bluegrass occur.

The branch has now become large and is about 35 feet broad. It makes several bends before emptying into Jacks Fork of Current River. Just below the limits of Alley Spring State Park at a floodgate on the right bank of the branch in a muddy place, occur some dark, grass-green plants of a species of *Chara*. At another place above this gate, away from the main current, is found some dark, grass-green pondweed (*Potamogeton foliosus* var. *genuinus*). In its last one-fourth of flow before reaching the river, a large gravel bar is seen along one side of the branch and a limestone bluff covered with red cedar (*Juniperus virginiana*) on the other. In this last portion and at the confluence with the river, water speedwell is the chief aquatic plant, and both the species and variety (*Veronica connata* and var. *glaberrima*) occur here. The plants of *Veronica connata* found in the upper half of the branch near the main outlet, where the water is deeper, are larger-leaved than those in the lower half of the branch.

LIST OF SPECIES

Water milfoil (*Myriophyllum heterophyllum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water starwort (*Callitriche heterophylla*)
Spring cress (*Cardamine bulbosa* f. *fontinalis*)
Bur-reed (*Sparganium americanum*)
Peppermint (*Mentha peperita*)
Water speedwell (*Veronica connata*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Water-weed (*Anacharis occidentalis*)
Annual bluegrass (*Poa annua* var. *reptans*)
Water speedwell (*Veronica connata* and var. *glaberrima*)

AMSDEN MILL SPRING

Also called Purtle's Spring, Amazon Spring, and Amsolen Spring; located in sec. 19, T. 31 N., R. 1 E., six miles south of Centerville, Reynolds County. The water used to bubble up from a gravel bed, but has been dammed to form a lake. The water flows from the lake as falls over a pipe and empties into the creek. The water in

the lake basin is mostly overgrown with water-weed, which, according to the owner of the property in 1936, was introduced and planted in the spring in 1934. At one end of the basin are quantities of cat-tail, along one side is creeping spike rush, and along the margins of the lake is knotty-leaved rush. Other water plants occurring in the lake basin are dull green plants of pondweed, scattered plants of water purslane, bur-reed, and grass-leaved sagittaria.

LIST OF SPECIES

Bur-reed (*Sparganium americanum*)
Water-weed (*Anacharis occidentalis*)
Cat-tail (*Typha latifolia*)
Creeping spike rush (*Eleocharis calva*)
Knotty-leaved rush (*Juncus acuminatus*)
Pondweed (*Potamogeton foliosus* var. *macellus*)
Water purslane (*Ludvigia palustris* var. *americana*)
Grass-leaved sagittaria (*Sagittaria graminea*)

ASPLEY SPRING

Located in sec. 28, T. 27 N., R. 5 E., two miles south of Williamsville, Wayne County. The spring rises in a small basin at the base of a rocky, wooded bluff, and the branch is dammed to form a lake. It is filled with many plants, including a species of *Chara*, bur-reed, water purslane with copper-colored leaves, pondweed, and water-weed.

The branch then flows from the lake and empties into Black River, a short distance away.

LIST OF SPECIES

Bur-reed (*Sparganium americanum*)
Water purslane (*Ludvigia palustris* var. *americana*)
Pondweed (*Potamogeton foliosus* var. *macellus*)
Water-weed (*Anacharis occidentalis*)
Chara sp.

BARTLETT MILL SPRING

Located in sec. 16, T. 36 N., R. 12 W., at Pippin Lodge, five miles northwest of Waynesville, Pulaski County. It rises in a long, elliptical-oblong basin at the base of a small, wooded, non-rocky hill. From the very beginning to a point where the water flows over a dam, it is very deep. "The water flows 600 feet to a dam 10 feet high where power is developed to operate a mill and to furnish electric lights for the lodge, and empties into Gasconade River." In the deep basin the aquatic plants are milfoil, water-weed, water starwort, water cress, and, along the margin, a liverwort (*Porella*). Of these the milfoil is by far the commonest, and with its long, sterile, brown strands, forms most of the vegetation. The water cress grows in submerged, green masses.

Only a short spring branch flows from the overflow of the dam to the Gasconade River. Over some artificial rocks composed of

cement and at the base of the overflow in the current of the water grows milfoil, and along the margin some plants of water star-grass, while rooting in the sand are plants of water starwort and horned pondweed.

On the muddy substratum along the margin of the Gasconade River at its junction with the spring branch are plants of hornwort.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Water-weed (*Anacharis occidentalis*)
Water starwort (*Callitriche heterophylla*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water star-grass (*Heteranthera dubia*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Hornwort (*Ceratophyllum demersum*)
Liverwort (*Porella*)

BEAVER SPRING

Located in sec. 34, T. 37 N., R. 5 W., six miles west of Steelville, Crawford County. It rises in a small opening at the head of a broad ravine at the base of a small limestone bluff 20–30 feet high, and then flows through a rock-lined chute about 25 feet long. This is filled with many plants of shining pondweed and with bronze or dull green pondweed.

The water continues from the chute into two lake basins. The first lake is filled with shining pondweed, while associated with this are plants of horned pondweed. In the second lake basin shining pondweed also is abundant and the dominant species.

The spring branch then flows from the second lake into the valley through which it winds. The branch, shallow and with a gravel bottom, is soon joined by another spring branch which issues from a field. This latter spring branch contains water cress, bur-reed, and water purslane.

Both branches merge and continue down the valley. From this point on, the water is devoid of any vegetation except water cress, and moss on the rocks.

LIST OF SPECIES

Shining pondweed (*Potamogeton lucens*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Bur-reed (*Sparganium americanum*)
Water purslane (*Ludvigia palustris* var. *americana*)

BENNETT SPRING (Plate I)

Also called Niangua Spring and Brice Spring. It is located in sec. 1, T. 34 N., R. 18 W., at Brice, in Bennett Spring State Park, Laclede County. The water issues from a circular basin 50 feet in

diameter in a gravel bed and flows one and one-half miles into Niangua River.

Around the edges of the circular spring basin are algae, mosses, and water cress, while at the beginning of the spring branch are occasional plants of bur-reed. Following down the branch, purplish submerged plants of mild water pepper, milfoil, and bur-reed are found. Large mats of water cress occur all the way down the spring branch.

Proceeding downstream, a series of sloughs or quiet extensions of the spring branch occur. In the first slough are milfoil, white water crowfoot, green mild water pepper, and bur-reed.

Downstream from the first slough are noticed large mats of water-weed along the side of the branch above a bridge. At one place is a small patch of red and green plants of water purslane, and this is the only place along the branch where the species was observed. A dam in the spring branch is used to develop power for a grist mill at Brice, and a series of trout hatcheries is located around the mill. Just above the falls, by the dam, in deep and more quiet water, are large beds of milfoil. Thus far along the spring branch milfoil and water-weed have been the most common plants, and water starwort and water cress also have been common. Dark bronze-green plants of pondweed (*Potamogeton foliosus* var. *macellus*) occur here, and this is as far down the branch as this species grows. Between here and the main spring are many more plants of it. Between the bridge by the hatchery and the mill are beds of milfoil, with occasional plants of bur-reed, water cress, and aquatic mosses.

By the mill race in the adjacent slow water is a large bed of white water crowfoot, associated with smaller amounts of water speedwell and water starwort. Below the mill race the water becomes deeper and more quiet, and the result is a greater variety of aquatic plants. Here are large mats of milfoil, some water speedwell, water cress, water-weed, reddish-tinged, submerged plants of mild water pepper, and small amounts of water starwort. This combination of aquatic plants continues for a greater part of the distance down the stream. The branch has dense clumps of water cress and needle spike rush along its banks.

Proceeding downstream, milfoil and mild water pepper are the commonest plants, with milfoil the more abundant. Farther down the branch the milfoil for the first time does not occur in mats. Dark grass-green plants of horned pondweed grow with water speedwell, algae, and mosses.

The spring branch then flows rapidly into the Niangua River. At and near the confluence water plants are sparse, only mosses and milfoil being found here. Water cress is the commonest plant between the circular spring basin and the dam, while milfoil is the commonest between the dam and Niangua River.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Bur-reed (*Sparganium americanum*)
Mild water pepper (*Polygonum hydropiperoides*)
Milfoil (*Myriophyllum heterophyllum*)
White water crowfoot (*Ranunculus longirostris*)
Water-weed (*Anacharis occidentalis*)
Water purslane (*Ludvigia palustris* var. *americana*)
Water starwort (*Callitriche heterophylla*)
Pondweed (*Potamogeton foliosus* var. *macellus*)
Water speedwell (*Veronica connata*)
Needle spike rush (*Eleocharis acicularis* var. *typica*)
Horned pondweed (*Zannichellia palustris* var. *major*)

BIG SPRING (Plates II and III)

Located in sec. 6, T. 26 N., R. 1 E., four miles southeast of Van Buren, in Big Spring State Park, Carter County. The water gushes from the base of a rocky cliff and flows 800 feet before emptying into Current River. Where the main jet of water rushes out, only algae and mosses cover the rocks. No species of higher plants is found until the water has become more quiet.

The aquatic vegetation is prolific, and very rich and diversified throughout the spring branch. Proceeding down the branch along the left margin in gravelly mud are submerged, red and olive-green mats of mild water pepper associated with aquatic mosses. On the same left side, near the *Polygonum*, are long strands of milfoil and olive-grass-green strands up to four feet long of shining pondweed. Near the shore are olive-green strands of water star-grass, and water starwort, the latter in the shallowest, broadest portions of the cove. In the muddy portions near shore grows horn-wort. The most common plant in this part of the branch is milfoil.

Proceeding downstream from this point, long strands of milfoil grow along both sides of the spring branch, but in the middle of the branch and between the strands of milfoil the water is clear and light blue and no plants are present. With the milfoil are dark grass-green strands three to four feet long of pondweed (*Potamogeton foliosus* var. *genuinus*) and dark copperish red and green clumps of water purslane. On the muddy substratum are shining pondweed and water star-grass. The last, with its broader and more curved leaves of a duller brown color, contrasts strongly with the greener leaves of the pondweed (*Potamogeton foliosus* var. *genuinus*).

Following down the branch, submerged clumps of flowering annual bluegrass occur with an occasional clump of water speedwell. About 200 yards downstream, on the muddy substratum, occurs horned pondweed, covered with a brown-colored alga. At this place water cress makes its appearance, and here also are some purplish red, submerged plants of mild water pepper.

Downstream there is a slough of quiet water filled with water-weed, milfoil, shining pondweed, water starwort, mild water pepper, and water cress. Covering the entire muddy bottom of this slough is water star-grass. On the left side of the slough, and between it and the confluence of the spring branch is a sandbar, on the freshly deposited part of which are young plants of horned pondweed and pondweed (*Potamogeton foliosus* var. *genuinus*). Milfoil is common here as in all other places along the branch.

Along the right side of the branch, near its confluence with Current River, are mats of milfoil and water-weed, together with water cress and pondweed (*Potamogeton foliosus* var. *genuinus*).

In the final portion of the spring branch, along the right side, the water is deeper and away from the current is seen a diversity of aquatic plants, for here the flora is more luxuriant in number of species than on the left side. Here are water star-grass, water cress, shining pondweed, water starwort, and mild water pepper.

The shining pondweed in the quiet water has erect, curved, and ascending leaves, but in running water the leaves have a darker, more grass-green color and the margins are less curled or ruffled.

Following the entire course of the spring branch, switch cane (*Arundinaria gigantea*) and mistletoe (*Phoradendron flavescens*) are very common, the latter occurring on sycamore (*Platanus occidentalis*) and American elm (*Ulmus americana*).

LIST OF SPECIES

Mild water pepper (*Polygonum hydropiperoides*)
Milfoil (*Myriophyllum heterophyllum*)
Shining pondweed (*Potamogeton lucens*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Water star-grass (*Heteranthera dubia*)
Water starwort (*Callitriche heterophylla*)
Hornwort (*Ceratophyllum demersum*)
Water purslane (*Ludvigia palustris* var. *americana*)
Annual bluegrass (*Poa annua* var. *reptans*)
Water speedwell (*Veronica connata*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water-weed (*Anacharis occidentalis*)

BIG SPRING

Located in sec. 19, T. 25 N., R. 31 W., at Neosho, Newton County. It issues from two places at the base of a limestone bluff in front of

the Big Spring Inn. At the base of the bluff it is walled in a narrow basin; then it flows over a gravel substratum. The water here is about one and one-half feet deep. With a gush, the water rushes under a bridge, then flows rapidly down over moss-covered boulders and rocks to the Big Spring Inn. The only higher plant at present known in the spring is water cress, and this occurs only in the shallower part of the branch. Formerly, around 1900, waterweed grew in the spring, but it has been exterminated. The collection of this *Anacharis* made by Mr. Henry Eggert resembled *A. canadensis*, because of exceptionally broad, ovate-lanceolate leaves, but the specimens evidently represent only an unusually vigorous vegetative state of *A. occidentalis*. Some plants of forget-me-not have been planted around the spring branch and grow partly in and along the water.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Water-weed (*Anacharis occidentalis*)
Forget-me-not (*Myosotis scorpioides*)

BIG SPRING (Plate III)

Located in sec. 2, T. 28 N., R. 27 W., four miles west of Mount Vernon, Lawrence County. It issues from the base of an exposed, arching, limestone bluff 120 feet high, known as Baptist Hill. The spring branch is rather wide and shallow where it issues from several places at the base of the bluff. Here it flows over rocks covered with moss and algae. The branch at first is about 30 feet wide. Farther downstream it is deeper and contains quantities of milfoil and water cress. The spring branch has a total flow of about 200 feet before discharging into Spring River. The milfoil continues in Spring River for some distance down the stream.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Water cress (*Rorippa Nasturtium-aquaticum*)

BLISS SPRING

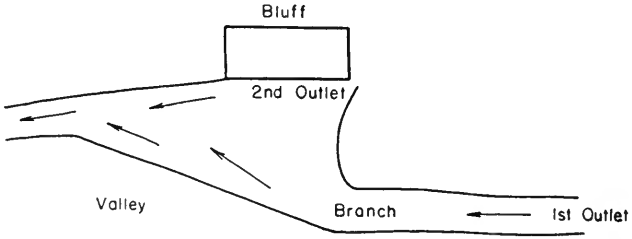
Located in sec. 7, T. 25 N., R. 2 W., in a small valley near Eleven Points River, two and one-half miles southwest of Wilderness, Oregon County. The spring arises in a small opening at the base of a slope in the valley and flows as a branch one-fourth of a mile before emptying into Eleven Points River. The only higher aquatic plants in the spring and branch are water starwort and water cress. Knotty-leaved rush occurs along the branch. The water is shallow and flows over a gravel substratum.

LIST OF SPECIES

Water starwort (*Callitriche heterophylla*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Knotty-leaved rush (*Juncus acuminatus*)

BLUE SPRING (Plate V)

Located in sec. 16, T. 22 N., R. 2 W., at "The Narrows," near the confluence of Fredericks Fork with Eleven Points River, about one mile northwest of Calm, Oregon County. The spring issues from two outlets. One outlet emerges at the base of a small bluff, and runs as a small spring branch over a sandy bottom bordered along the margins by mud. Here are water starwort, horned pondweed, a fresh-water red alga (*Batrachyspermum*), and milfoil. The last species is the commonest. This branch from the one outlet runs into the large spring or second outlet which issues from the base of a limestone cliff, "The Narrows," about 150 feet high, which separates Fredericks Fork from Eleven Points River. This larger spring from the second outlet is deep, has a blue color, and broadens into a triangular area.



The two branches converge and flow as one over a deep, sandy, mud bottom with muddy banks. Here are found milfoil and light green plants of horned pondweed. On these muddy bottoms the branch is practically devoid of vegetation. Along the muddy margins here are bronze and purplish plants of hornwort, which has a darker cast than has milfoil, when the two occur together.

Farther downstream, the following plants grow along the muddy margins: hornwort, horned pondweed, and pondweed (*Potamogeton foliosus* var. *genuinus*). In the part of the water colored a steel gray-blue, the milfoil is commonest.

Along the bend of the branch on the other side and at the base of a bluff are large beds of milfoil mixed with copper-colored plants of mild water pepper. Water cress also occurs here.

Near the confluence of the spring branch with Eleven Points River, milfoil and mild water pepper are dominant plants. All the

way down its course, the color of the water in the spring branch has been a clear steel gray-blue, varying from blue to gray-blue and back again to a blue. The total flow of the branch is 200 feet.

LIST OF SPECIES

Water starwort (*Callitriche heterophylla*)
Milfoil (*Myriophyllum heterophyllum*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Mild water pepper (*Polygonum hydropiperoides*)
Hornwort (*Ceratophyllum demersum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Fresh-water red alga (*Batrachyspermum*)

BLUE SPRING (Plate IV)

Located in sec. 30, T. 36 N., R. 17 W., six miles west of Eldridge, Laclede County. It issues from the base of a limestone bluff about 30 feet high and wooded above. It begins in a circular basin of deep and dark blue water. Milfoil borders the basin, growing on mud.

The branch then flows 200 feet and empties into Niangua River. The water is rather deep (2–3 feet) and about 30–50 feet wide. In it are many plants of hornwort and submerged mild water pepper. The latter species is exceedingly colorful because its broad leaves are bronze-purple on the lower surface and olive-green on the upper; it is the commonest species along the margin of the branch. In the center of the stream, where the current is swift and the substratum is more sandy, are bluish green plants of horned pondweed, this species being the common and dominant one in this part of the spring branch. Some water cress grows scattered among plants of mild water pepper, while light green strands of water starwort appear among clumps of hornwort.

The most interesting feature of the spring is the fact that milfoil is not the dominant aquatic plant, as is the case with most springs in the Ozarks. It appears around the main basin and there is a slight amount of it along the margin of the spring branch near its confluence with the Niangua River. The commonest aquatic plants in the spring are hornwort and mild water pepper.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Hornwort (*Ceratophyllum demersum*)
Mild water pepper (*Polygonum hydropiperoides*)
Water starwort (*Callitriche heterophylla*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water cress (*Rorippa Nasturtium-aquaticum*)

BLUE SPRING

Located in SW. ¼ NW. ¼ sec. 14, T. 24 N., R. 11 W., at McCabe, Ozark County. The spring bubbles up in a basin 20 feet deep at the

base of a small limestone cliff 30 feet high, along the side of the North Fork of White River. There is practically no spring branch, since the water flows only about 25 feet before emptying into the North Fork of White River. In the spring and spring branch only water starwort occurs. Along the North Fork of White River, downstream from the confluence with the spring branch, grow milfoil, water star-grass, water-weed, and pondweed (*Potamogeton foliosus* var. *genuinus*).

LIST OF SPECIES

Water starwort (*Callitriche heterophylla*)
Milfoil (*Myriophyllum heterophyllum*)
Water star-grass (*Heteranthera dubia*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Water-weed (*Anacharis occidentalis*)

BLUE SPRING

Located in sec. 2, T. 39 N., R. 3 W., two miles southeast of Bourbon, Crawford County. The spring rises in a wooded valley in a park which has a fish hatchery. The water rises at one place in a concrete-lined pool, the deep blue water arising from a hole in the limestone substratum. Two lakes, Blue Spring Lake and Osage Lake, are formed by damming the spring. The water of the spring and lakes is of a deep blue color. In Blue Spring Lake roots of white willow covered with algae occur all around the margin of its concrete-lined pool. In this place curly-leaved muck-weed is dominant and abundant. It is of a dark, brown-green color and the stems grow upright with the leaves growing out distichously. Scattered with the algae are broad-leaved pondweed, pondweed (*Potamogeton foliosus* var. *genuinus*), a small amount of water starwort, and some water-weed. The water flows into a lake basin filled with rainbow trout.

A part of this main spring is then diverted into another place underground, coming out through a pipe which gushes forth a large amount of water. Here the bottom is gravelly mud and is covered mostly with curly-leaved muck-weed and water-weed.

Another part of the spring emerges at the base of a small ledge farther down the valley and has a muddy bottom covered with water-weed growing in dense, light-green beds. Some curly-leaved muck-weed and pondweed (*Potamogeton foliosus* var. *genuinus*) occurs here. Lying on the mud in quiet water are many clumps of green algae. Rice cut grass (*Leersia oryzoides*) grows all along the margin. This part of the spring is separated by an earth fill from the main part, which flows quietly over the muddy bottom. It is a large, shallow pool about 75 feet long and 45 feet broad, known as Osage Lake.

Lining the pool and growing in mud are water cress, water starwort, white water crowfoot, curly-leaved muck-weed, and water-weed. Of these species the curly-leaved muck-weed is dominant, with scattered plants of water cress and water-weed next most common. Clumps of green algae grow plentifully in this basin, and along the rock ledges on one side are quantities of myrtle (*Vinca minor*).

This portion of the spring flows underneath the hill and has an outlet on the other side, forming another flow which runs as a small branch without higher plant life. It eventually enters a pool filled with algae and having a gravelly mud bottom.

The main spring branch from Osage Lake described above flows as a narrow branch over a concrete bottom lined with blue-green algae, and eventually enters the gravel-laden creek. The diverted basin portion of Blue Spring Lake runs as a long branch with an abundance of trout, but it does not contain higher plant life. This main branch continues, with water one and one-half feet deep. The stream has a concrete-lined bottom and sides.

Across the road from the spring area described above, the water is diverted into a couple of lakes bordered by sandbar willow (*Salix interior*). The first lake (the one nearest the spring outlet) is filled with quantities of water feather, water-weed, and curly-leaved muck-weed. Some Ozark spatterdock also grows here.

The other lake is about 300 feet long and 100 feet broad, and is larger than the first. The surface of the water is covered with sweet-scented water lily, and there is an abundance of hornwort. In one place along the margin of the lake in quiet water is lesser duckweed, while along the margins in deep, quiet water commonly occur naiad and water feather. False nettle (*Boehmeria cylindrica*), field mint (*Mentha arvensis* var. *glabrata*), mad-dog skullcap (*Scutellaria lateriflora*), boneset (*Eupatorium perfoliatum*), and ironweed (*Vernonia crinita*) occur along the banks. Some pickerel-weed grows along one edge of the muddy margins with broad-leaved arrowhead and some water purslane.

The water from the first lake falls over a concrete spillway about one-quarter mile from the source of Blue Spring. At the place where it falls grow hornwort, naiad, sweet-scented water lily, Ozark spatterdock, some water feather, and curly-leaved muck-weed. Water cress and water purslane are found on the gravelly substratum in the current along the margin of the branch.

