

A PRELIMINARY SURVEY AND ECOLOGICAL STUDY  
OF THE FISHES OF THE SOUTH NINNESCAH AND SPRING CREEK

by

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## INTRODUCTION

The studies of Kansas fishes and their distribution have not been complete, thorough or coordinated up to the present time. Certain areas of the southern half of Kansas have been partially neglected in respect to collection and ecological study. Until all areas have been surveyed, a true distributional picture cannot be presented.

This study was made to gather data that might supplement the existing data and aid in the preparation of a complete study. These consist of:

1. A determination of the fish species and relative abundance in the South Ninnescah, a prairie stream of south central Kansas.
2. A determination of the fish species and relative abundance in Spring Creek, a modified savannah stream of southeast Kansas.
3. A determination of the species occurring in both streams and those found only in one stream.
4. A determination of the type of habitat of each species.
5. A record of environmental features that might influence the distribution of the species.

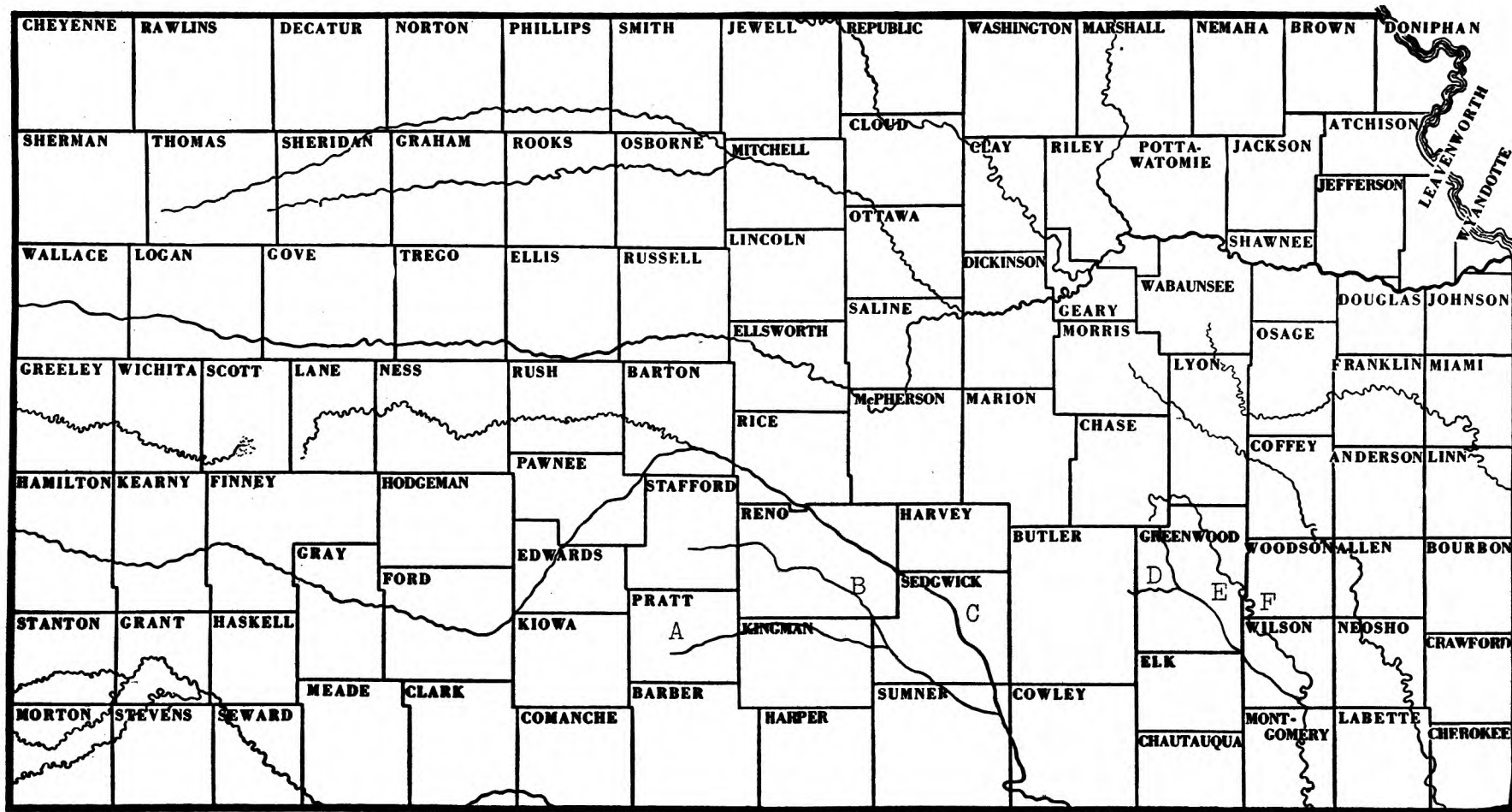


Fig. 1. Map showing the locations of Spring Creek and the South Ninnescah River.

A South Ninnescah River  
 B North Ninnescah River  
 C Arkansas River

D Spring Creek  
 E Fall River  
 F Verdigris River

## REVIEW OF LITERATURE

Much information concerning fresh water fishes, their distribution and habits in general is in the literature. Many specific and thorough studies have been made in regions and individual states of the United States but no extensive studies have been made in Kansas.

Kansas fishes did not receive much attention before the 1870's but in the following 20 years a good start was made in cataloging the fishes found in the state. This early start was not followed up except by uncoordinated, individual and infrequent collections with very little ecological study. This situation has existed until rather recently when interest began to grow and collecting and study were resumed.

Some of the earlier records of fishes from Kansas can be found in the reports of naturalists who accompanied railroad, government or institutional expeditions and surveys over the western half of the United States. Most of these early reports were rather casual, merely mentioning Kansas as a region collected in. Seldom was a specific locality stated.