This flows into the main spring branch, which continues over a limestone and gravel stream bed in shallow water. The most common

plants here are water cress and water feather. All along the margin of the branch grow water-weed and curly-leaved muck-weed. In a shallow and more quiet section of the branch is hornwort. In a portion of the branch with a fast current and a gravelly mud or silty sand substratum is found horned pondweed (*Zannichellia palustris* var. *major*). Along the margin is cat-tail with scattered plants of yellow flag (*Iris pseudacorus*). Curly-leaved muck-weed, so plentiful at Blue Spring, is an introduced species which is very rare in Missouri, being known otherwise in the state only from a spring in Newton County.

LIST OF SPECIES

Curly-leaved muck-weed (*Potamogeton crispus*)
Broad-leaved pondweed (*Potamogeton amplifolius*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Water starwort (*Callitriche heterophylla*)
Water-weed (*Anacharis occidentalis*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water feather (*Myriophyllum proserpinacoides*)
Water purslane (*Ludvigia palustris* var. *americana*)
White water crowfoot (*Ranunculus longirostris*)
Ozark spatterdock (*Nuphar ozarkanum*)
Sweet-scented water lily (*Nymphaea odorata*)
Hornwort (*Ceratophyllum demersum*)
Lesser duckweed (*Lemna minor*)
Naiad (*Najas guadalupensis*)
Pickerel-weed (*Pontederia cordata*)
Broad-leaved arrowhead (*Sagittaria latifolia*)
Horned pondweed (*Zannichellia palustris* var. *major*)

BLUE SPRING

Located in NE. ¼, sec. 21, T. 29 N., R. 2 W., 12 miles east of Eminence, and two miles east of Powder Mill Ford, Shannon County. The water, of dark turquoise-blue color, flows out of a deep hole at the base of a limestone bluff. The rim of this basin is rocky and appears as if it were a part of the bluff which surrounds it. Over the top of this rocky rim is a muddy substratum. All around its crater the spring basin is lined with bur-reed, growing as far down as 10 to 12 feet below the surface of the water. Because of the muddy substratum and quiet water, the bur-reed is common in the beginning. Nearer the shore and along the margin, also on the muddy substratum, grow water starwort, needle spike rush, water speedwell, water cress, and water-weed. Near the margin the mud is mixed with a little gravel. Various water mosses cover submerged boulders around the basin. All along the shore of this basin water cress is abundant, growing in shallow water on mud with water-weed and water speedwell. A small amount of ditch stonecrop is found in mud around the margin.

As the water leaves the beautiful blue basin and starts a spring branch, water cress is the first higher plant to be seen. It grows

submerged at the beginning of the branch. In sandy silt away from the current, along the margin of the branch, are submerged bunches of ivy-leaved duckweed and spring cress, growing with water cress. Proceeding down the branch, water starwort is encountered along the margins.

In the beginning this spring branch is 50 feet wide, one and one-half to two feet deep, and flows mostly over large pieces of rock and gravel. The rocks are covered by dark green and blackish green species of moss. About 100 feet downstream on the south or left side along the margin of the spring branch are plants of bur-reed. Across from these plants on the other side are clumps of water cress, water speedwell, and spring cress (*Cardamine bulbosa* f. *fontinalis*) growing on gravel in 6 to 12 inches of water near the margin where the current is less swift.

The branch continues, flowing over water speedwell and water cress, which grow near the margin in shallow water. Beds of mosses and floating green algae cover the surface on both sides of the stream, growing away from the direct flow of the current. In shallow, swift water on the gravel occur submerged blue-green strands of red top grass near the margin of the branch where water cress and water speedwell are growing.

Then, about 75 yards farther downstream, the spring branch passes a small, low island, 75 feet long and 50 feet broad. Its middle portion has been cut through by part of the spring branch, while two other branches of the spring pass on either side. The spring branch thus makes three forks here. The swiftest current is in the left fork, which dashes rapidly over moss-covered rocks, making white foam. The other forks are shallower. Only moss and algae grow here, with a small amount of spring cress (*Cardamine bulbosa* f. *fontinalis*) and water speedwell, both species occurring more plentifully where the water is quieter. Growing submerged and prostrate along the gravelly margin of the right side of the left branch is false dragon-head with dark green leaves.

Soon the forks join and the branch is narrow, only 20 feet broad at their junction, but it is faster and deeper here than above. It makes a sharp bend, then flows over light-colored gravel with mosses covering the rock. As the water becomes deeper in one place, it assumes a steel gray-blue color.

Then the branch reaches a more shallow stretch, where it flows over gravel and broadens to 30 feet across. Here bur-reed, of a rich green color, occurs on one side, while on the other side along the

margin growing on the gravel in shallow water are submerged, long (3–4 feet), grass-green strands of fowl meadow grass with water speedwell. The fowl meadow grass is readily distinguished by its distichous leaves of equal length appearing all along the stem, while submerged or sterile plants of red top grass, which may be confused with it, have paler, blue- or gray-green leaves which are long and unequal and appear only near the base of the plant. A small quantity of white water crowfoot occurs by the island.

In a place away from the current, where the gravel has been swept away, is a mud bar, and on it grow clumps of water starwort and water speedwell. Spring cress (*Cardamine bulbosa* f. *fontinalis*) and bur-reed occur near here in gravel in deeper water.

The spring branch, after a flow of one-quarter of a mile, makes another bend and flows swiftly, three to four feet in depth, just before it enters Current River. At the confluence it has a deep blue color. Just at the mouth on gravel and in 6 to 12 inches of water are blue-green clumps of fowl meadow grass. Its leaves are blue-gray on the upper surface and grass-green on the lower. Also at this point in shallow water on gravel is a small amount of water cress. On the other (north) side of the confluence the water is deeper.

Immediately downstream from the confluence (about five feet away) the water in Current River is warmer and of a bronze-green color. Here are plants of long-leaved pondweed with narrow and submerged leaves. This species is one which avoids the colder water of the springs, so that its appearance in the warmer water of the river proper, yet only a few feet from the mouth of the spring branch, illustrates how important the factor of water temperature is in relation to the distribution and occurrence of aquatic species.

An interesting and unusual feature of Blue Spring is the relative abundance of ivy-leaved duckweed, a species that is seldom found in Missouri.

LIST OF SPECIES

Bur-reed (*Sparganium americanum*)
Water starwort (*Callitriche heterophylla*)
Needle spike rush (*Eleocharis acicularis* var. *typica*)
Water speedwell (*Veronica connata*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water-weed (*Anacharis occidentalis*)
Ditch stonecrop (*Penthorum sedoides*)
Spring cress (*Cardamine bulbosa*)
Spring cress (*Cardamine bulbosa* f. *fontinalis*)
False dragon-head (*Physostegia virginiana*)
Water speedwell (*Veronica connata* var. *glaberrima*)
White water crowfoot (*Ranunculus longirostris*)
Ivy-leaved duckweed (*Lemna trisulca*)
Red top grass (*Agrostis stolonifera*)
Fowl meadow grass (*Glyceria striata*)

BLUE SPRING

Located in sec. 4, T. 25 N., R. 1 W., 10 miles northwest of Bennett, and 16 miles west of Grandin, in Carter County. The spring issues at the base of a wooded slope and flows in a small branch into Big Barren Creek. The only aquatic plants growing in the branch are milfoil and water cress.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Water cress (*Rorippa Nasturtium-aquaticum*)

BOILING SPRING

Located in sec. 33, T. 37 N., R. 10 W., four miles northeast of Hooker, Pulaski County. The water, bright blue in color, vigorously bubbles up in Gasconade River along the side of the stream. No water cress grows in the spring or around it. Aquatic plants are found only around its margins, and of these shining pondweed is commonest. The other plants are milfoil and pondweed (*Potamogeton foliosus* var. *genuinus*), of a bright green color.

LIST OF SPECIES

Shining pondweed (*Potamogeton lucens*)
Milfoil (*Myriophyllum heterophyllum*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)

BOILING SPRING

Located in sec. 24, T. 32 N., R. 10 W., eight miles southwest of Licking, Texas County. The spring bubbles up on the bank and bottom of Big Piney River. In its water occurs thin grass, with blue-green leaves. This is out of place here, normally growing in woods and along stream banks. Also in and around the spring are plants of pondweed (*Potamogeton foliosus* var. *genuinus*) with firm, dark green leaves, water purslane, needle spike rush, water cress, a species of *Nitella*, and water starwort. Along the mud in a nearby slough of Big Piney River is found false pimpernel.

LIST OF SPECIES

Thin grass (*Agrostis perennans*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Water purslane (*Ludvigia palustris* var. *americana*)
Needle spike rush (*Eleocharis acicularis* var. *typica*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water starwort (*Callitriche heterophylla*)
False pimpernel (*Lindernia dubia* var. *typica*)
Nitella sp.

BOYLERS MILL SPRING

Located in sec. 7, T. 41 N., R 19 W., at Boylers Mill, Morgan County. It rises in a circular lake basin having an area of about an

acre, and is situated in the valley of Big Buffalo Creek. The lake has quantities of shining pondweed and pondweed (*Potamogeton foliosus* var. *macellus*). The basin is deep and its bottom muddy.

A spring branch issues from the basin and flows over a dam which formerly was used to develop power for operating a mill. This branch flows in the valley next to a wooded slope. It is filled here with water cress and moss-covered rocks. It then flows, a shallow stream, only 10 feet wide, over a gravel substratum. Near its confluence with Big Buffalo Creek are beds of water speedwell, the only place in the spring where this species occurs.

LIST OF SPECIES

Shining pondweed (*Potamogeton lucens*)
Pondweed (*Potamogeton foliosus* var. *macellus*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water speedwell (*Veronica connata*)

BOZE MILL SPRING (Plate IV)

Located in sec. 16, T. 23 N., R. 2 W., 12 miles east of Alton, Oregon County. The main spring rises in a low swale or sink-hole basin in alluvial woods near Eleven Points River, and flows 500 feet in a short branch which has a dam built across it. The branch empties into Eleven Points River. The water of the spring in the main basin has a deep, murky, blue color. Around the margin of the spring basin are various kinds of green and blue-green algae. In order of their appearance from the margin towards the center of the basin occur water starwort, water cress, milfoil, pondweed (*Potamogeton foliosus* var. *genuinus*), water speedwell, and white water crowfoot.

From the beginning of the branch to where the dam crosses it, the water is swift-flowing. The higher plants found here are water cress with some milfoil, but most of the plants are cryptogams, comprising various algae and mosses (*Fissidens Julianus* and others), and a liverwort (*Porella pinnata*).

From the dam to the mouth of the branch are the same species previously encountered. In addition, there are slender, light green plants of a species of *Nitella*. Near the confluence of the spring branch with Eleven Points River, blue-green plants of red top grass grow in swift-running water.

At the mouth of the spring branch, at its confluence with the river, occurs a great variety of aquatic plants. In shallow, quiet water in muddy soil at the confluence are found water-weed, white water crowfoot, and pondweed (*Potamogeton foliosus* var. *macellus*). Also in the middle portion of the confluence, rooting in sandy or

gravel mud, is another assortment of aquatics, composed of milfoil, water cress, water purslane, annual bluegrass, water speedwell, water star-grass, and horned pondweed (*Zannichellia palustris* var. *major*). The last species grows here in long, light green strands, its branching resembling strands of pondweed (*Potamogeton foliosus* var. *macellus*).

This spring exhibits a larger number of species of aquatic plants than most of the Missouri springs.

LIST OF SPECIES

Water starwort (*Callitriche heterophylla*)
Milfoil (*Myriophyllum heterophyllum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water speedwell (*Veronica connata*)
White water crowfoot (*Ranunculus longirostris*)
Water-weed (*Anacharis occidentalis*)
Pondweed (*Potamogeton foliosus* var. *macellus* and var. *genuinus*)
Water purslane (*Ludvigia palustris* var. *americana*)
Water star-grass (*Heteranthera dubia*)
Annual bluegrass (*Poa annua* var. *reptans*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Red top grass (*Agrostis stolonifera*)
Liverwort (*Porella pinnata*)
Nitella sp.

BRYANT SPRING

Located at Bryant, Douglas County, in sec. 7, T. 27 N., R. 15 W., along a road about a mile west of highway No. 5. The spring rises in a valley along the slopes of a wooded hill in a quiet lake, formed by a dam. The lake has an area of about one and one-half acres. On its muddy bottom grow beds of a species of *Chara*. Towards the far head of the lake are clumps of water purslane and water plantain. Along the margin bur-reed is very common, and in the middle of the lake are quantities of water cress and green algae. A surprising feature of the spring is the total absence of milfoil, which is usually common in such springs.

The water of the spring then flows about 200 feet over a chute in a raceway to a mill which it operates, falling 16 feet in its course. This part of the spring branch is not more than 5 to 10 feet wide, especially where the current is strong and the flow rapid. It contains quantities of bur-reed, some water starwort, and olive-green strands of pondweed. All along the course of the branch water cress occurs, and in especially large quantities before the water flows over the turbine. Finally the branch empties into Bryant Creek.

LIST OF SPECIES

Water purslane (*Ludvigia palustris* var. *americana*)
Water plantain (*Alisma subcordatum*)
Bur-reed (*Sparganium americanum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Milfoil (*Myriophyllum heterophyllum*)
Water starwort (*Callitriche heterophylla*)
Pondweed (*Potamogeton foliosus* var. *macellus*)
Chara sp.

CARTER SPRING (Plates VIII and IX)

Located in sec. 34, T. 29 N., R. 2 E., seven miles west of Piedmont, Reynolds County. The water flows from a hole in a bluff about 15 feet high, by a farmhouse. It is used to operate a waterwheel and grindstone. The spring comes from the outlet, four feet across, with a steady, gentle flow, traveling over a gravel and rock bottom. The water is about one foot deep and clear, where it comes out. Horned pondweed and water starwort grow around the edge of the basin, which is 25 feet broad and 15 feet long.

The water then flows over a concrete wall, under a shed, and down a shallow, gravelly branch. Next it flows into deeper water over a muddy bottom. Here it is filled with water starwort, water cress, and horned pondweed. Peppermint grows abundantly along the margins of the branch, and in the water is some mild water pepper. Following down the branch, one sees beds of a species of *Chara* having an olive-green or grass-green color. There is an abundance of algae all along the water. Rooting on the muddy bottom are some strands of pondweed, of a brick-brown and olive-green color.

Farther down the branch, at another place, pondweed (*Potamogeton foliosus*) becomes common and assumes a bright green color. In a place away from the current along the margin of the branch is water purslane, with an orange and olive-green cast. Here also occurs water speedwell, with a grass-green color.

After a flow of another hundred yards, the branch narrows and flows in a shallow stream, only three inches deep, over a gravel substratum. Here pondweed (*Potamogeton foliosus*) is common and of a bright green color. From this locality onward the gravel is common and the flow more rapid. Here the branch is only 10 feet wide, and the commonest plants are water speedwell and a species of *Chara*. Some other algae and pondweed (*Potamogeton foliosus*) of a bright green color occur. Water speedwell is common on the gravel, while water starwort, which was found in the beginning, is commonest on mud and in more quiet water.

In the last half of the spring branch water speedwell and water cress are the species occurring most frequently. This dominance persists as the branch empties into Webb Creek, after a flow of about 200 yards.

An interesting feature of the spring is that no water milfoil or bur-reed occurs.

LIST OF SPECIES

Horned pondweed (*Zannichellia palustris* var. *major*)
Peppermint (*Mentha piperita*)
Pondweed (*Potamogeton foliosus*)
Water starwort (*Callitriche heterophylla*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water purslane (*Ludvigia palustris* var. *americana*)
Water speedwell (*Veronica connata*)
Mild water pepper (*Polygonum hydropiperoides*)
Chara sp.

CAVE SPRING

(1) Located in sec. 4, T. 30 N., R. 23 W., near Pearl, Greene County. In a well-cultivated area near a house on a grass-covered hill marginal to a valley, a small stream of water issues from a rock-lined cavity in the ground. It emerges from a low ledge of limestone rock and flows 200 feet into Asher Creek. The spring branch is small, only three feet wide, with a gravelly substratum. On its open bank it is lined along the side by limestone. The only higher water plant is water cress. Below the confluence of the spring branch with Asher Creek is found an aquatic moss.

(2) Another spring just one-eighth of a mile up Asher Creek is larger than Cave Spring, issues from a rock ledge, and flows over a gravel substratum. It has a larger branch than that of Cave Spring. In it are water cress and aquatic mosses (species of *Fissidens* and *Fontinalis*). It flows 200 feet, then empties into Asher Creek.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)

CAVE SPRING (Plate V)

Located in sec. 28, T. 31 N., R. 5 W., nine miles southeast of Cedar Grove, Shannon County. "It issues from a cave at the base of a rocky cliff 40 feet high and empties into Current River 50 feet away." In the deep blue water of the spring the commonest aquatic plant is milfoil. Many aquatic mosses occur throughout the spring, and other common plants are water cress, water speedwell, and shining pondweed. All these occur rather abundantly throughout the short spring branch, to and beyond its confluence with Current River. The river is much influenced by the temperature of the water from the spring, because along the river downstream one-fourth mile from its confluence with the spring branch occur water cress, milfoil, and water speedwell. Pondweed (*Potamogeton foliosus* var. *macellus*), which was not found in the spring or spring branch, grows in the Current River rooted in gravel in shallow water one-fourth mile below the mouth of the branch.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water speedwell (*Veronica connata*)
Shining pondweed (*Potamogeton lucens*)
Pondweed (*Potamogeton foliosus* var. *macellus*)

CHESAPEAKE SPRING (Plate VI)

Located in the SW. ¼ SW. ¼ sec. 21, T. 28 N., R. 25 W., at Chesapeake, in Chesapeake State Park, Lawrence County. It issues from a gravel bed 30 feet north of highway No. 38. The spring is in a circular, rock-lined basin 25 feet in diameter and about three feet deep. It flows a small spring branch about five feet wide through a valley. The rock and gravel substratum are covered with moss. The only higher plants in the branch are horned pondweed, which occurs in dense mats, water starwort, of which there are only occasional clumps, and submerged plants of annual bluegrass. Where the spring branch enters the creek there is water cress, but none grows in the branch proper.

LIST OF SPECIES

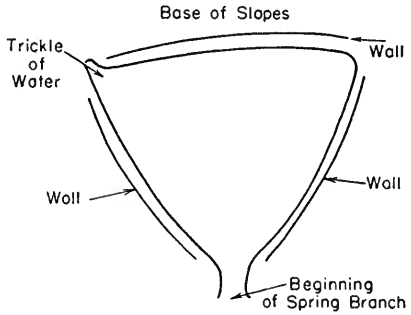
Horned pondweed (*Zannichellia palustris* var. *major*)
Water starwort (*Callitriche heterophylla*)
Annual bluegrass (*Poa annua* var. *reptans*)
Water cress (*Rorippa Nasturtium-aquaticum*)

CLARKSON SPRING

Located in SE. ¼ sec. 17, T. 27 N., R. 28 W., seven miles north of Pierce City, Lawrence County. The water comes out in a small seepage by a rock wall at the base of rocky ledges among wooded, red clay slopes. A concrete wall lines the spring on both sides, forming a triangular basin. No current or flow is evident in the basin; its bottom is muddy. At one end of this triangular basin, on gravel, water cress occurs, and it is present all along the borders. Water milfoil, masses of a liverwort (*Riccia fluitans*), and aquatic mosses are also found. At first the mud is red along one end of the basin, then as one proceeds farther away from the head of the spring, gravel becomes more common. Some water starwort grows near the margins. Water milfoil is the dominant plant in the basin, forming dense masses all over the bottom. This plant has a dark bronze color. The water in some of the deeper places is clear and bluish in color.

The basin, about 300 feet wide and 200 feet long at the base of the slopes, is surrounded by a concrete wall which makes it narrower as one approaches the end of the basin and the beginning of the spring branch. Springs appear from various places on the bottom within this enclosure.

The branch which issues as an outlet from the basin is shallow, from one to six feet deep, and flows over a gravel substratum. At the beginning of the branch in swift water on gravel occur water milfoil and water starwort, while along the sides grow mostly water cress and masses of water milfoil. Next, the branch continues with mud along its margins and gravel in the rest of the stream bed. On the muddy margins grow water cress, water milfoil, a liverwort (*Riccia*



fluitans), and occasional water starwort. In the middle of the stream bed practically no higher plants are seen except an occasional clump of water cress.

The flow of the lower half of the branch is slow. At its confluence with Center Creek mostly a mud substratum occurs. Here is found only water milfoil, water cress, and a liverwort (*Riccia fluitans*).

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Milfoil (*Myriophyllum heterophyllum*)
Water starwort (*Callitriche heterophylla*)
Liverwort (*Riccia fluitans*)

COLD SPRING

Located in E. ½ SW. ¼ sec. 4, T. 37 N., R. 1 E., near Floyd, Washington County. The water emerges as a small outlet in gravel at the head of a branch in a ravine. At this place is found water cress, bur-reed, a species of *Nitella*, and spring cress.

The water then travels down from one lake to another through a series of short falls and chutes which contain occasional plants of water cress, water starwort, and bur-reed. Around the margins of some of these lakes (formerly used as trout hatcheries), nothing is found except filamentous green algae and dark green clumps of *Nitella*.

The branch continues, bordered by a field on one side and wooded slopes on the other. Throughout this final portion of its course, no vegetation is found in the stream itself.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Spring cress (*Cardamine bulbosa* f. *fontinalis*)
Bur-reed (*Sparganium americanum*)
Water starwort (*Callitriche heterophylla*)
Nitella sp.

COPPEDGE SPRING (Plate XIX)

Also called Relfe Spring, Freeman Spring, and Spring Creek Spring. It is located in sec. 36, T. 35 N., R. 10 W., at Relfe, Phelps County. The spring rises at the side of a road from a terrace-like platform, gushing forth two cascades of water over rocks covered with moss and interspersed with peppermint and water cress. The branch which emerges makes a turn and flows parallel to Spring Creek, into which it empties a short distance away.

The dominant plant in the branch is water cress. In the lower part of the branch occur some plants of white water crowfoot and water starwort. Near the confluence of the branch with Spring Creek are a few plants of peppermint.

LIST OF SPECIES

Peppermint (*Mentha piperita*)
Water cress (*Rorippa Nasturtium-aquaticum*)
White water crowfoot (*Ranunculus longirostris*)
Water starwort (*Callitriche heterophylla*)

CREASY SPRING (Plates VI and VII)

Also called Bubble Spring. Located in sec. 16, T. 36 N., R. 12 W., about one mile upstream from Pippin Lodge, five miles northwest of Waynesville, Pulaski County. The spring rises from a heavily wooded bank along the side of Gasconade River. Sometimes the river submerges the spring during high-water stages. The water bubbles up from a circular basin only five feet away from the river. Sycamore (*Platanus occidentalis*), river birch (*Betula nigra*), and American elm (*Ulmus americana*), by means of their roots, hold the gravel, mud, and sand bank together; this is all that separates the spring from the river. The spring is located on the opposite side of the river and about one mile upstream from Bartlett Mill Spring and just slightly downstream from Falling Spring.

In the water of the spring, which is deep and of a gray-green color, milfoil is the commonest plant. A few plants of water cress occur

along one side of the spring, associated with some aquatic mosses and a liverwort (*Porella*).

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Liverwort (*Porella* sp.)

CRYSTAL SPRING

Located in sec. 22, T. 26 N., R. 15 W., at Larissa, Douglas County. The water emerges from a bed of Roubidoux sandstone boulders at the base of a hill and flows out of the gravel into a deep basin covered with sandy, gray mud. Immediately bordering the rocks, covered with moss, are plants of bur-reed.

The course of the spring is dammed by a rocky concrete wall which makes the water flow into a large basin about 200 feet long and 50 feet wide. Mats of water cress grow around the margins of the basin, associated with mats of species of *Chara*. Bur-reed is dominant all around the basin. Around its muddy margins needle spike rush and pondweed are common. Scattered on the muddy margins are dark green plants of water plantain. Most of the basin is filled with plants of water starwort and pondweed, together with quantities of milfoil.

The water next passes through a wooden chute, then flows a branch about 20 feet wide with a gravelly bottom. The branch is heavily lined with water cress. In deeper places of the branch and along its entire course in the middle are dark green mats of milfoil. The crystal-clear water in the middle of the branch flows above the substratum of gray, sandy mud. Immediately along the branch are flowering plants of speedwell or neckweed (*Veronica peregrina*).

Following down the spring branch there are found, in addition to milfoil, streaming olive-green strands of pondweed occurring in the main current, with some plants of water starwort along the margin. A small amount of bur-reed grows in the middle of the stream.

Where the branch makes a bend, are found many plants of milfoil with water starwort occurring in still water here. Lower down, milfoil becomes the dominant species.

The branch, after flowing 1,000 feet, empties into Hunter Creek.

LIST OF SPECIES

Bur-reed (*Sparganium americanum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Needle spike rush (*Eleocharis acicularis* var. *typica*)
Pondweed (*Potamogeton foliosus* var. *macellus*)
Water plantain (*Alisma subcordatum*)
Water starwort (*Callitriche heterophylla*)
Milfoil (*Myriophyllum heterophyllum*)
Chara sp.

DAVIDSON'S BLUE SPRING

Located along the St. Francis River, in sec. 5, T. 27 N., R. 6 E., five miles southeast of Greenville, Wayne County. The water issues at the base of a limestone bluff and forms a large basin of deep water, pale blue in color. Most of the substratum is muddy. The only aquatic plant in the spring or spring branch is horned pondweed, which grows in shallow water along the edge of the basin. There are no plants in the spring outlet proper.

The branch flows about 50 feet and empties into the St. Francis River.

LIST OF SPECIES

Horned pondweed (*Zannichellia palustris* var. *major*)

DOUBLE SPRING (Plates XIII and XIV)

Also known as Rainbow Spring. It is located in NE. ¼ NE. ¼ sec. 32, T. 24 N., R. 11 W., four miles northeast of Dormis, Ozark County. The water flows from the base of a moss-lined, semicircular slope of a wooded hill having an abundance of Roubidoux sandstone boulders. The spring gushes forth a large flow of clear water having a greenish blue color. It rushes over moss-covered boulders, making a white spray as it falls. Where the water emerges at the base of the bluff it "boils" up and forms a basin 40 feet across. Where the branch first comes out, the flow is 75 feet across. In the beginning and for the next 25 feet from the outlet occur moss-covered boulders along the margins and on the bottom. Fifty feet from the outlet the water divides into two branches, one flowing north, the other south. Growing partly in the water at the very beginning and along the margin is bitter dock, and around the head of the spring is spotted jewelweed (*Impatiens biflora*).

The left (north) branch will be described first. Twenty-five feet from the outlet along the margins are light green plants of spring cress, all submerged and growing with water milfoil and water mosses. In the deep water along the margin, away from the current, are bronze-green plants of broad-leaved pondweed, bur-reed, and water milfoil. Then at a place on the left side where the water is deep are grass-green beds of mild water pepper in masses five feet across and growing in two to four feet of water. Bur-reed, similarly, forms large mats. Now the branch is clogged with a wonderful diversity of aquatic plants—one of the richest floras to be found in the Missouri springs. All this variety and density of vegetation occurs about 40 feet from the outlet of the spring. Away from the right or left

currents and in the center of the broad spring branch are many plants of bur-reed and broad-leaved pondweed. In shallow (one foot) water are beds of water milfoil in dense mats with broad-leaved pondweed, bur-reed, horned pondweed, water-weed, and water cress. The water-weed and water cress are mostly in quiet water along the margins, while bur-reed, water milfoil, horned pondweed, and especially broad-leaved pondweed grow in the faster current.

This left branch broadens and flows north in an oblong basin about 150 yards long and 100 feet broad. Many floating as well as submerged masses of water cress dominate the branch now. The water cress occupies the shallow margins and the more quiet water between the several currents, and in these places forms dense beds. On the rest of the bottom water cress is supplanted by broad-leaved pondweed, colored bronze and russet-red and orange mixed with olive-green and dull grass-green, by bur-reed, and by water milfoil. Of these, the broad-leaved pondweed is dominant. Along the right side of the left branch, on the mud and away from the current, is water milfoil, dark green in color. It is the dominant species here and occurs with light green plants of water starwort and dark grass-green plants of water-weed. Dense beds of this water-weed are seen all along the muddy and quiet margins, and even greater quantities of water cress grow here. In the water on mud, but mostly out of water, are plants of broad-leaved arrowhead. Hornwort also is found here; it is of a dark, dull green color with light green tips.

Towards the end of this stretch of muddy water without a current are white water crowfoot, dull green plants of pondweed (*Potamogeton foliosus*) in spreading, large beds, in water six feet deep, and the broad-leaved arrowhead. This is in a bog away from the main branch along part of an old dam site.

The left branch makes several meanders around a small, grassy island covered by a few large trees of sycamore (*Platanus occidentalis*), American elm (*Ulmus americana*), walnut (*Juglans nigra*), and bitternut hickory (*Carya cordiformis*). The main branch or current follows along the extreme left side or west bank, while the slow meander with quiet water and muddy substratum, covered with white water crowfoot and hornwort, is along the east or right fork around the island. The preceding discussion of the vegetation described the right or east fork of the left branch.

Proceeding now to the left side or west bank of the left branch, where the flow is steady and the water deep, there is found on the muddy substratum large quantities of water milfoil, water-weed, and

water cress. Halfway down the branch are slightly submerged plants of mild water pepper. Proceeding towards the end of this branch, nearer the dam, water-weed is the commonest plant, occurring as large beds of dark green in water three to four feet deep. Just before reaching the dam, as the water flows into a deep pocket with a mud substratum, occur long, bronze-green strands of pondweed (*Potamogeton foliosus*). Then the water flows through holes in the wooden dam and drops two feet into the remnants of the spring branch, which now flows over a gravel substratum and is only six inches to one foot deep and about 30 feet across. In this shallow gravel stretch is water milfoil in dark green, blackish bronze, and dull bronze, prostrate mats. In one place along the margin is found water purslane with red and green or dark grass-green color. Pondweed (*Potamogeton foliosus* var. *macellus*) grows along the margin in gravel. Making prostrate growths over gravel substratum in shallow water, with the current flowing over them, are plants of bur-reed and mild water pepper. Along one side on the muddy margins are some plants of lizard's tail. Along the muddy, gravelly, shallow margins occur submerged plants of blue-green red top grass and field mint. Here also, in swift, shallow water over a gravelly bottom, along the margins, are dense, small-leaved mats of pastel green water speedwell. After flowing 700 feet, this branch enters North Fork of White River. At the confluence are beds of prostrate water milfoil, followed in lesser abundance by light green mats of water speedwell, with occasional water cress and spring cress. Away from the current and mostly in the deeper and more quiet water of the river at the confluence with this part of the spring branch are bur-reed and flowering water milfoil.

Having described the nature and distribution of the vegetation in and along the left (north) branch of Double Spring, we come to a discussion of the right (south) branch. In the beginning the stream flows over some moss-covered rocks, but soon forks around a small, rocky island. The latter is bordered with water cress, bur-reed, and broad-leaved pondweed. The bur-reed grows both in the strong current of rapid water in the submerged condition, and away from the current, where it is flowering. Farther down the branch are large quantities of water milfoil, bur-reed, and submerged bunches of water cress. This right (south) branch has a more gravelly or sandy mud substratum of a lighter color than has the left (north) branch. In this right branch now occur large, submerged beds of light green water cress, with broad-leaved pondweed, mild water pepper, and,

along the margins, water milfoil. The spring branch now maintains a steady, rapid current in a stream 100 feet wide. The flow is over a light-colored substratum with gravel and sandy mud along the margin. On some of the shallower sandy mud bottoms are light green plants of horned pondweed growing with water cress and water milfoil. On the gravelly portion of the stream bed are pale, delicate olive-green or light green, submerged and sterile plants of needle spike rush. Towards the other side, where the water is deeper and the current more swift, occur bur-reed, water cress, broad-leaved pondweed, and large quantities of water milfoil. Proceeding down the branch, the dominant species are water milfoil, water cress, bur-reed, and broad-leaved pondweed. The broad-leaved pondweed grows among the water milfoil. Here the substratum is sandy, silty mud. Along the margins grows water speedwell.

The spring branch possesses several currents and where the current is less strong in the middle, bur-reed is common and grows upright in dense colonies. Along both margins the current is stronger. Water cress is scattered throughout the course of the branch and along the right side is more or less continuous. Water milfoil forms almost continuous beds of dark bronze-green color on the left side. Water-weed occurs along the margins. In the deeper, swifter current on the right side are bur-reed, water cress, and aquatic mosses.

Proceeding downstream, we find the middle of the branch completely covered with dense beds of darker brown water milfoil. Water starwort occurs in small quantities now with hornwort and water-weed. The last is found in large quantities on a muddy substratum along the quiet margin of the left-hand side. Where hornwort and water milfoil occur side by side, they may be distinguished by certain field characters. Hornwort possesses many bushy, closely ascending branches near the tips, giving a cone-shaped appearance to the branches. Moreover, the branching occurs from all sides all along the stem. On the other hand, water milfoil has long stems, mostly unbranched, with especially long, simple, unbranched tips.

Farther down, the branch approaches the wooden wall of an old dam. About 100 yards from the dam the substratum is much muddier and from the margins inward towards the center for 20 feet occur large quantities of hornwort. It grows in long, large mats of bronze-green tipped with light, dull green. Water cress occurs with it. Some small clumps of water starwort grow in the mud along the margin. The hornwort grows best here on mud in water from four to five feet deep with a slight current, growing in clumps as much

as 10 feet long and four feet wide. Here it occurs next to the water milfoil, water cress, and water-weed, all dominant species in this part of the branch. Bur-reed is found here in insignificant, small, submerged patches only. At the dam the water is from 8 to 12 feet deep. Here are beautiful beds of hornwort, water milfoil, bur-reed with leaves three feet long, and, near the margin, water-weed.

Below the dam the water rushes from the outlet and emerges as a swift branch flowing over a gravel substratum. The branch has narrowed to 50 feet now. The dominant species here on the gravel in shallow water are water cress, mosses, and mild water pepper with grass- or olive-green, rose and red leaves in submerged condition, and green leaves in emerged condition. Most of the red color of this species is present on the lower side of the leaves and along the lower and basal leaves. In the shallow margins away from the current grows water milfoil. Farther down the branch in gravel near the margin and away from the main current are water speedwell and water milfoil. Along the left bank occurs the rare water pennywort. After flowing 300 feet from the wooden dam, and 1,500 feet from the main spring outlet, the branch enters North Fork of White River. At the confluence are water speedwell, mild water pepper, water cress, horned pondweed, water milfoil, mosses, algae, and submerged clumps of red top grass. Away from the main current occurs water milfoil.

Down river from here the plants enumerated above continue growing as a result of the influence of the temperature of the spring water on that of the river. This cool spring water is important in delimiting the occurrence of the various aquatic species which are characteristic of spring water. Water milfoil and bur-reed grow, especially along the margins. In the middle of the branch no plants occur except mosses, which cover the rocks.

LIST OF SPECIES

Bitter dock (*Rumex obtusifolius*)
Pondweed (*Potamogeton foliosus* var. *macellus*)
Water milfoil (*Myriophyllum heterophyllum*)
Broad-leaved pondweed (*Potamogeton amplifolius*)
Bur-reed (*Sparganium americanum*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water-weed (*Anacharis occidentalis*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water starwort (*Callitriche heterophylla*)
Broad-leaved arrowhead (*Sagittaria latifolia*)
Hornwort (*Ceratophyllum demersum*)
White water crowfoot (*Ranunculus longirostris*)
Water purslane (*Ludvigia palustris* var. *americana*)
Mild water pepper (*Polygonum hydropiperoides*)
Lizard's tail (*Saururus cernuus*)
Red top grass (*Agrostis stolonifera*)
Field mint (*Mentha arvensis* var. *glabrata*)
Water speedwell (*Veronica connata*)
Spring cress (*Cardamine bulbosa*)
Spring cress (*Cardamine bulbosa* f. *fontinalis*)
Needle spike rush (*Eleocharis acicularis* var. *gracilescens*)

EBB AND FLOW SPRING

Located in NW. ¼ sec. 35, T. 27 N., R. 6 W., near Rymer's Ranch, six miles northwest of Birch Tree, Shannon County. "It issues from the base of a high hill and flows into Jacks Fork at a distance of 10 feet." The water rises quietly at the base of a small rock ledge about 15 feet high and 25 feet broad. There is no higher plant growth in the spring. The spring basin is small, only 20 feet long and 10 feet broad, and has a depth of about two feet. Its bottom is gravelly mud.

The spring flows over some large rocks and then sends a short branch 10 feet long and one foot broad over some moss-covered rocks. At its confluence with Jacks Fork the substratum is a sandy silt upon which grow in the quiet water bronze-green plants of pondweed (*Potamogeton foliosus* var. *macellus*), water milfoil, broad-leaved pondweed (*Potamogeton amplifolius*), and Ozark spatterdock. No other plants occur. The plants enumerated above do not occur in the spring branch, but grow in the river just at the confluence.

The spring is exceptional in not having at the present time water cress. It is now used as a water supply for a fishing club, and its continued use and thorough cleaning out may have led to the extermination of any water cress or any other species which may have grown there formerly. "As its name implies, the spring ebbs and flows at periodic intervals."

LIST OF SPECIES

Pondweed (*Potamogeton foliosus* var. *macellus*)
Broad-leaved pondweed (*Potamogeton amplifolius*)
Water milfoil (*Myriophyllum heterophyllum*)
Ozark spatterdock (*Nuphar ozarkanum*)

ELM SPRING

Located in sec. 2, T. 26 N., R. 10 W., three miles southwest of Willow Springs, Howell County, in the valley of Noblett Creek. The water bubbles up in sand in a small outlet, and forms a swamp.

Around the spring grow water cress, bur-reed, water plantain, and water purslane. Water cress and bur-reed are the dominant aquatic plants in the water of the spring-fed swamp. Here also occur plants of broad-leaved pondweed.

A tiny spring branch one foot wide flows from the swamp.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Bur-reed (*Sparganium americanum*)
Water plantain (*Alisma subcordatum*)
Water purslane (*Ludvigia palustris* var. *americana*)
Broad-leaved pondweed (*Potamogeton amplifolius*)

EVANS SPRING

Located in NW. ¼ sec. 2, T. 37 N., R. 4 W., one mile southeast of Steelville, Crawford County. The water issues from the base of a high limestone bluff into a large, concrete-lined basin, and is carried in a canal to a small plant which is sometimes used to develop electric power. In the basin immediately at the base of the bluff are quantities of moss and algae. The water here is a clear blue-gray in color.

At first the spring branch used to flow out directly in front of the bluff, but concrete-lined chutes have forced its flow parallel to the bluffs into a series of basins. In these pools the naiad forms dense, brownish green to blackish mats 5 to 10 feet long. Where the water in these pools is more quiet, water starwort is common, and it and a species of *Nitella* comprise the dominant plants of the pools. There is also some water purslane here.

After leaving the pools, the spring branch begins to follow its natural course, and here water cress becomes the dominant species. The branch then flows about one mile before emptying into Yadkin Creek, but is devoid of any aquatic vegetation, except water mosses, water cress, and annual bluegrass, which are found rooting on its shallow gravel bottom.

LIST OF SPECIES

Naiad (*Najas guadalupensis*)
Water starwort (*Callitriche heterophylla*)
Water purslane (*Ludvigia palustris* var. *americana*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Annual bluegrass (*Poa annua* var. *reptans*)
Nitella sp.

FALLING SPRING

Located on a line between secs. 17 and 20, T. 36 N., R. 12 W., about three-fourths of a mile upstream from Pippin Lodge, five miles northwest of Waynesville, Pulaski County. It is about 200 yards upstream from Creasy Spring and on the opposite side of Gasconade River. From a circular basin about 20 feet in diameter the water rises from the base of a rocky, wooded slope covered at the base above the spring by sugar maple (*Acer saccharum* var. *glaucum*), butternut (*Juglans cinerea*), American hornbeam (*Carpinus caroliniana*), and sycamore (*Platanus occidentalis*). The water of the basin is of a dark, turbid, green color.

The only higher plant in the water of the basin is milfoil. In running, shallow water of the basin are plants of a fresh-water red alga, *Batrachyspermum*. The water next flows with ripples over five feet of gravel, then cascades over some small boulders one and one-

half feet in diameter and covered with moss. As the water falls over these boulders it makes a drop of about eight feet. Finally, it flows a spring branch 30 feet long over muddy substratum and empties into Gasconade River after a course of 150 feet from the main spring. No higher aquatic plants are found between the circular basin of the spring and its confluence with Gasconade River.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*) Fresh-water red alga (*Batrachyspermum*)

GAINES FORD SPRING (Plate XIV)

Located in the NW. ¼ sec. 35, T. 39 N., R. 9 W., 10 miles northwest of Rolla, in Maries County. The water bubbles out at the base of a limestone bluff and flows a spring branch about 20 feet across, into Gasconade River—a distance of 500 feet. Around the outlet of the spring are piled up boulders of limestone and Roubidoux sandstone.

The water in the branch flows over a gravelly bottom and is one and one-half feet deep. It is bordered by moss-covered rocks. At the very beginning of the stream, rooted on the gravel substratum, are buff-brown plants of shining pondweed—the first higher aquatic plant to appear in the spring. It occurs about 25 feet from the spring outlet. Then appear along the sides quantities of dark grass-green plants of water-weed in large clumps. These grow in shallow water and on a gravel substratum.

Downstream the water becomes deeper and flows over a mud substratum. Here milfoil begins to predominate after the first 100 feet of flow, and scattered clumps of water starwort and water-weed are seen now rather frequently with the milfoil.

The two most common plants throughout the spring branch are milfoil and water-weed. Over the muddy substratum and during the last two-thirds of flow, water cress is common.

LIST OF SPECIES

Shining pondweed (*Potamogeton lucens*) Water starwort (*Callitriche heterophylla*)
Water-weed (*Anacharis occidentalis*) Water cress (*Rorippa Nasturtium-aquaticum*)
Milfoil (*Myriophyllum heterophyllum*)

GRAVEL SPRING

Located at the base of Paint Rock Bluff along Current River, sec. 4, T. 28 N., R. 1 E., 20 miles southeast of Eminence, Shannon County. The spring bubbles up from the gravel in the bed of Current River at the base of Paint Rock Bluff and spreads out in a

series of deep holes, flowing a short branch into Current River, along which it issues. In the deep water of the spring is a species of *Chara*. Other aquatic plants in the spring are milfoil, water-weed, and pondweed.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Water-weed (*Anacharis occidentalis*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Chara sp.

GRAVOIS MILLS SPRING (Plate XI)

Also called Collins Spring. Located in sec. 19, T. 41 N., R. 17 W., one mile west of Gravois Mills, Morgan County. It issues as a small branch, five feet broad and from four to six inches deep, coming from gravel at the head of a wooded ravine, and flows a short distance. Along its sides it is overgrown with water cress, and throughout the first part of the flow this plant is the common one. The branch broadens into a funnel-shaped basin filled with water cress growing mostly away from the current. Then the water spills over a small dam and enters a series of trout basins filled with algae. At the end of the first basin in deep quiet water are long leaves of bur-reed.

The water then rushes over a second basin and through chutes. In some of the basins with more quiet water large quantities of green algae have accumulated, and the only higher plant is bur-reed. In some basins where no other higher plants exist are dull green plants of pondweed and water cress. Both pondweed and bur-reed grow in ponds where there is not much current.

In one basin on the right side are large quantities of bur-reed growing on mud in quiet water from three to five feet deep. Here also are plants of water cress and pondweed. In another large basin next to the preceding one are plants of pondweed. In the deep basin on the right side, growing with bur-reed, water cress, and pondweed, are floating plants of hornwort and submerged ones of mild water pepper. There are also plants of the last species with stems flowering above the surface of the water.

Following down the valley one encounters the next basin, which is dammed and does not receive water from any part of the main current. Its bottom is muddy. Most of this lake (on the left side as you proceed down the valley) is filled by hornwort, while along its shallow margins in mud in quiet water grow water purslane (*Ludvigia palustris* var. *americana*), tooth-cup, and creeping love grass. The water of this lake, as previously stated, is modified spring water.

However, in the lake adjacent to it on the right side, water flows through a chute and there grow bur-reed, hornwort, and bronze-red and green plants of water purslane (*Peplis diandra*), in still water 10 to 12 feet deep. This latter basin broadens into a large lake, deep and still, with the water of a deep blue-green to deep dark green in color. On the right side this lake lies along the base of a limestone, wooded bluff, and on its sunny, exposed, muddy margin are large rose-red and brick-colored, rounded clumps of water purslane (*Peplis diandra*), olive-gray-green, submerged plants of ditch stonecrop, bur-reed, and pale green and pastel-colored plants of pondweed, with widely spreading leaves. The water from this lake then runs out from the sides of a rock dam 20 feet high and sends forth a spring branch. This branch will be described later.