Several species were reported from Kansas in a railroad survey made between 1853 and 1857. Rathbun (1884) mentions explorations in Kansas by Dr. P. R. Hay in 1854 and by Dr. Suckley in 1859. Evermann and Cox (1896), in their publication on the fishes of the Missouri River Basin, mention early collections from Kansas. Cope (1864, 1865) described several

new species of fishes collected by Dr. Hammond in the vicinity of Fort Riley in the late 1850's and early 1860's. Some of the localities of these collections are not too definite. Gill (1861) described fishes reported taken from Kansas on a continental exploration made by Captain Simpson in 1858-1859. Abbott (1860) described two new species of Pimelodus taken from the vicinity of Fort Riley. Gill (1864) published a description of a species of Percopsis from Kansas.

Perhaps the first studies of any importance were those made by Snow (1875) who presented a list of fishes observed in the Kansas River at Lawrence, and by Wheeler (1878) who prepared a list of fishes from the Marais des Cygnes River.

The Washburn College Laboratory of Natural History apparently started a biological survey of Kansas in the early 1880's under the auspices of F. W. Cragin. Several papers pertaining to fishes were published by this organization. Gilbert published four series of notes on Kansas fishes, using material furnished by Cragin. The first of these notes by Gilbert (1884) dealt with the fishes collected in various tributaries of the Kansas River. Nineteen species were enumerated. The second paper (Gilbert, 1885) was based upon additional materials supplied by Cragin. This report included new species and new locations for previously reported species. It was in this report that a few specimens from western Kansas were mentioned. Cragin (1885a) prepared and published a preliminary list of Kansas fishes which was a summary of previous

work. In the same year he described the silvery lamprey and its variations as found in Kansas (Cragin, 1885b).

Graham (1883-1884) presented as a report to the Commission of Ichthyology of the Kansas Academy of Science another preliminary list of Kansas fishes and in the year following (Graham, 1885) gave a paper before the Scientific Club listing the Kansas fishes in the Kansas State College Museum.