In the lake on the left side occur solid beds of bronzy-green plants of pondweed. Also on the muddy margin around one lobe of the lake are solid mats of rose-red plants of tooth-cup, growing mostly out of the water. Where they are submerged, the plants are of a deep dark green color, but out of water in bright sun they assume a rose-red color. Farther out in the deep water along this side of the lake, exposed to the bright sun, grow broad-leaved pondweed with leaves of a rose-red or brick-red color mixed with brown. Here the floating leaves of this species are olive-green. Water purslane (*Peplis diandra*) also occurs here, assuming various colors according to the amount of sunlight present. For instance, in shade and along margins where growing with other plants, the leaves are dark or grass-green, but where the plants are exposed to the full rays of the sun for most of the day, the leaves assume chiefly a bright rose-red or brick-rose color. Some plants of bright rose-red-colored water purslane (*Ludvigia palustris* var. *americana*) also grow here in the sun. It is interesting to note that certain species, even though similarly exposed to the sun, never seem to turn a rose or brick color. Such species are pondweed and bur-reed, which remain shades of green, while other plants, such as water purslane (*Ludvigia palustris* var. *americana*), water purslane (*Peplis diandra*), and broad-leaved pondweed, turn to shades of rose-red or brick-red when exposed to the sun. In some of the shallow, muddy, swampy depressions along this lake are plants of pondweed, hornwort, and naiad. This is the only place in the spring where naiad grows. Along the margins here are also large quantities of water purslane (*Ludvigia palustris* var. *americana*), creeping spike rush, and tooth-cup.

This lake on the left side reaches its outlet and flows a branch coming from one of the chutes in a channel. In the beginning the

branch is narrow and deep, and flows over a muddy substratum covered mostly by bur-reed. This species grows where the water is deep and has a muddy substratum.

Going back now in the description to the outlet of the lake on the right side, the branch at the base of the rock dam proceeds over a gravelly bottom with a fast current. At first only bur-reed and water cress are seen along the margins. Then the stream becomes narrower and deeper, 20 feet broad and two feet deep, and flows over a sandy gravel substratum. Here occur bur-reed and water cress, mostly along the sides but also in the middle of the stream bed. Growing in the loose substratum are dull grass- and rich grass-green, small mats of pondweed (*Potamogeton foliosus* var. *macellus*), and plants of shining pondweed, growing only where the water is more shallow (six inches deep) and the current is rapid. Now the stream enters a basin where the flow is less rapid, and from two to three feet deep. The deeper and less rapid water at this point is caused by a flood sluice gate built across the branch, located about 50 yards downstream from the rock dam, described above. Here in deep, rather quiet water on the muddy, sand-gravel bottom are a few mats of water purslane (*Peplis diandra*) with a light, dull, grass-green color at the tips of the plants, and otherwise dark, dull green mixed with bronze or pinkish lower down and at the base of the plant. This coloring of the plants exists in shade. There are also some submerged mosses here where the bottom is of a muddy sand-gravel. Past the sluice gate this branch has a faster flow. Its course is over gravel and the water usually is only from two to six inches deep, although in places one foot deep, and from 10 to 20 feet broad. Water cress occurs along the sides and is commonest along the margins where the water is shallow and the current less swift. Some plants of bur-reed also grow along the margins and in gravel in the middle of the stream bed.

Farther down in some swift water where the main current flows over the middle of the stream bed and the stream narrows, occur bright green plants of pondweed (*Potamogeton foliosus* var. *genuinus*). After making a couple of bends the branch meets the other spring branch which came from the original source of Gravois Mills Spring, and which runs along the left (north) side as one goes downstream. The two branches unite to form a swift but narrow branch, 10 feet in width, which flows over a gravel bed. Mostly water cress occurs along the margin of the branch now. Where part of it flows over a riffle in the gravel-bed and is only one or two feet deep, are blue-green plants of fowl meadow grass. Where the rocks are larger

in this portion of the branch, they are often covered by aquatic mosses. The stream continues to flow with shallow water over a gravel substratum. In some places the water is deeper. Along the sides grow water cress, and from here on it is the only higher plant to occur until the branch flows into the Lake-of-the-Ozarks.

The left branch which originally started its flow near the head of Gravois Mills Spring at first has a gravel bottom, is narrow (five feet broad), and flows through a ditch or depression along the road. Water cress, bur-reed, pondweed (*Potamogeton foliosus* var. *genuinus*) of a bright green color, and shining pondweed with bright green leaves, occur here. The bur-reed and shining pondweed are very common. The latter occurs mostly in a shallow, swift current in the middle of the stream bed.

LIST OF SPECIES

IN SPRING WATER

Water cress (*Rorippa Nasturtium-aquaticum*)
Bur-reed (*Sparganium americanum*)
Hornwort (*Ceratophyllum demersum*)
Mild water pepper (*Polygonum hydropiperoides*)
Water purslane (*Peplis diandra*)
Ditch stonecrop (*Penthorum sedoides*)
Pondweed (*Potamogeton foliosus* var. *macellus* and var. *genuinus*)
Shining pondweed (*Potamogeton lucens*)
Fowl meadow grass (*Glyceria striata*)

IN LAKE ON LEFT

Hornwort (*Ceratophyllum demersum*)
Water purslane (*Ludvigia palustris* var. *americana*)
Tooth-cup (*Rotala ramosior* var. *interior*)
Creeping love grass (*Eragrostis hypnoides*)
Water purslane (*Peplis diandra*)
Bur-reed (*Sparganium americanum*)
Broad-leaved pondweed (*Potamogeton amplifolius*)
Pondweed (*Potamogeton foliosus*)

GREER SPRING (Plate XV)

Located in sec. 36, T. 25 N., R. 4 W., a mile north of Greer post office, and about eight miles northeast of Alton, Oregon County. "It has two outlets 300 feet apart, both of which are located in a deep, narrow gorge." At its upper outlet about one-fourth of its water issues horizontally from a cave situated at the head of a deep ravine cut in cherty dolomitic Ordovician rocks. The water is clear and cold. Around the first outlet from the cave, where the water is deep and swift-flowing, only moss grows around the rocks. The stream dashes rapidly over boulders covered with mosses and a liverwort (*Marchantia*). There are no higher plants between the first and second outlets except spring cress, which occurs along the margins away from the main current. The branch from the first outlet dashes into the second, larger outlet which "boils up" the remaining three-fourths of the water volume of the spring in a cir-

cular basin 40 feet in diameter. The water here is of steel-blue color. No plants grow in the direct force of this large volume of water, but around its margins there are various submerged mosses on the rocks. Also found here in mats are light green plants of spring cress. Dark green fowl meadow grass, some of which is submerged, occurs along the margin. Directly above this lower outlet is an American elm (*Ulmus americana*) bearing on its branches a clump of mistletoe (*Phoradendron flavescens*). A liverwort (*Dumortiera hirsuta*) grows on some of the rocks around the margin of the lower outlet.

At first the spring branch is about 30 feet broad on the average, widening in some places to 40 or 50 feet. Fifty yards from the second outlet, water cress forms a large bed along the margin away from the current, and grows from rather deep water all the way to shore. The branch dashes rapidly over moss-covered boulders and sounds like a mountain stream in the canyon. It is from two to three feet in depth here and flows over many large rocks. A liverwort (*Dumortiera hirsuta*) grows on the rocks and submerged logs in the current itself. Away from the current along the margin and at one place in the middle of the stream, behind the protection of a tree trunk which protrudes above the water and throws the current to both sides of the branch, are flowering mats of white water crowfoot. The latter and water cress are the dominant and only species of higher plants thus far.

On the north side of the branch the water is shallower, about one foot deep, and contains beds of water cress and white water crowfoot. The strands of the latter have a grass-green color, and all grow on more or less shallow, level places in the stream bed. The gravel is fine and light-colored. It is a common sight here to find masses of this species occurring as rich, dark green or grass-green mats from four to six feet long. They grow somewhat away from the main current, along the sides, but nevertheless in the actual current. Here and there are flowering clumps of water speedwell in the shallower water near the margin. Water cress grows here away from the current, but is in some deep water where it forms masses of stems, lying upon one another.

Along more quiet margins on a shallow, muddy substratum next the shore are water starwort, water pimpernel, and water cress.

Water cress lines the remainder of the flow of the spring branch. For the first one-quarter of a mile the branch has been a rough and tumbling one, then, as it becomes less rough, the species of plants mentioned above, especially white water crowfoot, become more

conspicuous and continue in prolific quantities for the last half-mile of flow.

Occasional mats of spring cress are found floating where they have become detached from rocks or attached at other places. Both the spring cress and water cress, which occurs with it in long bunches, are of a light green or grass-green color.

The branch now makes a turn to the left with a stretch of grassy meadow on the left and a steep bank on the right. Here, adjacent to the bank, is a pool with deep blue rapid-running water, while along the left side the water is shallower and flows over a light-colored gravel. The latter area receives more sunshine, which accounts for the bronze color of the mats of white water crowfoot found here. After making this bend the branch becomes 100 feet wide in places and spreads out over a shallow stream bed covered by a foot of water flowing over light-colored, small gravel. The current here is much less rapid and has few places where the water is white and foamy from cascades and waterfalls. In this shallower and slower water the bottom is covered with mats of light green water cress, and white water crowfoot with a bronze color where the sun is strong, but with a grass-green or dark green where it grows in the shade. This latter species assumes the dark green or grass-green phase along and near the shady margins. White water crowfoot is the dominant and most common species now, with water cress second in abundance.

Along the margins of the grassy meadow mentioned above grow field mint, of an olive-green or light green color, some of it slightly submerged, and mats of spotted touch-me-not (*Impatiens biflora*) among beds of water cress, and submerged, dark green, leafy, sterile plants of fowl meadow grass.

Downstream along the north side of the branch on the margin, in shade and shallow water, are olive-grass-green plants of a liverwort (*Riccia fluitans*) and duckweed.

Growing in the full sun on the stream is water speedwell, which has a light olive-green color suffused with a pastel brick or russet-brownish tinge. Again the white water crowfoot growing in the sun assumes a bronze or brown mixed with green.

Following down the lower part of the course of the branch is seen for the first time a plant of bur-reed, growing along the margins behind a bed of water cress mixed with creeping spike rush. Land plants found near the margin at this point are blue flag (*Iris virginica*), water horehound (*Lycopus rubellus*), bugle weed (*Lycopus*

virginicus), mountain mint (*Pycnanthemum virginianum*), blue lobelia (*Lobelia siphilitica*), spotted touch-me-not (*Impatiens biflora*), and *Rudbeckia palustris*.

Farther down the stream, beds of water cress cover the shallowest portions of the spring branch, to the exclusion of almost everything else. A liverwort (*Riccia fluitans*) occurs all along the quiet margins. Growing in the shallow water are bunches of water speedwell, with small leaves and short internodes, their color tinged with brick or even reddish. In grassy places water pepper (*Polygonum punctatum*) is common, in association with monkey flower (*Mimulus alatus*), water horehound (*Lycopus rubellus*), boneset (*Eupatorium perfoliatum*), false nettle (*Boehmeria cylindrica*), and willow herb (*Epilobium coloratum*). Red top (*Agrostis stolonifera*) is the chief sod-making grass. Here and there, in shallow water on gravelly substratum with water cress, occurs bitter dock (*Rumex obtusifolius*).

As the flow becomes less rapid and the water shallower, water speedwell and water cress become the commonest species. In this lower stretch of the stream are islands of water cress, where the species of the grassy, swampy meadows sometimes have their beginning. The thick beds of water cress make it possible for a large amount of detritus and silt to accumulate under a slower current, and initiates a mucky substratum in which red top grass (*Agrostis stolonifera*) and creeping spike rush (*Eleocharis calva*) can take root. When the latter have established enough of a sod, the beginning of a swampy meadow is formed, and the previously mentioned species of the swampy meadow rapidly close in upon the now available soil.

After having had broad and shallow stretches for most of its course, the branch again narrows and becomes much swifter and deeper, flowing here over some large rocks. At this point is found for the first time horned pondweed, growing here in a fast current in water one and one-half feet deep. It roots on gravel among the rocks. Its foliage is of a bright grass-green and it forms dense, prostrate, rich-colored beds in mats one to two feet long and six inches to one foot broad. Red top grass (*Agrostis stolonifera*), with a blue-green or gray-green color, occurs along gravelly margins here.

Next, as the branch becomes deeper and the current stronger, water cress disappears from most of the stream except the margins. Consequently, water speedwell and horned pondweed dominate the bottom of the stream bed, growing in patches. Along the quiet, shallow margins in sandy mud occur more clumps of bur-reed, the first seen for a quarter of a mile.

Now the branch divides around an island covered by a swampy meadow. One fork continues to flow straight, and in its shallow water are more patches of water speedwell and water cress; but the other branch curves around a bend where, on gravel in the shallow current, grows shining pondweed, with a bronze and brick color on some plants and a bright green on others. It is fully exposed to sunlight. Adjacent to this curve is a stretch of mud on one side. On it grow water cress and water speedwell, and behind them, nearer the land, bur-reed and broad-leaved arrowhead. The water is choked with beds of white water crowfoot. The muddy substratum here is due to the silty deposit made by a small spring which enters at this point and is surrounded by a swampy meadow overgrown with *Rudbeckia palustris*, *Panicum agrostoides*, and many other species. Down the remainder of the main branch, bur-reed is common along the margins. Around this small spring branch water speedwell and bronze-colored shining pondweed are dominants, with water cress and broad-leaved arrowhead occurring along the muddy margins. In muddy places here also grow white water crowfoot and water speedwell with shining pondweed. The latter species forms beds of floating leaves while some of it is in flower. Also seen along these muddy margins nearer land are creeping spike rush, rice cut grass, and knotty-leaved rush.

After the branches have forked around this island, they join in a shallow, gravelly branch about 100 feet broad. Here are abundant beds of water cress, water speedwell, and horned pondweed. A smaller amount of white water crowfoot is present. A beautiful mottled color effect is produced by the light green of water cress growing with pastel brick- and russet-colored water speedwell and light olive-green horned pondweed. The water speedwell forms large beds, while the other two species occur in lesser abundance.

Finally, the spring branch joins the Eleven Points River, after a flow of one and one-quarter miles throughout, in which it has fallen 46 feet. At the confluence the following species grow submerged: Water cress, white water crowfoot, water speedwell, and horned pondweed. The two last species are dominant here, and where the current is strongest, at the mouth of the spring branch, horned pondweed becomes the dominant species, forming large beds three or four feet long and four or five feet broad. It grows here mostly in a strong current of shallow water, rooted on the gravel, but in places the water is from two to three feet deep.

After the branch enters Eleven Points River, there are many beds of water milfoil and smaller amounts of hornwort; neither species

was found in the spring branch proper. The hornwort grows in shallow places in gravel along the river margin, while the water milfoil occurs along the margin in muddier soil, away from the current. It grows also in the river with water speedwell and white water crowfoot. On the shallow gravel away from the current are beds of water speedwell.

LIST OF SPECIES

Bitter dock (*Rumex obtusifolius*)
Spring cress (*Cardamine bulbosa* f. *fontinalis*)
Water cress (*Rorippa Nasturtium-aquaticum*)
White water crowfoot (*Ranunculus longirostris*)
Water speedwell (*Veronica connata*)
Water starwort (*Callitriche heterophylla*)
Water pimpernel (*Samolus parviflorus*)
Field mint (*Mentha arvensis* var. *glabrata*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Shining pondweed (*Potamogeton lucens*)
Bur-reed (*Sparganium americanum*)
Broad-leaved arrowhead (*Sagittaria latifolia*)
Little duckweed (*Lemna minor*)
Creeping spike rush (*Eleocharis calva*)
Knotty-leaved rush (*Juncus acuminatus*)
Fowl meadow grass (*Glyceria striata*)
Rice cut grass (*Leersia oryzoides*)
Liverwort (*Marchantia*)
Liverwort (*Dumortiera hirsuta*)
Liverwort (*Riccia fluitans*)

HAHATONKA SPRING (Plate XVI)

Located in sec. 2, T. 37 N., R. 17 W., at Hahatonka, Camden County. The outlet appears at the base of a high, limestone bluff. The color of the water is greenish gray-blue. At the very beginning, in deep water, are large beds of milfoil, alternating with water cress. Along the sides are rocks covered with algae and mosses. In the beginning the substratum is gravelly.

This deep basin of water continues for several hundred feet enclosed by wooded bluff slopes. All along the margin and in the center of the basin are long strands of milfoil, and along the deeper portions of the margin grow plants of hornwort. These two species are the only ones found in the basin. A low, narrow, wooded ridge extends towards the middle of the basin and divides the spring into two main branches. The right spring branch runs along the base of a precipitous, rocky wall and is deep. The only plants which occur in it are hornwort, milfoil, and occasionally water cress.

The left spring branch is very rich in aquatic plants. It is narrow, about 10 to 12 feet wide, and has a deep blue-gray color. Here are beds of broad-leaved, purple or green mild water pepper, bur-reed, water starwort, and water speedwell, the last very abundant. Mild water pepper grows where the current is fastest, while bur-reed occurs mostly along the margin of the branch.

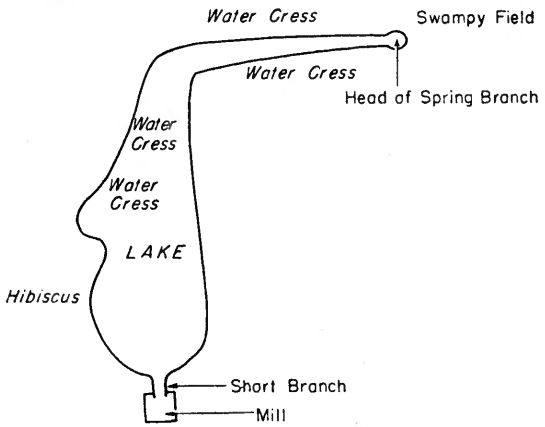
The spring empties into the Niangua River about a half-mile away from its source.

LIST OF SPECIES

Water milfoil (*Myriophyllum heterophyllum*)
Hornwort (*Ceratophyllum demersum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Mild water pepper (*Polygonum hydropiperoides*)
Bur-reed (*Sparganium americanum*)
Water speedwell (*Veronica connata*)
Water starwort (*Callitriche heterophylla*)

HAZLETON SPRING (Plate XVI)

Located in sec. 34, T. 33 N., R. 10 W., at Hazleton, Texas County. It rises in a 5-acre lake "formed by a dam in the spring branch, which is used to run a grist mill," and empties into Piney River 500 feet



below the mill. The lake lies in a field in a swampy section. The branch is bordered by dense masses of water cress, with which occur horned pondweed and bur-reed, and the lake is surrounded by clumps of silky willow (*Salix sericea*). The swampy ground is further inhabited by black willow (*Salix nigra*), ladies' thumb (*Polygonum lapathifolium*), panic grass (*Panicum dichotomiflorum*), swamp dock (*Rumex verticillatus*), masses of tear thumb (*Polygonum sagittatum*), and plants of swamp mallow (*Hibiscus lasiocarpos*).

The water cress grows along both sides of the spring branch, and where the latter curves around a great bend of standing water there are many plants of water starwort and masses of *Ricciocarpus* and greater duckweed.

The branch gradually widens into a long lake, at the other end of which is the grist mill. Along one side of the lake is a bay. Much swampy ground, overgrown with alder (*Alnus rugosa*), spreads around the bay. Below the bay and along one side of the lake are many plants of swamp mallow, associated with ladies' thumb and

cocklebur (*Xanthium chinense*). In this portion of the lake are many clumps of bur-reed. The chief plants of the lake, however, are water cress and water-weed. With them are associated submerged masses of *Riccia fluitans* and hornwort. Towards the end of the lake near the mill grow many plants of water-weed with milfoil and pondweed (*Potamogeton foliosus* var. *genuinus*). Plants of water purslane occur along the margin.

A short branch flows from the lake to the grist mill and then empties 500 feet below the mill.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Bur-reed (*Sparganium americanum*)
Water starwort (*Callitriche heterophylla*)
Greater duckweed (*Spirodela polyrhiza*)
Water-weed (*Anacharis occidentalis*)
Hornwort (*Ceratophyllum demersum*)
Milfoil (*Myriophyllum heterophyllum*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Water purslane (*Ludvigia palustris* var. *americana*)
Liverwort (*Riccia fluitans*)
Liverwort (*Ricciocarpus* sp.)

HODGSON MILL SPRING (Plate XVII)

Located in sec. 34, T. 24 N., R. 12 W., near Sycamore, Ozark County. The water, which flows from the narrow mouth of a cave, is dark green-blue in color, and about 15 feet deep. It then flows into an almost circular, rock-walled basin, about eight feet deep, 50 feet wide one way, and about 30 feet the other. In this basin occurs water starwort, water speedwell, water cress, bur-reed, and milfoil, the last species the most common. The water then flows over a dam. It has a direct fall of nine feet and the power is used by the grist mill erected nearby.

The spring branch formed is clear and swift-flowing, and about 50 feet wide. Milfoil is the dominant plant. It grows plentifully along the sides, leaving free only the narrow, clear, sandy, gravelly center of the spring branch. Scattered beds of bur-reed occur in the branch, and along the muddy bottoms are occasional clumps of water starwort, bronze-green plants of pondweed, and dark copper-red and green plants of water purslane. Most of the bur-reed is found on the left side of the spring branch. Also on the left side are occasional plants of white water crowfoot, in the mud, and plants of the fresh-water red alga, *Batrachyspermum*, which grows in the main current of the water.

Along the margin of the spring branch, and towards its confluence with Bryant Creek, occurs horned pondweed. The substratum in this portion of the branch is a yellow-gray, sandy mud. At and near

the confluence are a few plants of water star-grass. The water then flows into Bryant Creek over a ledge covered with mud from the branch.

Throughout the course of the branch milfoil predominates.

LIST OF SPECIES

Water starwort (*Callitriche heterophylla*)
Water speedwell (*Veronica connata*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Bur-reed (*Sparganium americanum*)
Milfoil (*Myriophyllum heterophyllum*)
Pondweed (*Potamogeton foliosus* var. *macellus*)
Water purslane (*Ludvigia palustris* var. *americana*)
White water crowfoot (*Ranunculus longirostris*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water star-grass (*Heteranthera dubia*)
Fresh-water red alga (*Batrachyspermum*)

HOWE'S MILL SPRING

Located in sec. 15, T. 34 N., R. 3 W., at Howe's Mill, Dent County. It arises as a dammed-up lake basin filled with a species of *Chara*, water cress, pondweed, and bur-reed. The branch from the basin runs into Howe's Mill Branch, which empties into Huzzah Creek.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Bur-reed (*Sparganium americanum*)
Chara sp.

KEENER SPRING (Plates VII and VIII)

Located in sec. 9, T. 26 N., R. 5 E., one mile northwest of Keener, Butler County. The water flows from several places at the base of a brown and gray, dolomitic limestone bluff, 20 feet high. At its outlet there are only algal and moss-covered rocks. The spring is shallow but broad, since it flows from several outlets over the gravel. After flowing over shallow gravel for 20 feet with a stream bed 20 feet broad, the spring falls over a large rock pile and broadens out. In deep water away from the current at the base of the bluff and away from the outlet is flowering water milfoil.

Another spring enters the valley from the north and flows 100 feet into the same water into which the main spring flows. The former is loaded along its sides with water milfoil.

From the first rock pile, which forms a dam, the water goes over a second rock pile, then empties into a main branch which is about 40 feet wide at first. The main branch then enters a large basin and from here it commences to flow over gravel; the water is clear down the entire course.

About 100 feet down the branch the first plants of water cress occur, being found along the margins away from the main current. The branch then bends abruptly here, and water milfoil grows in the shallow current, assuming a dark green color, but red at the tips; it grows prostrate, with roots sent out from the stems into the gravel. The plant is reddish purple and green. At this bend, in shallow mud along the margin, grow water-weed, water milfoil, a little water cress, some water purslane, pondweed with a dull, pale brown color, and water milfoil, rooting in the mud and with its dissected leaves resembling milfoil (*Myriophyllum scabratum*). Along the muddy shore occur whorled loosestrife (*Lysimachia longifolia*), primrose-willow (*Jussiaea decurrens*), broad-leaved arrowhead (*Sagittaria latifolia*), and tooth-cup (*Rotala ramosior* var. *interior*).

Farther down the branch in swift-running, shallow water near the margin is a bright green pondweed in long strands. Water milfoil, in strands four feet long, is dominant and commoner than water cress, forming beds of dull bronze-green all along the margin of the stream.

On a muddy bar or "island" in the latter half of flow of the branch, along its margin mostly in mud where there is a slight current, is found horned pondweed, growing mostly loose and not in its usual dense, green mats. It has a rich, grass-green color. It occurs with water milfoil.

After flowing for 600 feet, and averaging six inches deep and 12 to 15 feet broad, the branch enters Black River.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Water purslane (*Ludvigia palustris* var. *americana*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water-weed (*Anacharis occidentalis*)
Water milfoil (*Myriophyllum heterophyllum*)

KRATZ SPRING (Plate XVII)

Located in sec. 19, T. 41 N., R. 2 W., four miles west of Stanton, Franklin County. The water bubbles up from three places in a gravel bed, forming the beginning of Spring Creek. It arises in a cultivated field. The spring makes several semicircular loops, and then forms one main branch which flows a very swift current with clear, greenish blue water over a gravel substratum. On one side of the branch is the valley; on the other side are low, wooded bluff slopes. The dominant plants of the branch are water cress and bur-reed. Quantities of moss grow on the rocks in the branch.

In the lower quarter of the branch, in a muddy place away from the main current of the spring, is a colony of water speedwell. In one deep place along the margin are plants of *Nitella*. The branch flows a distance of one-fourth mile before emptying into Spring Creek.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Bur-reed (*Sparganium americanum*)
Water speedwell (*Veronica connata*)
Nitella sp.

MABREY SPRING

Located near the mouth of Big Barren Creek, sec. 3, T. 25 N., R. 1 E., five and one-half miles northeast of Bennett, Ripley County. The spring rises in a valley and issues from a small opening at the base of a rocky, cherty, limestone hill, flowing into a lake-like basin. Along the margin of the lake grow white water crowfoot, tooth-cup (*Rotala ramosior* var. *interior*), *Eryngium prostratum*, clammy hedge hyssop (*Gratiola lutea*), and needle spike rush. In the water of the lake occur hornwort, horned pondweed, water starwort, large-leaved pondweed, forming large colonies in the lake, milfoil, and water-weed.

From the lake a spring branch flows one-fourth mile to empty into Current River. Floating in still water of the branch are a liverwort (*Ricciocarpus*), and duckweed.

LIST OF SPECIES

White water crowfoot (*Ranunculus longirostris*)
Needle spike rush (*Eleocharis acicularis* var. *typica*)
Hornwort (*Ceratophyllum demersum*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water starwort (*Callitriche heterophylla*)
Large-leaved pondweed (*Potamogeton amplifolius*)
Milfoil (*Myriophyllum heterophyllum*)
Water-weed (*Anacharis occidentalis*)
Duckweed (*Lemna valdiviana*)
Liverwort (*Ricciocarpus*)

MARKHAM SPRING

Located in sec. 23, T. 27 N., R. 4 E., three miles west of Williamsville, Wayne County. "It rises in a small natural lake and empties into Black River a half-mile away." The lake is full of plants. In the deepest portion of it, near the center, the color of the water is deep blue. The commonest plant of the lake is milfoil; it has purplish red stems, and occurs in the deepest waters as well as elsewhere throughout the water. Along the deep margins grow light green plants of bur-reed, some of the plants growing in deep water and having long leaves. Dark green plants of hornwort are scattered along the margin, while along the muddy shore occur plants of creeping spike rush. Horned pondweed is rather common along the margin. Shin-

ing pondweed is very common, and occurs from near shore towards deeper water in the center.

The spring branch flowing from the lake has many aquatic plants. Water-weed, bur-reed, and needle spike rush are found commonly along the stream. On a sandy riffle exposed to the sun, where a road crosses the branch about halfway down, are plants of horned pondweed, which is found also in a slough at one end of the lake. Plants of water purslane with brownish red and green leaves occur here and there along the branch. In shaded, swift-running water, water star-grass grows in long, leafy strands, all the plants in a vegetative state with long internodes, while on sunny portions of the branch, creeping on the mud, are found flowering plants of this species with short stems and crowded internodes. Water speedwell occurs about halfway down the branch, then continues commonly as far as the confluence of the branch with Black River.

Near the confluence the water flows more slowly and runs over a more muddy substratum. In this slower water occurs Ozark spatterdock. In a slough back of the lake are plants of long-leaved pondweed (*Potamogeton americanus*), creeping on the mud, with short stems and crowded internodes, and also plants of naiad.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Bur-reed (*Sparganium americanum*)
Hornwort (*Ceratophyllum demersum*)
Creeping spike rush (*Eleocharis calva*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Shining pondweed (*Potamogeton lucens*)
Water-weed (*Anacharis occidentalis*)
Needle spike rush (*Eleocharis acicularis* var. *typica*)
Water purslane (*Ludvigia palustris* var. *americana*)
Water star-grass (*Heteranthera dubia*)
Water speedwell (*Veronica connata*)
Ozark spatterdock (*Nuphar ozarkanum*)
Naiad (*Najas guadalupensis*)

MERAMEC (MARAMEC) SPRING

Located in sec. 1, T. 37 N., R. 6 W., six miles southeast of St. James, Phelps County. "The water issues from a circular basin at the base of a rocky cliff, spreads and falls over the remains of an old rock dam, and flows swiftly down the spring branch one mile into Meramec River."

The main portion of the spring is too deep for aquatic plants, but farther down, as the water becomes shallower, strands of milfoil can be seen in the center. Along the sides of the deep portion are water cress, bur-reed, which roots in the gravel, needle spike rush, and flowering plants of the aquatic phase of annual bluegrass. Around the main, deep portion of the spring are arching limbs of American

linden (*Tilia glabra*), and along the sides are trees of hop hornbeam (*Ostrya virginiana*).

The spring then narrows into a broad branch which contains some water-weed. The branch cascades down the remains of the old rock dam, where there are green, moss-covered rocks with mats of water cress growing between them. Below the cascades occur peppermint and a liverwort (*Porella pinnata*).

At this point a small bridge crosses the spring branch, and below the bridge the shallow water flows swiftly over a gravel bottom. In the shallow stream are many moss- and algae-covered rocks, but water cress is the chief species of aquatic seed plant occurring here; it is found along the sides of the branch. Occasionally there are seen in this portion of the spring strands of milfoil and bur-reed. These latter species are found along the depositional area of the branch farthest away from the main current of the spring.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Bur-reed (*Sparganium americanum*)
Needle spike rush (*Eleocharis acicularis* var. *typica*)
Annual bluegrass (*Poa annua* var. *reptans*)
Water-weed (*Anacharis occidentalis*)
Peppermint (*Mentha piperita*)
Liverwort (*Porella pinnata*)

MILL CREEK SPRING

Located in sec. 19–30, T. 22 N., R. 23 W., four miles southwest of Radical, Stone County. The water rises as a small outlet in a ravine and flows a short branch 50 feet long which empties into White River. The branch flows with a smooth trickle over a gravel bottom. The only plants are water cress, pondweed, water mosses, and algae.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Water mosses
Algae

MILL SPRING

Located in sec. 36, T. 28 N., R. 3 E., at the town of Mill Spring, Wayne County. The water bubbles out into an oblong basin at the base of a limestone bluff near the Missouri Pacific Railroad, and is used by the company to furnish water for locomotives. The water in the basin is clear and blue. Along the margins and growing also in the water of the main spring basin, is peppermint, although the chief aquatic plants of the spring basin are russet-bronze and green clumps of water-weed, growing with shining pondweed and

a liverwort (*Porella*). Annual bluegrass and peppermint grow along the margins of the spring.

The spring branch then flows in a grassy, cultivated valley one-fourth mile before emptying into Black River. At first the branch has a gravel bottom covered in places by beds of dull greenish red water-weed, light green horned pondweed, and peppermint. Farther down, the bottom becomes more muddy. Stretches of sand alternate with mud farther along and are covered by large patches of light green horned pondweed and brown-red water-weed. Submerged plants of red top grass along the margins of the spring branch here add a blue-green cast of color to the varied greens.

Proceeding farther down the spring branch, bright olive-green plants of pondweed in long strands are found. These occur in the lower portion of the stream. Growing here in the water are plants of sour dock (*Rumex crispus*). Along the margin grows butter weed (*Senecio glabellus*). The mouth of the branch at its confluence with Black River is covered with beds of spike rush.

LIST OF SPECIES

Peppermint (*Mentha piperita*)
Water-weed (*Anacharis occidentalis*)
Shining pondweed (*Potamogeton lucens*)
Annual bluegrass (*Poa annua* var. *reptans*)
Red top grass (*Agrostis stolonifera*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Spike rush (*Eleocharis Smallii*)
Liverwort (*Porella* sp.)

MILL POND

Located in sec. 18, T. 23 N., R. 15 W., at Hammond, Ozark County. The spring rises in a lake formed by the damming of two branches. Quantities of Ozark spatterdock occur all around the margins of the pond. At the far end is water purslane, while milfoil is found at the lower end of the pond. Pondweed occurs below the dam along the creek, which emerges at one end of the lake and eventually flows into Little North Fork of White River.

LIST OF SPECIES

Ozark spatterdock (*Nuphar ozarkanum*)
Water purslane (*Ludvigia palustris* var. *americana*)
Milfoil (*Myriophyllum heterophyllum*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)

MILLER SPRING

Located in sec. 6, T. 34 N., R. 10 W., three miles north of Big Piney post office, Pulaski County. The spring bubbles up in a more or less circular pool about 30 to 40 feet wide at the base of a wooded, cherty slope. The color of the water is a turbid green-blue. The main part of the spring is devoid of plant life, except for a few scattered plants of white water crowfoot.

The spring branch which issues forth flows through low woods of sycamore (*Platanus occidentalis*) and black willow (*Salix nigra*). At the head of the branch, where the road crosses it, are grass-green rosettes of peppermint, and following down the branch a large variety and abundance of aquatic plants are found. Here occur water starwort, water cress (not so common), water-weed, light green plants of shining pondweed, bronze-green plants of pondweed (*Potamogeton foliosus* var. *genuinus*), white water crowfoot, with dark green leaves and grass-green stems, horned pondweed occurring in long, light green strands streaming in the current in the middle of the spring branch, submerged and light green plants of water speedwell, and water purslane, which has olive-green leaves with red and orange at the tips.

At first the spring branch flows over a cherty, gravelly substratum and is shallow, with many curves. Proceeding down the branch, the substratum becomes muddy as more silt is deposited. On the deeper mud farther down the branch are some plants of mud plantain. Near the mouth of the branch in deep water are long, sterile strands of plants of water star-grass, some of whose leaves are almost 1 cm. broad. In this same area occur dark green fragments of plants of hornwort along the muddy bottom in deep water. At its confluence with Big Piney River the spring branch broadens out to 90 feet. The distance from the head to the mouth of the branch is about one-fourth mile.

Of all the species in the spring branch, the three commonest are water starwort, horned pondweed, and water-weed. A striking feature is the absence of milfoil, which is one of the commonest species of Missouri springs.

LIST OF SPECIES

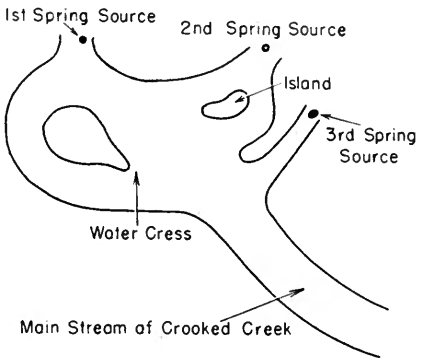
Peppermint (*Mentha piperita*)
Water starwort (*Callitriche heterophylla*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water-weed (*Anacharis occidentalis*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water speedwell (*Veronica connata*)
Water purslane (*Ludvigia palustris* var. *americana*)
Mud plantain (*Alisma subcordatum*)
Water star-grass (*Heteranthera dubia*)
Hornwort (*Ceratophyllum demersum*)
White water crowfoot (*Ranunculus longirostris*)
Shining pondweed (*Potamogeton lucens*)

MONTAUK SPRING (Plate XII)

Located in SE. ¼ sec. 22, T. 32 N., R. 7 W., a half-mile north of Montauk, in Montauk State Park, Dent County. In the beginning Montauk Spring is made up of several sources which head in a low-land woods of American elm (*Ulmus americana*), while the spring sources themselves are surrounded by Ward's willow (*Salix longipes*

var. *Wardii*) and smooth alder (*Alnus rugosa*). All the sources are in basins with a gravelly substratum. One of them is in a basin covered by water cress. The basin is egg-shaped, shallow, 20 feet broad and 30 feet long, with water cress and little duckweed along the margins. Then a slight amount of spring cress is seen. Away from the main current on the right side of the branch bur-reed roots in fine, muddy, sandy silt and fine gravel. In the main current and in sandy silt there is a small amount of water speedwell.

After flowing 50 feet the branch forks on either side of an island covered with sycamore (*Platanus occidentalis*) and eventually joins the



main stream of Crooked Creek. The confluence is completely filled with water cress and spring cress, the former occurring in greater quantities and growing all along the sides as well as in the main stream bed. A small amount of white water crowfoot occurs on gravel at the confluence of this spring branch and Crooked Creek.

The right spring branch is dominated by spring cress. This branch meets another branch from the extreme right (north) side. The latter fork curves in around a bed of water cress as it meets the other branch. The water cress forms here a dense, spongy mass growing mostly over deep water. Around its head on marshy land occur spotted touch-me-not (*Impatiens biflora*) and arrow-leaved tear thumb (*Polygonum sagittatum*).

Altogether three or four main sources or branches of the spring converge. All flow out from their point of origin, join, and form a main branch 30 feet broad with a depth of one to two feet of clear, sparkling, colorless water flowing rapidly over a gravel substratum.

The main stream now makes a sweeping curve. Some submerged, blue-green plants of fowl meadow grass occur here. The branch

then tumbles rapidly over larger rocks on which are scattered dark green clumps of white water crowfoot growing in swift water a foot deep. Along the margins here occurs a slight amount of water cress.

For the first 300 yards water cress, spring cress, and white water crowfoot are the predominant growth, occurring as scattered clumps with some aquatic mosses. Along the margins farther downstream grow mostly water cress and creeping spike rush. Then the branch broadens, the water here being deep and of a clear, dull blue. Mud occurs along one side and on it grow water cress and white water crowfoot. Proceeding downstream a small amount of water starwort is found growing along the muddy margin with mosses, in three feet of water. Now, most of the bottom is muddy and the stream broadens out to 50 feet.

Then the branch again flows over gravel and here are water cress, white water crowfoot, and fowl meadow grass. Proceeding downstream another one-quarter of a mile, the same conditions continue except that the stream eventually broadens to 100 feet or more, with little or no current, flowing over a muddy bottom lined on the margin with water cress. In one to three feet of water near the muddy margin are upright, dull green and olive-bronze strands of pondweed (*Potamogeton foliosus* var. *macellus*).

The water then falls three feet over a concrete dam and continues its course downstream. Water cress is dominant now. Before crossing the road which goes to the park hotel and office, it receives another branch from the right. This branch from the right contains large quantities of pondweed (*Potamogeton foliosus* var. *macellus*) and water speedwell. It and the main branch unite and flow across the road. Rooting in the gravel in shallow water are water cress and fowl meadow grass. The latter occurs in the swift, shallow portion of the water.

There is little aquatic vegetation besides water cress from the last point farther downstream until the branch curves sharply to the left and flows along the base of the bluffs. Here it receives the spring branch of Bubbling Spring, which originates farther up the valley on the west side, and will be described later. Now there occur many plants of pondweed, water speedwell, horned pondweed, water starwort, and water cress. This branch continues downstream, becoming larger and deeper, and forms the main source of Current River.

Additional Features.—On the right side of the valley of the spring branch is Bubbling Spring, which arises as a circular pool

eight feet in diameter in a depression in a swampy meadow. The water bubbles up from a soft, gray-brown, sandy mud. Water cress immediately clogs its branch. The branch curves around from the pool and flows along limestone bluffs. A large thicket of silky willow (*Salix sericea*), *Hibiscus lasiocarpos*, and smooth alder (*Alnus rugosa*) grow in the swampy meadow here. This small branch, four feet broad and two inches to one foot in depth, flows gently over a sandy, silty bottom, its margins lined with water cress and broad-leaved arrowhead. Farther down this branch at the base of the bluffs is a slough-like part without any noticeable current, and filled with white water crowfoot. Finally, after passing this slough, the branch flows around at the base of the bluffs and empties into the main branch described above.

The other spring branch which meets the main branch just before it crosses the road leading to the park hotel and office may be described to its source as follows: It starts originally from the base of high bluffs on the west or right side of the valley, directly opposite the portion of the valley (east side) where the three or four main sources of Montauk Spring occur. However, the original source of the outlet of the spring at the base of bluffs on the west side of the valley has been dammed to form a lake of dark blue-green color, whose water is very deep. The lake is about 1,000 feet long and 200 feet broad. In it now grow in water 5 to 10 feet deep, along the sides of the slopes and bluffs, long strands of water purslane, pondweed (*Potamogeton foliosus* var. *genuinus*), and white water crowfoot. Some water cress occurs along the margin. It is the water originating from this spring source by the bluff on the west side which forms a series of lakes and hatchery ponds. Some plants of water starwort and bur-reed occur along the deep margins. Also submerged here is water cress. The original spring here has been covered from 5 to 10 feet deep. Near its head are large quantities of bur-reed. In part of the narrow, spring-fed channel, along the base of the bluffs, submerged 5 to 10 feet, occur plants of water plantain and water purslane.

After leaving the lake the water flows over a concrete dam and makes a waterfall about 25 feet high. This water forms the main right branch which flows down the valley along the main road leading through Montauk Park. It is this branch which possesses the most plentiful supply of aquatic plants. It has variations of substratum, but is mainly of a gravel type.

The branch varies in depth from six inches at the base of the fall to four or five feet in other places. Where the water is deep, it is of a green-blue color. One of the commonest plants in the branch is pondweed (*Potamogeton foliosus* var. *macellus*), with long green strands. White water crowfoot forms here solid beds three feet in length. Also common in this spring branch are submerged plants of water speedwell, in dense, light green mats. Water cress occurs along the margins and grows submerged also. In one to two feet of water are some plants of water starwort. Mats of pondweed (*Potamogeton foliosus* var. *macellus*) grow with mats of water speedwell, and plants of the latter also occur with large beds of white water crowfoot. In addition, one finds reddish or brick-colored clumps of water purslane. Occurring occasionally along the margins in deep, quiet water are floating or rooting mats of a dark green species of alga (*Chara*). The commonest plants in this branch are pondweed (*Potamogeton foliosus* var. *macellus*) and white water crowfoot.

In the fish hatcheries between the main spring-fed lake (just described in the preceding section) and the main spring branch of Montauk Spring (described in the beginning of the report) are a series of ponds with muddy bottoms. These contain submerged plants of the alga (*Chara*), and pondweed (*Potamogeton foliosus* var. *macellus*), which have mostly died owing to the rapid drainage of the ponds followed by their refilling. Here occur a variety of plants characteristic of quiet water and mud substratum, such as water plantain, false pimpernel, and water purslane. Creeping spike rush is present around the margins.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Little duckweed (*Lemna minor*)
Spring cress (*Cardamine bulbosa* f. *fontinalis*)
Bur-reed (*Sparganium americanum*)
Water speedwell (*Veronica connata*)
Fowl meadow grass (*Glyceria striata*)
White water crowfoot (*Ranunculus longirostris*)
Creeping spike rush (*Eleocharis calva*)
Water starwort (*Callitriche heterophylla*)
Pondweed (*Potamogeton foliosus* var. *macellus* and var. *genuinus*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Broad-leaved arrowhead (*Sagittaria latifolia*)
Water purslane (*Ludvigia palustris* var. *americana*)
Water plantain (*Alisma subcordatum*)
False pimpernel (*Lindernia dubia* var. *typica*)
Chara sp.

MOSSY SPRING

Located in sec. 2, T. 36 N., R. 11 W., three miles west of Hooker, Pulaski County. It rises in a field along the Gasconade River and flows a small branch three feet wide and about one-half foot deep. The water is clear and flows over a gravel substratum for a few

hundred feet. The branch empties into Gasconade River. Water cress is the only higher aquatic plant found in the water.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)

OLD POND

Located in sec. 35, T. 23 N., R. 16 W., two miles southeast of Long Run, Ozark County. This is a spring-fed slough located in a valley along Pond Fork Creek, the slough fed by a small spring which issues from a low slope. In the immediate spring occurs water starwort. In the slough, which has a muddy bottom, grows a great variety of aquatic plants. Floating on the still water are lesser duckweed, greater duckweed, bladderwort, and a liverwort (*Ricciocarpus*). In the slough are milfoils, *Myriophyllum heterophyllum* and *M. scabratum*, the latter rooting along the muddy margins. Common all along the margin of the slough are quantities of bur-reed, growing with water speedwell, water purslane, and cat-tail. On the bottom are plants of a species of *Chara*. At one end of the slough is lotus. Here along the shore grow knotty-leaved rush, chairmaker's rush, and rice cut grass.

LIST OF SPECIES

Water starwort (*Callitriche heterophylla*)
Lesser duckweed (*Lemna papulifera*)
Greater duckweed (*Spirodela polyrhiza*)
Bladderwort (*Utricularia gibba*)
Milfoil (*Myriophyllum heterophyllum*)
Milfoil (*Myriophyllum scabratum*)
Bur-reed (*Sparganium americanum*)
Water speedwell (*Veronica connata*)
Water purslane (*Ludvigia palustris* var. *americana*)
Cat-tail (*Typha latifolia*)
Lotus (*Nelumbo pentapetala*)
Knotty-leaved rush (*Juncus acuminatus*)
Chairmaker's rush (*Scirpus americanus*)
Rice cut grass (*Leersia oryzoides*)
Liverwort (*Ricciocarpus*)
Chara sp.

ONANDAGO SPRING[1] (Plate XIX)

Located in sec. 35, T. 39 N., R. 3 W., five and one-half miles southeast of Leasburg, Crawford County. It rises at the base of a limestone bluff 25 feet high in a ravine and flows into a large basin filled with deep, murky blue water. The basin is 150 feet long and 60 feet wide. Along its sides the rocks are covered with masses of dirty yellow-brown and green-yellow algae. Milfoil is the common and dominant plant in the spring basin. It occurs mostly along the margins of the basin and is covered with algae. A small amount of water cress and water starwort grows along the side of the basin. Just before the water of the basin plunges over a cataract are clumps of the fresh-water red alga, *Batrachyspermum*.

[1] Sometimes spelled Onondaga.

Then the water flows as two cataracts over rocks and the resulting spring branch flows 150 feet into a small branch filled with moss-covered rocks, water cress, and water starwort. The stream then makes a sharp bend to the left and enters the valley of the Meramec River. The branch is now broad (25 feet) and has a murky, milky blue color with deep water flowing over a muddy substratum. The chief plants in the branch here are water-weed and water starwort, the latter plant here very foliose, with a broad-leaved growth throughout. Along the margin of the branch the water starwort and water cress form most of the plant growth, being conspicuous and floating along the margin. In depressions of sandy mud in the middle of the branch are occasional large colonies of dark grass-green plants of horned pondweed with fine, long leaves. Bronze-red clumps of milfoil occur along the margin. In one place, rooting in the mud, are dull olive-green plants of shining pondweed. By far the largest masses of plant growth in the spring branch are water-weed, which gives the water a black appearance wherever it occurs in large masses rooting in deep mud. A few plants of hornwort root along the muddy bottom and have a dark bronze-green color. Where the latter grows with milfoil, as it here does, the two, which resemble one another superficially, may be distinguished quickly if it is noted that the leaves of milfoil spread horizontally, while those of hornwort curve upward.

After flowing down the valley in a more or less straight course for 200 yards, the branch makes a right turn across the road, and flows for 100 feet with water cress and water starwort. It then makes another right bend, and flows into alluvial woods of river birch (*Betula nigra*) and black willow (*Salix nigra*). Here, where the branch is cluttered with brush, there is no vegetation, and it has muddy, gravelly margins. In the lower portion of its flow, the branch widens and joins the river as a slough about one-half mile long. There are no aquatic plants in this slough.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water starwort (*Callitriche heterophylla*)
Water-weed (*Anacharis occidentalis*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Shining pondweed (*Potamogeton lucens*)
Hornwort (*Ceratophyllum demersum*)
Fresh-water red alga (*Batrachyspermum* sp.)

PAYDOWN SPRING

Located in SW. ¼ sec. 2, T. 40 N., R. 8 W., near Paydown post office, Maries County. The spring bubbles up from the

gravel in several places along the stream bed in a lowland wooded valley dominated by Shumard oak (*Quercus Shumardii*), sycamore (*Platanus occidentalis*), shagbark hickory (*Carya ovata*), mulberry (*Morus rubra*), and American elm (*Ulmus americana*).

In the beginning the spring flows through a cover of water cress which has started growth on the gravel. One branch from the left starts out surrounded by rice cut grass, sedge (*Carex Frankii*), fowl meadow grass, honewort (*Cryptotaenia canadensis*), wood reed grass (*Cinna arundinacea*), and hog peanut (*Amphicarpa comosa*). This branch flows a narrow stream 40 feet long, lined heavily with water cress.

The other right branch begins in the gravel bed on the other side as a sort of continuation of an underground stream and for about 200 yards contains water cress, aquatic mosses, algae, and, along the edges, bur-reed. This main branch meets another spring branch which starts in the gravel bed of another part of the valley. The bur-reed roots in the gravel. The water here has a murky, gray-blue color and flows rather rapidly over a gravel bottom. As the branch continues, one finds quantities of bur-reed and water cress. The sedges (*Carex lurida, C. Frankii*) and common bulrush (*Scirpus atrovirens*) occur in wet soil along the banks.

This small branch then joins the main branch, which forks almost immediately at a gravelly place and runs two branches. These continue separately for 50 or 75 yards. The right branch has a slow current, while the left one has a faster current with more volume. The right branch has a liverwort (*Porella*) along its sides.

After uniting with the main spring branch, the course makes several turns. The water becomes deeper, with less current. In some places along the gravelly margins only water cress occurs, while in other portions no higher type of plant life is found. Parallel to the branch at this point is a slough of still water with a mud bottom, at the base of a hill slope. In it are quantities of milfoil and bur-reed.

Farther down the branch, rooting in the gravel along the sides as well as in the middle of the stream bed, is water speedwell. Throughout the course of the spring flow, water cress remains dominant. Annual bluegrass occurs here also, growing on the gravel in swift water, and flowering.

The water speedwell increases in abundance down the lower half of the main spring branch, growing mostly in running water

in the current in midstream. Most of it is in sterile condition, and only where the plants are growing in the more quiet margins do they flower much. Along the margins in wet, muddy ground away from the current occurs water plantain.

As the flow of water continues downstream, it becomes deep and still, and assumes a murky, gray-blue color. No higher water plants occur in some places. After making a bend around a mill, the water flows over a slightly muddy, gravel bottom. Here the branch widens and along the muddy margins away from any current is horned pondweed of a grass-green color. This plant is common here all along shallow muddy islands, bars, and margins, and in one muddy place occurs water purslane. Then the branch continues over a gravel bottom with water cress growing here and there.

On its course down the remainder of the valley, the spring branch makes several curves, in some places being much narrower than in others. There is, for the most part, no water cress here and little of any other form of higher plant life.

In places along the gravel in the current of the branch horned pondweed grows. The branch in the lowest portion of its flow is narrower than just above and below the mill, then it widens and becomes deeper just before reaching the Gasconade River around another bend. Next it grows narrower and flows swiftly over gravel, with annual bluegrass and horned pondweed. In one place waterweed occurs on gravelly mud along the margin in quiet water. The branch makes some large sweeping bends, and becomes a deep, slow, murky-muddy stream just before entering Gasconade River. Lizard's-tail (*Saururus cernuus*), monkey flower (*Mimulus alatus*), broad-leaved arrowhead (*Sagittaria latifolia*), and cocklebur (*Xanthium chinense*) occur along the banks at the confluence.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Bur-reed (*Sparganium americanum*)
Milfoil (*Myriophyllum heterophyllum*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water speedwell (*Veronica connata*)
Water plantain (*Alisma subcordatum*)
Water purslane (*Ludvigia palustris* var. *americana*)
Water-weed (*Anacharis occidentalis*)
Annual bluegrass (*Poa annua* var. *reptans*)
Liverwort (*Porella* sp.)

PHILLIPS SPRING

Also called Twin Springs. Located in sec. 10, T. 25 N., R. 1 E., 12 miles southeast of Van Buren, Carter County. The water bubbles out of the gravel as two outlets at the base of a ledge of limestone rock about four feet high. One outlet is about 10 feet in diameter,

the other 20 feet. In the portions of the outlets which are constantly bubbling up, there are no water plants.

Soon the water rushes over some gravel and moss-covered boulders. Along the side of one of the outlets are light green plants of needle spike rush and along the sides of both outlets occur purplish red plants of mild water pepper.

Away from the current of the spring water a slough is found about 50 feet downstream. In it are mild water pepper, water cress, and water-weed. Bur-reed and water cress grow in another slough near one of the outlets and about 20 feet distant from the first.

The spring branch then rushes down the valley along wooded, limestone slopes, passing swiftly over a gravelly bottom where there is very little plant growth. There are found in this part of the branch only some algae and mosses on the rocks in the current of the branch. Along the sides of the branch and away from the main current are water cress, bur-reed, and purplish red, submerged plants of mild water pepper, and on the side near the bluff is a colony of water-weed.

The branch then turns to the right and flows in a deep slough which empties into Current River. The bottom of the slough is covered with a deposit of mud and in the deeper and more quiet, clear water occur for the first time plants of shining pondweed and milfoil. Mild water pepper also is found here, while of uncommon and spotted occurrence is water speedwell. Hornwort grows plentifully on the muddy bottom in the quiet water. The plants of hornwort are of a dark green color, while nearby in places occur reddish green clumps of water purslane, with large leaves. There are only a few plants of bur-reed in the slough.

The spring branch flows about one-fourth mile before emptying into Current River.

LIST OF SPECIES

Needle spike rush (*Eleocharis acicularis* var. *typica*)
Mild water pepper (*Polygonum hydropiperoides*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water-weed (*Anacharis occidentalis*)
Bur-reed (*Sparganium americanum*)
Shining pondweed (*Potamogeton lucens*)
Milfoil (*Myriophyllum heterophyllum*)
Water speedwell (*Veronica connata*)
Hornwort (*Ceratophyllum demersum*)
Water purslane (*Ludvigia palustris* var. *americana*)

PINEY SPRING

Located in SE. ¼ sec. 4, T. 35 N., R. 8 W., one and one-half miles southeast of Yancy Mill post office, Phelps County. The spring issues from the base of a small, semicircular, limestone bluff,

the water very deep and murky blue in color. Growing in the spring is a small amount of water starwort. A spring branch then passes down the valley; its banks and bottom are muddy. The chief plant in and along the branch is water cress, and in one place is a plant of horned pondweed. The spring flows 500 feet, with very little plant life, before emptying into Little Piney River.

LIST OF SPECIES

Water starwort (*Callitriche heterophylla*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Horned pondweed (*Zannichellia palustris* var. *major*)

PREWETT SPRING (Plate XVIII)

Also called Mammoth Spring. Located in Pulaski County in sec. 32, T. 34 N., R. 10 W., one mile north of Edanville, Texas County. It issues from the base of a bluff and flows into Big Piney River. Around the head of the spring occur plants of mad dog skullcap (*Scutellaria lateriflora*) and willow herb (*Epilobium coloratum*). There are many moss-covered rocks in the spring, with some plants of water cress, spring cress, and water starwort.

Proceeding down the spring branch there are plants of duckweed, horned pondweed rooting in the gravel, water speedwell, water-weed, bur-reed, and in one place halfway down the branch, a clump of water starwort. Along the margins grow mild water pepper, broad-leaved arrowhead, and sticktight (*Bidens cernua*).

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Spring cress (*Cardamine bulbosa*)
Water starwort (*Callitriche heterophylla*)
Duckweed (*Spirodela polyrhiza*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water speedwell (*Veronica connata*)
Water-weed (*Anacharis occidentalis*)
Bur-reed (*Sparganium americanum*)
Mild water pepper (*Polygonum hydropiperoides*)
Broad-leaved arrowhead (*Sagittaria latifolia*)

PULLTIGHT SPRING

Located in NE. ¼ sec. 4, T. 30 N., R. 5 W., five miles south of Akers, Shannon County. "The water flows from the rocks at the base of a rocky cliff and after passing over three small dams with a combined height of about 10 feet it empties into Current River 500 feet away. The spring is located in a small valley which has a club house in it."

Along the margin of the spring proper at the base of the bluff grow water-weed and white water crowfoot, the latter species rooting in the mud. The branch which flows from the spring has quantities of water cress in it, and this plant is dominant all along the course

of the stream as far as the first spillway. Growing in masses with the water cress is the submerged aquatic state of spring cress. Other plants in the branch are milfoil, bur-reed, water starwort, and ivy-leaved duckweed. The last species is found in dense bunches.

At the base of the first spillway and along the branch to the second spillway occur milfoil, bur-reed, water cress, ivy-leaved duckweed, and spring cress. Along the shore here are spotted jewelweed (*Impatiens biflora*), boneset (*Eupatorium perfoliatum*), mad dog skullcap (*Scutellaria lateriflora*), and creeping love grass (*Eragrostis hypnoides*).

From the base of the second spillway to the confluence of the branch with Current River occur quantities of milfoil, water cress, and bur-reed. There is also some water starwort in this last branch.

LIST OF SPECIES

Water-weed (*Anacharis occidentalis*)
White water crowfoot (*Ranunculus longirostris*)
Milfoil (*Myriophyllum heterophyllum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Spring cress (*Cardamine bulbosa* f. *fontinalis*)
Bur-reed (*Sparganium americanum*)
Water starwort (*Callitriche heterophylla*)
Ivy-leaved duckweed (*Lemna trisulca*)

RANDOLPH SPRING

Also called Flowers Spring. Located in sec. 20, T. 30 N., R. 1 E., along highway No. 21, two and one-half miles north of Ellington, Reynolds County. The spring rises in a small slough in a cultivated field in Dry Valley, next to a farm house, and empties into Logan Creek. The spring itself bubbles up in a shed. The muddy bottom of the slough is covered with water cress, water starwort, bur-reed, and bronze-green bunches of pondweed (*Potamogeton foliosus* var. *genuinus*). These are the only species represented.

The slough is about 20 to 30 feet wide, with remains of buttonbush plants (*Cephalanthus occidentalis*). The spring branch flows from the slough and contains only plants of pondweed and water cress. The branch continues across the road, becoming small, only 10 feet wide, then flows down the valley. From this point on, no more aquatic plants occur. The branch flows into Logan Creek.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Water starwort (*Callitriche heterophylla*)
Bur-reed (*Sparganium americanum*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)

REEDS SPRING

Also called Ball's Spring. Located in sec. 28, T. 32 N., R. 1 E., one-half mile east of Centerville, Reynolds County. The water

issues at the base of a steep, wooded hill around a cultivated slope of a hill. It comes out as a narrow stream through red clay and limestone and flows into a small basin studded with sunken limestone boulders. In some places the limestone boulders surround the basin. The water is deep, dark blue, clear, and cold. This small basin has a dam across it.

From the bottom of the basin grow plants of water starwort and pondweed (*Potamogeton foliosus* var. *genuinus*), from five to six feet long, in bright green strands. The bottom is filled with dark green bunches of a species of *Chara*. There occur also masses of algae, mosses, and a little water cress.

The water then passes out through a walled dam bank into a second deep basin and is carried out in a wooden flume to a water wheel, where power is generated to operate a grist mill and to furnish electric lights for Centerville. Where the current is swift, are long, leafy strands of water starwort. Away from the current in the deep basin are pondweed (*Potamogeton foliosus* var. *macellus*), a species of *Chara*, and some water cress. The pondweed and *Chara* occur here only where the water is deep. Then the water falls over a dam and some moss-covered rocks. Water cress and peppermint grow around these rocks.

The spring branch then flows from the water wheel across the road and makes a branch 150 feet long before emptying into the West Fork of Black River. In this part of the branch grow mosses, water cress, submerged, flowering plants of annual bluegrass, and milfoil. The last is found for the first time in this part of the spring, and occurs on gravelly mud.

The water in the last part of the spring branch becomes deep near its confluence with West Fork and no higher plant life exists.

LIST OF SPECIES

Water starwort (*Callitriche heterophylla*)
Pondweed (*Potamogeton foliosus* var. *genuinus* and var. *macellus*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Peppermint (*Mentha piperita*)
Annual bluegrass (*Poa annua* var. *reptans*)
Milfoil (*Myriophyllum heterophyllum*)
Chara sp.

ROARING RIVER SPRING (Plate XVIII)

Located in sec. 27, T. 22 N., R. 27 W., seven miles south of Cassville, in Roaring River State Park, Barry County. The water issues as a strong-flowing branch from a cave at the base of a high limestone bluff, 150 to 175 feet high, the water gushing rapidly over

moss-covered boulders. Here the water is of a dark green color. Near the outlet of the cave from the bluff are dark and bright green plants of pondweed (*Potamogeton foliosus* var. *genuinus*) and water starwort.

Downstream the water becomes deeper and contains a large swaying mat, four feet long, of a species of *Nitella*. This plant continues into an artificial lake where the spring branch has been dammed. A narrow chute leads from the lake and contains pondweed (*Potamogeton foliosus* var. *genuinus*) and water starwort. Then the water rushes out over two spillways. It passes into a second lake, larger than the first artificial basin. The water in it is deep and dark green. No plants, except a slight amount of water cress, were seen in this second lake.

After leaving the lake, the water goes over a large, broad spillway and becomes a broad spring branch (about 50 feet wide). It now flows over a gravel substratum. No plants are found here. Soon the branch flows into Roaring River, but no higher plants occur at the confluence.

LIST OF SPECIES

Pondweed (*Potamogeton foliosus* var. *genuinus*)
Water starwort (*Callitriche heterophylla*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Nitella sp.

ROARING SPRING

Located in E. ½ sec. 19, T. 41 N., R. 1 W., two miles east of Stanton, Franklin County. The spring issues from a cave at the base of a limestone bluff 150 feet high, in a small branch which flows rapidly over limestone boulders covered with mosses and a liverwort (*Marchantia*). The branch is only four feet wide. The only higher plant besides mosses is water starwort. Most of the latter appears in mud near the confluence of the branch with the Meramec River, only 50 feet from the outlet of the branch.

LIST OF SPECIES

Liverwort (*Marchantia*)
Water starwort (*Callitriche heterophylla*)

ROCKBRIDGE SPRING

Located in sec. 5, T. 24 N., R. 13 W., at Rockbridge, Ozark County. It has a beautiful setting, rising as a series of springs in the bed of a lake about 1,500 feet long and 400 feet wide. The lake has a deep, bluish green or brownish green color. It is formed by a dam, which develops a head of nine feet and is used to operate a mill. The dam backs up water along beautiful, wooded bluffs

on one side. The substratum in the lake is mud. The principal plants in the lake, all in still water, on the side opposite the bluff are large clumps of milfoil, with pondweed (*Potamogeton foliosus* var. *genuinus*), horned pondweed, and a species of *Chara* along the sides.

On the side of the lake along the bluff are milfoil, bur-reed, water starwort, a species of *Chara*, pondweed (*Potamogeton foliosus* var. *macellus*), and shining pondweed.

In a slough along one side the water is filled with a species of *Chara*, milfoil, white water crowfoot, water speedwell, horned pondweed, water purslane, and sweet flag.

From the dam the water falls vertically about nine feet and then rushes down to form a spring branch which flows over a gravelly bottom. Here water speedwell, bur-reed, and mosses dominate. Farther on, scarcely any aquatic plant occurs with the exception of a slight amount of moss and scattered clumps of milfoil.

Downstream, another little spring joins the main branch and here is found a rich variety of aquatic plants, comprising bur-reed, milfoil, quantities of water speedwell, dark green clumps of a species of *Nitella*, and shining pondweed.

High limestone bluffs, as one proceeds downstream, appear along one side of the spring branch, and here, besides algae and water cress, are found many plants of water speedwell, in dense mats. The water at this place rushes over large boulders in the stream.

Then the branch curves around and flows by some high, limestone bluffs that are flanked above by Roubidoux sandstone. At this point the water is deep, clear, and of a gray-blue color. Milfoil is still common, but most of the other species have disappeared.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Pondweed (*Potamogeton foliosus* var. *genuinus* and var. *macellus*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Bur-reed (*Sparganium americanum*)
Water starwort (*Callitriche heterophylla*)
Shining pondweed (*Potamogeton lucens*)
Water speedwell (*Veronica connata*)
White water crowfoot (*Ranunculus longirostris*)
Water purslane (*Ludvigia palustris* var. *americana*)
Sweet flag (*Acorus Calamus*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Chara sp.
Nitella sp.

ROUBIDOUX SPRING (Plate IX)

Also called Waynesville Spring. Located in sec. 25, T. 36 N., R. 12 W., one-half mile from highway No. 66, at Waynesville, Pulaski County. The water, enclosed on one side by a semicircular cement wall 20 feet high, "boils up" from the ground along the road

at the base of a high, limestone bluff. In the spring basin itself the only higher aquatic plant is milfoil.

The water then flows a branch from the basin for 50 feet before emptying into Roubidoux Creek. The water of the branch is shallow and dashes over moss-covered boulders. In the spring branch water cress and milfoil are the commonest plants, the former occurring chiefly along the margin of the branch.

At the beginning of the spring branch, near its head and along the margin, are submerged flowering plants of annual bluegrass. Farther down, also along the margin, are submerged clumps of mild water pepper with olive-green and rose-colored, lanceolate leaves which are closely matted and give the plant an appearance similar to that of water purslane. On the other side of the branch, near its junction with Roubidoux Creek, are copper or rose-green plants of water purslane, growing in close mats along the gravelly substratum.

Milfoil and water cress are the commonest plants in the spring and its branch.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Bluegrass (*Poa annua* var. *reptans*)
Mild water pepper (*Polygonum hydropiperoides*)
Water purslane (*Ludvigia palustris* var. *americana*)

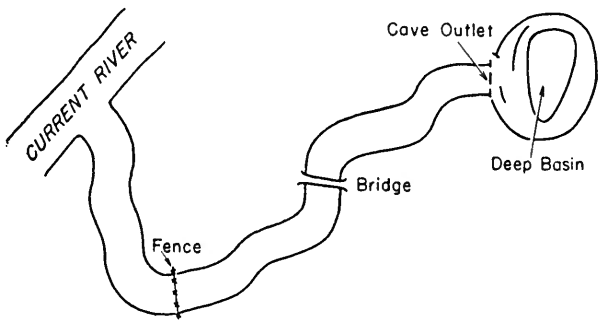
ROUND SPRING (Plates XX and XXIII)

Located in sec. 20, T. 30 N., R. 4 W., along highway No. 19, 10 miles north of Eminence, Shannon County. "The spring rises in a circular basin about 80 feet in diameter surrounded by a rock wall 30 feet high." The water in this deep hole has a prussian-blue color. The only aquatic plants here are milfoil and a small amount of water cress, both around the margin of a deep basin. The water then flows through a cave for 80 feet. Near this cave are a few plants of spring cress and rocks covered with mosses, liverworts, and green and brown flowing strands of algae.

Where the water emerges at the foot of a small hill on the other side of the cave are quantities of rocks covered with mosses and algae. Here the water is filled with many plants of milfoil coated by a growth of brown-colored algae, and water cress. Growing along the sides of the spring here are plants of knotty-leaved rush and water pimpernel.

After issuing from the cave, the spring branch flows through a part of the valley and, 700 feet from its cave outlet, empties into Current River.

The occurrence and arrangement of the aquatic vegetation from the point where the spring branch emerges from the cave to where it empties into the river are as follows: The milfoil, which was observed at the outlet by the cave, continues dominant along the course of the branch. On both sides of the stream, starting 50 feet from the cave outlet, bur-reed is common. Proceeding downstream, a rocky riffle occurs and here water cress appears, associated with moss-covered rocks, and spring cress grows along the banks. It is



here that a small bridge was built across the branch. Bur-reed is common all along the margin of the branch on one side, while water cress is plentiful along the opposite margin. Milfoil is common all the way down the branch to this point.

Farther down, mats of algae-covered milfoil and water cress harbor a colony of water speedwell. Where the water becomes shallower and flows over a pure gravel bottom, water speedwell is common. Growing directly in the water of the branch are plants of the aquatic state of spring cress, with flowering stems.

Downstream is a water-gap fence where the branch turns before emptying into the river, and here where deeper water occurs grow water-weed and water starwort.

At the junction of the branch with Current River are found milfoil and water speedwell, these being the chief species occurring here. At this point the bottom of the branch is sandy and gravelly and annual bluegrass sends up flowering stalks from the water.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Knotty-leaved rush (*Juncus acuminatus*)
Water pimpernel (*Samolus parviflorus*)
Bur-reed (*Sparganium americanum*)
Water speedwell (*Veronica connata*)
Spring cress (*Cardamine bulbosa*)
Spring cress (*Cardamine bulbosa* f. *fontinalis*)
Water-weed (*Anacharis occidentalis*)
Water starwort (*Callitriche heterophylla*)
Bluegrass (*Poa annua* var. *reptans*)

SANDS SPRING

Located in sec. 19, T. 35 N., R. 11 W., two and one-half miles east of Tribune, Pulaski County. It arises in the bed of Gasconade River. The aquatic plants found in the river in the vicinity of the spring are hornwort, milfoil, and large-leaved pondweed.

LIST OF SPECIES

Hornwort (*Ceratophyllum demersum*)
Milfoil (*Myriophyllum heterophyllum*)
Large-leaved pondweed (*Potamogeton amplifolius*)

SCHLICHT SPRING

Located in sec. 30, T. 37 N., R. 12 W., seven miles northwest of Waynesville, Pulaski County. The spring flows from the base of a small, 25-foot, limestone bluff and into a mill pond formed by a small dam built in the spring branch. This pond is enclosed all around by a rock wall and stands at the base of a small, rounded hill. Quantities of algae border the margin of the pond, but grow chiefly towards the overflow at its farther end. A few plants of a species of *Nitella* and one plant of pondweed (*Potamogeton foliosus* var. *genuinus*) also occur in the pond, but the dominant plant is water-weed, which forms a dense, dark grass-green growth around the entire margin.

From the overflow of the pond flows a branch in which there is much water cress in the first 100 feet from the mill; after this the stream is devoid of most plants with the exception of peppermint and mosses. The lower part of this branch flows through a valley bordered by black willow (*Salix nigra*), silver maple (*Acer saccharinum*), American elm (*Ulmus americana*), and sycamore (*Platanus occidentalis*).

Part of the branch is diverted to form two large basins, dammed up by a mud bank. The basin nearest the cabin is full of algae, while the other, and the branch leading to it, are loaded with olive-gray-green, fine-leaved plants of a species of *Nitella*.

At the confluence of the branch with the Gasconade River is a small gravel bar overgrown with black willow (*Salix nigra*).

LIST OF SPECIES

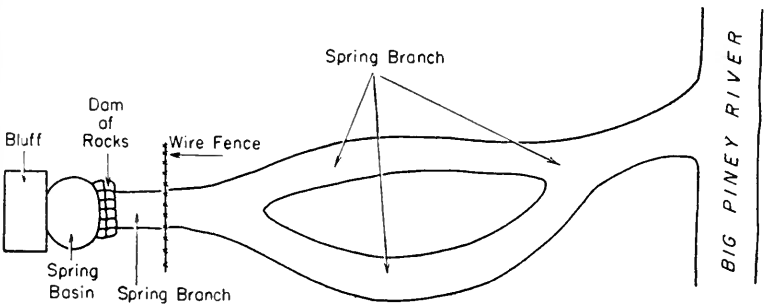
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Water-weed (*Anacharis occidentalis*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Peppermint (*Mentha piperita*)
Nitella sp.

SHANGHAI SPRING

Also called Blue Spring. Located in SW. ¼ sec. 24, T. 36 N., R. 11 W., seven miles east of Waynesville, Pulaski County. It

issues in a large, circular basin 40 feet in diameter at the base of a limestone bluff 60 feet high, and flows 1,000 feet into Big Piney River. A private clubhouse is located nearby. At the base of the bluff just above the spring basin occurs hop hornbeam (*Ostrya virginiana*), one tree on each side.

Along the margin of the basin are clumps of light green water starwort. Some plants have a bronze or coppery color, others have only a tint of this color mixed with light green. Also here are bunches of aquatic mosses and a few elongate strands of pondweed (*Potamogeton*



foliosus var. *genuinus*) and water cress. On rocks by the wall near the head of the basin are submerged flowering plants of annual bluegrass. On the bluff side of the basin is one clump of olive-green white water crowfoot. Near the farther end of this basin are submerged plants of the aquatic state of spring cress, with large elongate leaves. The color of the water in the basin where the water gently bubbles up is a dark, turbid, blue-green; around the margin of the spring it is somewhat bluer.

The water from the basin flows over five feet of rocks, forming a low dam, then rushes as a spring branch which flows 1,000 feet before emptying into Big Piney River.

Along the branch are clumps of water cress and white water crowfoot, the commonest plant of the branch. This plant is common all along the branch on a gravelly substratum. It grows in dense, circular to almost four-sided masses and has a dull olive-green color when submerged; it appears dark green when taken out of the water.

From the fence down the branch to its confluence with Big Piney River, are clumps of white water crowfoot, light green plants of bur-reed, water-weed occurring in long mats, some of which are coppery in color, and water starwort.

After crossing the road, the spring branch diverges into two prongs, the left one of which is much more prolific in vegetation, containing mostly water cress and white water crowfoot. Both branches are lined on their muddy shores with lizard's tail. Also in one area along the muddy margins of the branch, away from the current, are plants of bur-reed. The right spring branch near its confluence with the left branch contains quantities of bur-reed.

Near the junction of the branch with Big Piney River are long strands of water-weed, of dark, copper-green color. Also here in the mud away from the main current is bur-reed. At the junction are plants of water cress.

LIST OF SPECIES

Water starwort (*Callitriche heterophylla*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Annual bluegrass (*Poa annua* var. *reptans*)
White water crowfoot (*Ranunculus longirostris*)
Spring cress (*Cardamine bulbosa* f. *fontinalis*)
Bur-reed (*Sparganium americanum*)
Water-weed (*Anacharis occidentalis*)
Lizard's tail (*Saururus cernuus*)

SILVER LAKE

Located in sec. 1, T. 34 N., R. 9 E., at Silver Lake post office, Perry County. This spring-fed natural lake originates in the valley of Saline Creek. The water in the lake is deep and crystal-clear, and aquatic plants of various colors grow abundantly on the bottom of the basin. Milfoil forms large mats of light green and grass-green in the lake, and is very common. Other plants of the lake are a species of *Chara*, shining pondweed, a moss (*Drepanocladus aduncus*) growing in two feet of water, and hornwort, forming bronze to reddish clumps. Floating in shallower water of the lake are masses of a rare pondweed (*Potamogeton panormitanus* var. *minor*).

The spring branch flowing from the lake contains water speedwell and needle spike rush, and in slow water of the branch grows horned pondweed. Forming yellow-green mats in the branch is a moss (*Drepanocladus aduncus*).

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Shining pondweed (*Potamogeton lucens*)
Hornwort (*Ceratophyllum demersum*)
Pondweed (*Potamogeton panormitanus* var. *minor*)
Water speedwell (*Veronica connata*)
Needle spike rush (*Eleocharis acicularis* var. *typica*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Moss (*Drepanocladus aduncus*)
Chara sp.

SLABTOWN SPRING (Plate XXI)

Located in sec. 15, T. 33 N., R. 10 W., five miles south of Edanville, Texas County. It emerges at the base of a rock-strewn, wooded

slope in a series of bubbles in shallow water. At the very beginning are rocks plentifully covered with mosses. Quantities of water cress grow on all sides, and in about two feet of water on one side of the spring basin are submerged plants of water starwort and horned pondweed. The water flows into an oblong basin, about 75 feet long, 30 feet wide, and three feet deep. Next it cascades and tumbles over a pile of rock, and here are many large clumps of water cress. Where the water is shallow and tumbles over rocks, mosses and algae appear. The gravel bottom is densely covered with water cress, and little else grows except a few scattered plants of water starwort.

The spring branch then flows across the road. Water cress is the chief plant here, but horned pondweed is very common, and is associated with submerged plants of annual bluegrass.

Farther down the branch is found a zonal arrangement correlated with distance from the main current. Where the main current flows, there are only rocks covered with mosses and algae, but away from the current grow horned pondweed and water cress.

Down most of the branch, which flows in a valley, at first through a field and finally through an alluvial stretch of woods, water cress is the dominant plant, but about 100 yards from the confluence of the branch with Big Piney River are clumps of water speedwell, water-weed, and bur-reed, all on a gravelly substratum.

Most of the flow of the spring branch is rapid, the water shallow, flowing over a gravelly substratum, and only 10 to 20 feet wide. It empties into Big Piney River about one-fourth mile from its outlet. The place is used as a watering area for livestock.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Water starwort (*Callitriche heterophylla*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Annual bluegrass (*Poa annua* var. *reptans*)
Water speedwell (*Veronica connata*)
Water-weed (*Anacharis occidentalis*)
Bur-reed (*Sparganium americanum*)

STEELVILLE SPRING

Located in sec. 33, T. 38 N., R. 4 W., in the south part of the town of Steelville, just south of highway No. 19, Crawford County. The water issues from the base of a low, limestone bluff at the head of a ravine and emerges in an oblong basin. Water starwort is the first plant found, occurring in the very head of the spring. A straight spring branch flows from the basin and is bordered along its gravelly bottom with annual bluegrass. The water of the branch is shallow and flows mostly over a gravel substratum. Water cress then appears and remains the dominant growth until,

in a deeper place in the branch, with less rapid current, are found bur-reed, water starwort, and water cress. Along the margins of the branch grow beggar-ticks (*Bidens frondosa*), water pepper (*Polygonum punctatum*), and barnyard grass (*Echinochloa pungens*).

Farther downstream the water spreads out, becomes wider, and the bottom becomes muddier. Here water cress is commonest. At this point is the first occurrence in the spring of water-weed, and there is also some water starwort. The branch flows about 200 feet, then empties into Yadkin creek, located in Steelville.

LIST OF SPECIES

Water starwort (*Callitriche heterophylla*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Annual bluegrass (*Poa annua* var. *reptans*)
Bur-reed (*Sparganium americanum*)
Water-weed (*Anacharis occidentalis*)

STONE MILL SPRING (Plate XX)

Located in Pulaski County in sec. 21, T. 35 N., R. 10 W., two miles southwest of Spring Creek post office, Phelps County. The water rises in a bubbling, whirling mass about 10 feet in diameter in a pool at the base of a semicircular arch of a wooded, limestone and moss-covered bluff. The margins of the spring proper are covered by water cress and bordered by moss-covered rocks.

The spring flows a branch 100 feet long into Big Piney River, the water clear and flowing over a gravel bottom. On its course it dashes rapidly over cascades and there are several falls. In this particular portion of the branch there are no plants except water cress and mosses.

All along the branch the shallow water flows rapidly, dashing over rocks, and only water cress occurs, but at the confluence of the spring branch with Big Piney River, where the water is one and one-half to two feet deep and not so swift, many species of water plants grow. They occur in the river itself adjacent to the mouth of the branch. Here are milfoil, water-weed, water purslane, and pondweed (*Potamogeton foliosus* var. *genuinus*). Milfoil is the commonest species, while pondweed is next commonest. Water-weed is confined to the deeper and more quiet portion of the water.

Farther away from the confluence, down the Big Piney River, a little cove away from the direct flow of the current contains milfoil, water-weed, and dark, olive- and grass-green plants of shining pondweed. The dominant plant in the water at and below the confluence is milfoil. Pondweed and water star-grass are fairly common.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Milfoil (*Myriophyllum heterophyllum*)
Water purslane (*Ludvigia palustris* var. *americana*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Shining pondweed (*Potamogeton lucens*)
Water-weed (*Anacharis occidentalis*)
Water star-grass (*Heteranthera dubia*)

THOMASSON MILL SPRING

Located in sec. 16, T. 22 N., R. 2 W., one-fourth mile from "The Narrows," near the confluence of Fredericks Fork with Eleven Points River, about one mile northwest of Calm, Oregon County. "The spring rises in a small lake formed by a dam at which power is developed to operate a small grist mill, and flows one-fourth mile into Eleven Points River." The lake is oblong, about 900 feet long and 200 feet wide, is quite deep, and is a deep blue-green in color in the center. It is filled mostly with long strands of milfoil. On one side, in deep mud bordering the flat margin, are water starwort, pondweed (*Potamogeton foliosus* var. *genuinus*), horned pondweed, scattered plants of water plantain, occasional clumps of water-weed, and quantities of algae. On the opposite side, along the wooded slopes, the shore is not so steep nor so abrupt. Here occur more commonly than on the other more level side, plants of water-weed, water starwort, horned pondweed, and milfoil. Near the dam the aquatic plants are very prolific, with quantities of water cress and milfoil, these two plants being the most common ones. Associated with them by the dam are also water starwort, water purslane, pondweed, and horned pondweed.

The water then flows over the rocky dam and sends forth a spring branch with a gravelly mud bottom. Here the horned pondweed is very common, appearing in long, grass-green or light green strands that wave in the current. Large beds of milfoil also occur with the horned pondweed. These two species continue as the two most common plants about halfway down the branch.

Farther down the stream on the muddy shore of one side is a bed of mild water pepper with water plantain. An occasional clump of water-weed also is found along the muddy shore.

As the branch is followed downstream, beds of milfoil are scattered all along the way. This species and reddish or bronze-green plants of mild water pepper occupy most of the substratum of the branch. The latter occurs in both a submerged and emerged state along the muddy shores.

At the confluence of the spring branch with Eleven Points River is found a variety of aquatic plants. In the deepest water at this

point and nearest the current of the river occurs milfoil. Nearer the shore in shallower water and on muddy substratum next to the main current at the confluence occur pondweed, horned pondweed, a large bed of orange and green plants of mild water pepper, red and purple water purslane, olive-green and brick-colored plants of water speedwell, water starwort, water cress, and milfoil. Along the bank are light green plants of ditch stonecrop, creeping spike rush, and rice cut grass.

LIST OF SPECIES

Milfoil (*Myriophyllum heterophyllum*)
Water starwort (*Callitriche heterophylla*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water plantain (*Alisma subcordatum*)
Water-weed (*Anacharis occidentalis*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water purslane (*Ludvigia palustris* var. *americana*)
Mild water pepper (*Polygonum hydropiperoides*)
Ditch stonecrop (*Penthorum sedoides*)
Creeping spike rush (*Eleocharis calva*)
Rice cut grass (*Leersia oryzoides*)

TOPAZ SPRING (Plates XXI and XXII)

Located in sec. 12, T. 26 N., R. 12 W., at Topaz, Douglas County. The water arises in a lake 150 feet in diameter. In the deepest part of the lake the water is a beautiful, deep turquoise blue. The bottom is muddy and covered with fine sand. Here occur water cress, milfoil, and olive-green plants of pondweed (*Potamogeton foliosus* var. *macellus*).

Then the water goes through a race to a mill, makes a waterfall, then sends a swift spring branch about 10 to 12 feet wide and one to one and one-half feet deep for about one-fourth mile before emptying into North Fork of White River.

Along the branch are water cress and milfoil, the latter, very common at first, growing rarer as one proceeds down the branch.

The substratum of the branch is gravel and sand. Along the margins, where the water is deeper and the substratum muddier, bur-reed occurs occasionally. Pondweed is common throughout the entire course of the stream.

The last half of the flow of the branch is dominated by rooting plants of water speedwell, which grows here in large clumps. About three-fourths of the way down the branch one clump of white water crowfoot is found, rooting in the sand in the middle of the branch.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Milfoil (*Myriophyllum heterophyllum*)
Pondweed (*Potamogeton foliosus* var. *macellus*)
Bur-reed (*Sparganium americanum*)
Water speedwell (*Veronica connata*)
White water crowfoot (*Ranunculus longirostris*)

TUCKER BAY SPRING

Located in sec. 3, T. 25 N., R. 1 E., five miles northeast of Bennett, Ripley County. The spring arises in a valley along the west side of Current River and flows a long branch into Current River at Tucker Bay. The branch flows along a grassy bank covered with fowl meadow grass (*Glyceria striata*), beggar-ticks (*Bidens frondosa* and *B. cernua*), water smartweed (*Polygonum punctatum*), and arrowhead (*Sagittaria latifolia*). Along the muddy banks grow lizard's tail and false pimpernel. In large masses on the gravelly bottom of the branch is the rare ivy-leaved duckweed. In the water also are found water-weed, water star-grass, in long, dense, sterile strands, pondweed (*Potamogeton panormitanus* var. *major*) in strands three feet long growing below the surface of the water, and needle spike rush, also growing under the surface in fast-flowing water. Other plants in the spring are milfoil, hornwort, and mild water pepper.

The spring branch has a blue color, and is especially dark blue as it enters Tucker Bay, where it is deep and there is less current.

LIST OF SPECIES

Lizard's tail (*Saururus cernuus*)
False pimpernel (*Lindernia dubia* var. *typica*)
Ivy-leaved duckweed (*Lemna trisulca*)
Water-weed (*Anacharis occidentalis*)
Pondweed (*Potamogeton panormitanus* var. *major*)
Water star-grass (*Heteranthera dubia*)
Needle spike rush (*Eleocharis acicularis* var. *gracilescens*)
Milfoil (*Myriophyllum heterophyllum*)
Hornwort (*Ceratophyllum demersum*)
Mild water pepper (*Polygonum hydropiperoides*)

TURKEY CREEK SPRINGS

Three small springs arise in the wooded valley of Turkey Creek, sec. 17, T. 23 N., R. 15 W., east of Hammond, Ozark County, and flow narrow branches only three to five feet wide, which run a short distance before emptying into Turkey Creek. The dominant plants are water cress and milfoil. Associated with them are shining pondweed, rooting in the gravel, and water purslane, growing in the mud.

A larger spring nearby has a good flow, and the water is deeper than that in the springs above described. In the water of this spring grow water milfoil and bur-reed, which are the dominant plants. Water speedwell occurs here only locally. There is a slight amount of shining pondweed and water purslane, but no pondweed or water-weed. In places along the branch grow peppermint, common bulrush, water pepper (*Polygonum punctatum*), and fowl meadow grass (*Glyceria striata*). The dominant shrubby plants along the branch

are heart-leaved willow (*Salix cordata*) and buttonbush (*Cephalanthus occidentalis*).

LIST OF SPECIES

Water cress (*Roripa Nasturtium-aquaticum*)
Milfoil (*Myriophyllum heterophyllum*)
Shining pondweed (*Potamogeton lucens*)
Water purslane (*Ludvigia palustris* var. *americana*)
Bur-reed (*Sparganium americanum*)
Water speedwell (*Veronica connata*)

TURNER MILL SPRING (Plates XXII and XXIII)

Located in sec. 3, T. 24 N., R. 3 W., 10 miles northeast of Alton, Oregon County. The water flows from a cave located at the base of a high bluff, and "is carried 500 feet in a wooden flume to a water wheel which is used to operate a small lumber mill, and then flows into Eleven Points River." Where the water comes out of the bluff, it rushes over limestone boulders and rocks covered with mosses and algae. The spring branch, which flows down off the moss-covered rocks and winds around beneath the high wooden flume, has clear water flowing over a gravel and sand substratum. In it are quantities of horned pondweed, red plants of water purslane, and water starwort. Horned pondweed is the commonest of these.

Farther downstream past the mill and between the mill and Eleven Points River are horned pondweed, water speedwell, water starwort, and white water crowfoot. Quantities of the last plant are found in the last 50 feet of flow of the branch. The plants of water speedwell are olive-green, small, and rooted in gravel.

The branch for practically its entire course is about 15 feet wide, the water swift-flowing and rather shallow. The fact that the water is not deep and that it has a rapid, continuous current may explain the absence of milfoil, water-weed, and bur-reed. However, in Eleven Points River north of the confluence with the branch, many plants of milfoil occur.

LIST OF SPECIES

Horned pondweed (*Zannichellia palustris* var. *major*)
Water purslane (*Ludvigia palustris* var. *americana*)
Water starwort (*Callitriche heterophylla*)
Water speedwell (*Veronica connata*)
White water crowfoot (*Ranunculus longirostris*)

TWIN SPRINGS (Plate XXIV)

Located in sec. 11, T. 34 N., R. 4 W., 12 miles east of Salem, Dent County. The springs are in a swampy meadow of a valley. One of the springs issues from the base of a north-facing, limestone, wooded bluff and flows a branch. The other rises in a swampy meadow surrounded by clumps of Ward's willow (*Salix*

longipes var. *Wardii*) and silky willow (*Salix sericea* f. *glabra*). In grassy places around the head of the spring occur rice cut grass (*Leersia oryzoides*), common bulrush (*Scirpus atrovirens*), rush (*Juncus effusus* var. *solutus*), and water pepper (*Polygonum punctatum*). A slow, deep branch flows from the head of the spring and is covered with floating plants of bladderwort. Milfoil occurs in this still water. Ozark spatterdock grows along the margins in deep water. The surrounding shore is quite marshy and here grow Ward's willow, heart-leaved willow (*Salix cordata*), spotted cowbane (*Cicuta maculata*), buttonbush (*Cephalanthus occidentalis*), and a sedge (*Carex lurida*).

Proceeding down the branch, we find rooting on the muddy shore, as well as submerged on the bottom, plants of needle spike rush, water cress, bur-reed, pondweed (*Potamogeton foliosus* var. *genuinus*), and spring cress.

After the two spring branches meet, the united branch continues along the base of the bluffs, the water flowing over a muddy substratum. Peppermint (*Mentha piperita*), broad-leaved arrowhead (*Sagittaria latifolia*), willow herb (*Epilobium coloratum*), spike rush (*Eleocharis obtusa*), rush (*Juncus diffusissimus*), moneywort (*Lysimachia Nummularia*), mild water pepper (*Polygonum hydropiperoides*), arrow-leaved tear thumb (*Polygonum sagittatum*), and club moss (*Selaginella apus*) occur on muddy, marshy ground bordering the branch. A species of *Chara*, forming dull olive-green masses, is common along the muddy bottom. In the water of the branch occur Ozark spatterdock, water speedwell, growing both in and out of water, water purslane, bur-reed, pondweed, lying upon the muddy substratum, broad-leaved pondweed, and milfoil. Of all the plants in the main spring branch, milfoil and water cress are commonest.

LIST OF SPECIES

Bladderwort (*Utricularia gibba*)
Milfoil (*Myriophyllum heterophyllum*)
Needle spike rush (*Eleocharis acicularis* var. *gracilescens*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Spring cress (*Cardamine bulbosa*)
Ozark spatterdock (*Nuphar ozarkanum*)
Water speedwell (*Veronica connata*)
Water purslane (*Ludvigia palustris* var. *americana*)
Bur-reed (*Sparganium americanum*)
Broad-leaved pondweed (*Potamogeton amplifolius*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Chara sp.

WARNER BAY SPRING (Plate X)

Located in sec. 9, T. 31 N., R. 2 E., six miles south of Lesterville, Reynolds County. The water issues from two separate outlets in a cave at the base of a limestone bluff, and flows a branch one-

fourth mile long before emptying into Black River. The water at the main spring is greenish and on the rocks bordering the spring are mosses, species of blue and green algae, and a liverwort. Immediately over the spring on the bluff hang plants of cat-brier (*Smilax Bona-nox*). On the bank at the beginning of the branch are plants of thyme-leaved speedwell (*Veronica serpyllifolia*), and on rocks in the branch water mosses are common.

The branch is shallow, with a gravelly substratum. In its upper half horned pondweed is common and occurs with some scattered plants of pondweed (*Potamogeton foliosus* var. *genuinus*). In the lower half of the branch the latter is dominant. In this portion of the stream there are local occurrences of water speedwell, and along the shore grows fragrant bedstraw (*Galium triflorum*).

At the confluence of the branch with Black River sterile plants of milfoil are found.

A smaller branch occurring up the valley from the main outlet of the spring, but part of the same spring, contains horned pondweed, water starwort, and bur-reed.

LIST OF SPECIES

Horned pondweed (*Zannichellia palustris* var. *major*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Water speedwell (*Veronica connata*)
Milfoil (*Myriophyllum heterophyllum*)
Water starwort (*Callitriche heterophylla*)
Bur-reed (*Sparganium americanum*)
Liverwort (*Marchantia*)

WELCH SPRING (Plate XIII)

Located in sec. 14, T. 31 N., R. 6 W., three miles southeast of Cedar Grove, Shannon County. "The water flows out of a cave at the base of a rocky cliff and discharges into Current River 100 feet away." At the base of the bluff the water forms a fairly deep basin filled with quantities of shining pondweed, which has an olive-green color, and milfoil. Rooting in mud around the head of the spring are white water crowfoot, water starwort, water-weed, and submerged plants of slender rush. Occurring also around the main part of the spring are plants of peppermint and bur-reed.

From the main spring flow two branches, one directly to Current River 100 feet away; the other is diverted and flows through woods paralleling the river about one-eighth mile before emptying into it. In the branch which flows directly to the river are horned pondweed and water cress. In the diverted branch grow water speedwell, submerged plants of annual bluegrass, bur-reed, and water cress,

and rooting along the margins occur knotty-leaved rush and rush. In the slow water of a slough along this branch occur, rooting in the sand, false pimpernel, tooth-cup (*Rotala ramosior* var. *interior*), water plantain, *Cyperus rivularis*, and *Fimbristylis mucronulata*.

At the confluence of the diverted spring branch with Current River are found in swift water submerged plants of annual bluegrass.

LIST OF SPECIES

Shining pondweed (*Potamogeton lucens*)
Milfoil (*Myriophyllum heterophyllum*)
White water crowfoot (*Ranunculus longirostris*)
Water starwort (*Callitriche heterophylla*)
Water-weed (*Anacharis occidentalis*)
Slender rush (*Juncus macer*)
Peppermint (*Mentha piperita*)
Bur-reed (*Sparganium americanum*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water speedwell (*Veronica connata*)
Annual bluegrass (*Poa annua* var. *reptans*)
Knotty-leaved rush (*Juncus acuminatus*)
Rush (*Juncus Dudleyi*)
False pimpernel (*Lindernia dubia* var. *typica*)
Water plantain (*Alisma subcordatum*)

WESTOVER SPRING

Located in SW. ¼ SE. ¼ sec. 14, T. 37 N., R. 3 W., at Westover, Crawford County. The spring emerges from several sources within an area of about two acres. The main branch issues near Dry Creek in a low field surrounded by woods, flows into a marshy lake, curves around an island, then spreads out into a broad stream filled with water cress, bur-reed, milfoil, water starwort, and pondweed (*Potamogeton foliosus* var. *genuinus*). These are the main plants found throughout the course of the branch.

Down the stream are seen occasionally plants of hornwort, shining pondweed, and a species of *Nitella*.

The water is then turned into a series of chutes for a trout hatchery, where the dominant plant is milfoil. Other plants associated with it are horned pondweed, which is seen only occasionally in the branch, bur-reed, long strands of dark bronze-green pondweed, and an occasional light green clump of water speedwell.

The water ends at a mill, and pours out into Dry Creek, which empties eventually into Huzzah Creek.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Bur-reed (*Sparganium americanum*)
Milfoil (*Myriophyllum heterophyllum*)
Water starwort (*Callitriche heterophylla*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Hornwort (*Ceratophyllum demersum*)
Shining pondweed (*Potamogeton lucens*)
Horned pondweed (*Zannichellia palustris* var. *major*)
Water speedwell (*Veronica connata*)
Nitella sp.

WILDER SPRING (Plate X)

Also called Breakup Spring. Located in sec. 14, T. 23 N., R. 11 W., on the Kelly-Wilder Ranch, six miles north of Elijah, Ozark County. The spring bubbles out in a series of small, moss-lined springs at the base of low, wooded, southwest-facing, rock bluffs in the channel of Spring Creek. Moss and algae cover the rocks, while water cress is the chief flowering plant. The spring flows along the rock ledge over a broad, gravelly bottom and forms a branch, the water here being deep sky-blue in color. In this deeper water of the branch milfoil is dominant and is almost the only plant growth, except mosses and algae. Bur-reed and white water crowfoot occur in occasional clumps.

Farther down the branch, before it makes a turn, a great variety of aquatic flowering plants is found. Here are clumps of water speedwell of an olive-green color, water starwort, pondweed (*Potamogeton foliosus* var. *macellus*), of a dark, bronze-green color, and dark green plants of *Nitella*, growing in close clusters. These are interspersed with quantities of milfoil and aquatic mosses, which grow in the dashing water of the branch.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Milfoil (*Myriophyllum heterophyllum*)
Bur-reed (*Sparganium americanum*)
White water crowfoot (*Ranunculus longirostris*)
Water speedwell (*Veronica connata*)
Water starwort (*Callitriche heterophylla*)
Pondweed (*Potamogeton foliosus* var. *macellus*)
Nitella sp.

WILKINS SPRING

Located in S. ½ SE. ¼ sec. 17, T. 36 N., R. 9 W., seven miles southwest of Newburg, Phelps County. "It rises in a 2-acre lake formed by an earth dam, flows down the valley 1,000 feet, and empties into Mill Creek." The circular basin in which the spring rises is bordered by rocks and a concrete wall. Here occur aquatic mosses, hornwort, with a dark brown and blackish green color, mild water pepper, a species of *Riccia*, water starwort, needle spike rush, bur-reed in deeper water but still around the margin, and water cress, both around the edge and in the center of the basin.

From the main part of the spring flows the branch, which curves around a low meadow in the valley of Mill Creek. In and along the branch are quantities of water cress, bur-reed, and long strands of pondweed (*Potamogeton foliosus* var. *genuinus*) with dark green and bronze leaves. The dominant plants in the branch are water cress

and pondweed. Other plants occurring, but much rarer, are submerged flowering annual bluegrass with bluish green leaves, duckweed, and a species of *Riccia*, both of which are found along the more quiet margins of the branch, needle spike rush, growing on the sand along the branch, and water purslane, which was found in only one place about halfway down the branch. It has very large and long, olive-green leaves tinged with bronze and orange.

In the lower portion of the branch grow water cress, pondweed, bur-reed, and water starwort, which is quite rare here. Water cress and bur-reed are the commonest plants all along the branch.

LIST OF SPECIES

Hornwort (*Ceratophyllum demersum*)
Mild water pepper (*Polygonum hydropiperoides*)
Water starwort (*Callitriche heterophylla*)
Needle spike rush (*Eleocharis acicularis* var. *typica*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Bur-reed (*Sparganium americanum*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Annual bluegrass (*Poa annua* var. *reptans*)
Duckweed (*Spirodela polyrhiza*)
Water purslane (*Ludvigia palustris* var. *americana*)
Riccia sp.

WILLIAMS SPRING

Located in sec. 34, T. 25 N., R. 1 E., in a valley tributary to Current River, near Pike Slough, on the east side of the river, southwest of Grandin, Ripley County. The spring rises at the base of a wooded slope and flows a small branch containing water-weed, water starwort, water speedwell, bur-reed, and water cress. After flowing several hundred feet, the stream empties into Current River.

LIST OF SPECIES

Water-weed (*Anacharis occidentalis*)
Water starwort (*Callitriche heterophylla*)
Water speedwell (*Veronica connata* var. *glaberrima*)
Bur-reed (*Sparganium americanum*)
Water cress (*Rorippa Nasturtium-aquaticum*)

WOODS LAKE

Located in sec. 24, T. 37 N., R. 1 W., one mile south of Berryman, Washington County. This lake is spring-fed, has a dark green color, and varies from one to ten feet in depth. It is an old meander cut off from the main course of Courtois Creek. The aquatic plants found in it are water cress, milfoil, hornwort, water starwort, and large-leaved pondweed. In deep water grow grass-green plants of pondweed (*Potamogeton foliosus* var. *genuinus*) and Ozark spatterdock.

LIST OF SPECIES

Water cress (*Rorippa Nasturtium-aquaticum*)
Milfoil (*Myriophyllum heterophyllum*)
Hornwort (*Ceratophyllum demersum*)
Water starwort (*Callitriche heterophylla*)
Large-leaved pondweed (*Potamogeton amplifolius*)
Pondweed (*Potamogeton foliosus* var. *genuinus*)
Ozark spatterdock (*Nuphar ozarkanum*)

YANCY MILL SPRING

Located in SW. ¼ sec. 32, T. 36 N., R. 8 W., at Yancy Mill post office, Phelps County. "The water bubbles up in a gravel bed, which is surrounded by a low wall and dam," and empties into Little Piney River.

In the spring at the very beginning is an abundance of needle spike rush, water cress, water starwort, a small amount of milfoil, and some aquatic mosses (*Fontinalis* and other genera). The spring branch which flows from the spring across the road and into Little Piney River has an abundance of water cress, water starwort, and olive-green strands of pondweed (*Potamogeton foliosus* var. *macellus*). Of these plants water cress is dominant and by far the commonest.

Along the Big Piney River near its confluence with the branch are water cress, water-weed, and a species of *Chara*.

Another part of the flow from the spring has been dammed to form a large lake bordered by a rocky, wooded slope on one side, and on the other by an alluvial field. Most of the lake is overgrown with a species of *Chara*, having a dull, olive-green color, and water-weed is common along the margin. The other aquatic plants in the lake are hornwort, milfoil, and least duckweed, the last a rare species, floating among the dead leaves and algae on the surface of the water. Around the margin are alder (*Alnus rugosa*), heart-leaved willow (*Salix cordata*), and aster (*Aster lateriflorus* var. *pendulus*).

At the far end of the lake, back of the dam wall, is an outlet from the mill, which forms a small branch loaded with water plants. Here are quantities of water cress and milfoil, short-stemmed, dark green plants of pondweed, and water-weed.

LIST OF SPECIES

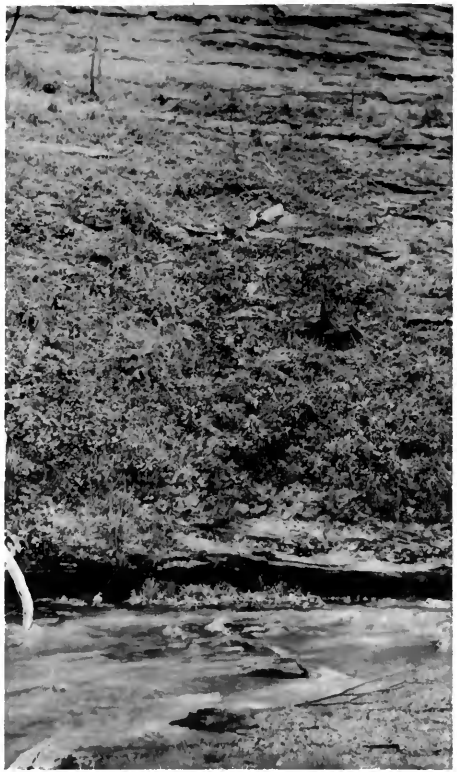
Needle spike rush (*Eleocharis acicularis* var. *gracilescens*)
Water cress (*Rorippa Nasturtium-aquaticum*)
Water starwort (*Callitriche heterophylla*)
Milfoil (*Myriophyllum heterophyllum*)
Pondweed (*Potamogeton foliosus* var. *macellus*)
Water-weed (*Anacharis occidentalis*)
Hornwort (*Ceratophyllum demersum*)
Least duckweed (*Wolffia punctata*)
Aquatic mosses (*Fontinalis*)
Chara sp.

ALTHEA SPRING, OZARK COUNTY
Spring branch near confluence with North Fork of White River

BENNETT SPRING, LACLEDE COUNTY

BIG SPRING, CARTER COUNTY
Part of spring branch, showing mats of *Myriophyllum heterophyllum*

BIG SPRING, CARTER COUNTY

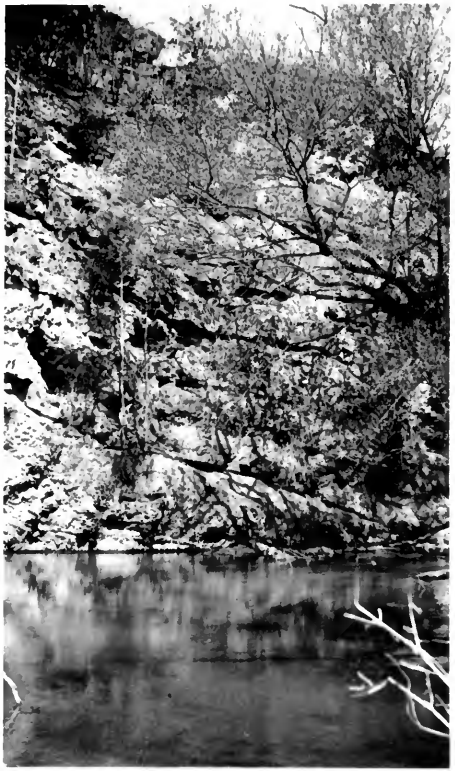


BIG SPRING, LAWRENCE COUNTY

BIG SPRING, CARTER COUNTY

BLUE SPRING, LACLEDE COUNTY

BOZE MILL SPRING, OREGON COUNTY



BLUE SPRING, OREGON COUNTY

CAVE SPRING, SHANNON COUNTY
Head of spring

CHESAPEAKE SPRING, LAWRENCE COUNTY

CREASY SPRING, PULASKI COUNTY

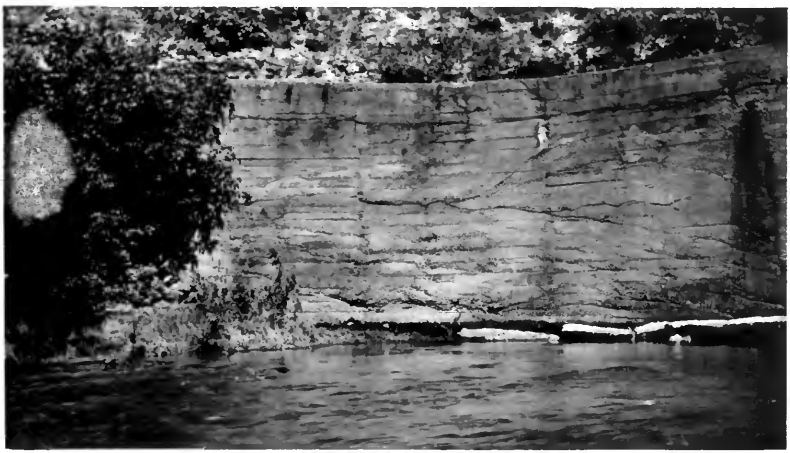
CREASY SPRING, PULASKI COUNTY

KEENER SPRING, BUTLER COUNTY
Head of spring

KEENER SPRING, BUTLER COUNTY
Head of spring

CARTER SPRING, REYNOLDS COUNTY
Head of spring

CARTER SPRING, REYNOLDS COUNTY
Narrow lower part of spring branch



WAYNESVILLE SPRING, PULASKI COUNTY
Head of spring

WARNER BAY SPRING, REYNOLDS COUNTY
Head of spring

WILDER SPRING, OZARK COUNTY
Head of spring

GRAVOIS MILLS SPRING, MORGAN COUNTY
One of spring-fed basins

GRAVOIS MILLS SPRING, MORGAN COUNTY
Lower part of spring branch

MONTAUK SPRING, DENT COUNTY

One of heads of spring, showing island of *Rorippa Nasturtium-aquaticum*

MONTAUK SPRING, DENT COUNTY

Junction of spring heads

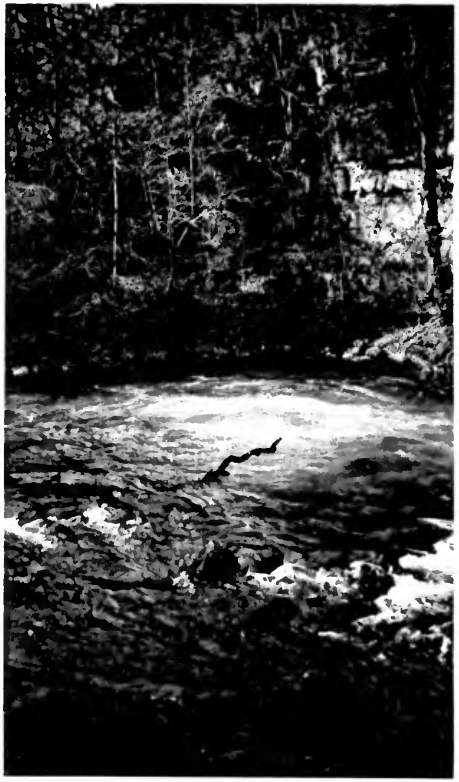
WELCH SPRING, SHANNON COUNTY
Head of spring

DOUBLE SPRING, OZARK COUNTY
Head of spring

DOUBLE SPRING, OZARK COUNTY

GAINES FORD SPRING, MARIES COUNTY
Head of spring

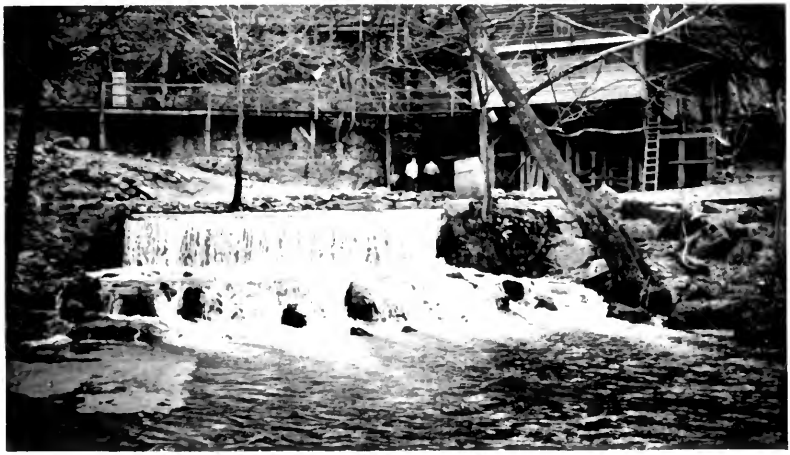
GREER SPRING, OREGON COUNTY
Upper outlet of spring



GREER SPRING, OREGON COUNTY
Lower outlet of spring

HAHATONKA SPRING, CAMDEN COUNTY

HAZLETON SPRING, TEXAS COUNTY
Part of spring branch



HODGSON MILL SPRING, OZARK COUNTY

KRATZ SPRING, FRANKLIN COUNTY
Head of spring

PREWETT SPRING, TEXAS COUNTY
Head of spring

ROARING RIVER SPRING, BARRY COUNTY
Head of spring

ONANDAGO SPRING, CRAWFORD COUNTY
Head of spring

RELFE SPRING, PHELPS COUNTY
Head of spring

ROUND SPRING, SHANNON COUNTY
Head of spring

STONE MILL SPRING, PULASKI COUNTY
Head of spring

SLABTOWN SPRING, TEXAS COUNTY, LOOKING DOWN SPRING BRANCH
Note abundance of *Rorippa Nasturtium-aquaticum*

TOPAZ SPRING, DOUGLAS COUNTY
Head of spring

TOPAZ SPRING, DOUGLAS COUNTY
Part of spring branch

TURNER'S MILL SPRING, OREGON COUNTY

ROUND SPRING, SHANNON COUNTY

TURNER'S MILL SPRING, OREGON COUNTY

TWIN SPRINGS, DENT COUNTY
Head of spring

TWIN SPRINGS, DENT COUNTY
Spring branch

INDEX

STUDIES OF THE VEGETATION OF MISSOURI—II

PHANEROGAMIC FLORA OF THE FRESH-WATER SPRINGS IN THE OZARKS OF MISSOURI

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