Hay (1887) published a list of 29 species of fishes collected in Cloud, Mitchell, Phillips, Trego, Norton and Wallace counties in 1885. Small collections were made in Harvey and Cowley counties in 1884 and the list of the 15 species secured was published by Evermann and Fordice (1886). These collections were from streams in the Arkansas River system.

Gilbert (1886) published a third series of notes based upon material supplied by Cragin giving more information upon previously reported species, new locations, etc. The fourth and final set of notes (Gilbert, 1889) merely supplemented the preceding papers.

For an interval of several years following Gilbert's report, only occasional collections and new species were reported. Crevecoeur (1901-1902) reported the possibility of a new species of Etheostoma near Onaga, Kansas. The possibility of a new species of Campostoma in the vicinity of Onaga was also reported by Crevecoeur (1907).

Breukelman (1946), in his review of Kansas Ichthyology, mentions the biological survey made by the University of Kansas in the years 1910 to 1912. R. D. Lindsey directed the work which was done in widely scattered areas. Nearly 60 species of fishes were taken.

Minna Jewell, formerly of Kansas State College, collected fishes throughout the state between 1924 and 1930. These collections have been placed in the Museum of Zoology at the University of Michigan.

In 1926, Cheatum presented a thesis at Kansas State College upon the distribution of Kansas fishes. This was chiefly a compilation.

One of the few, if not the only published paper on the ecology of Kansas fishes, appeared in 1934 when Hall (1934) published the results of an ecological study of the fishes of Mineral Lake, Cherokee County. In this study, the fishes present were determined and their habitats described. Hoyle (1936) mentions collecting the gar, Lepisosteus osseus, in the Walnut River in 1934.

In 1938 Breukelman (1946) and assistants collected fish from the Republican, Smoky Hill, Solomon Rivers and tributaries. They secured 1600 specimens representing 20 species. This material was later used in a report of fishes of northwestern Kansas made by Breukelman (1940a). In 1940 Breukelman (1946) and assistants collected in the southwestern part of the state securing specimens from the Ninnescah, Chikaskia,



Medicine Lodge, Cimarron, Arkansas Rivers and tributaries.

Over 3000 specimens were secured representing 41 species. The fishes of these last two collections have been placed in the Zoology Museums of Emporia State Teachers College and the University of Michigan. Breukelman (1940b) published a list of fishes in the University of Kansas Museum.

Hassler (1940) presented a thesis at Kansas State College on a preliminary survey of Chapman Creek. In this survey, the fish species collected were determined and a study of environmental features of the stream was made. The last published work pertaining to collections of Kansas fishes was a catalog of fishes in the Kansas State College Museum prepared by Jennings (1942).

Investigation of this previous work reveals incomplete lists of Kansas fishes and little published material on ecological studies. No material concerning ecological studies of the fishes of the Arkansas River system in Kansas and no complete list of species has been published.

#### MATERIALS AND METHODS

Specimens were collected by seining and by hook and line. The seines used were four feet wide and six, ten, 12 and 18 feet long and were operated by two people.

Usually two or more seinings were made in the same place to assure a fairly representative collection. Care was

exercised to get the fish from under bank ledges; stones and debris were moved in order to get all the fish possible. Little attempt was made to seine pools of considerable depth; fish when secured from these places were caught on hook and line. Several of each species were taken from each haul and a note was made concerning the frequency of the species.

The fish were dropped into ten percent formalin. When placed in this percentage of formalin, they died quickly and with their fins extended. Large specimens were injected or slit to allow the penetration of the preservative into the body cavity. The fish were later stored in a five percent solution of formalin.

Specimens were identified as quickly as possible in order to take advantage of the colors which gradually fade during storage.

Collections were made by taking hauls at the same place several times along the entire length of Spring Creek. Collections from the Ninnescah were made along a territory of about seven or eight miles. Some of the localities of both streams were reseeded in different seasons.

Pictures were taken of the streams in order to illustrate their characteristics (Plate I) and to show some of the collecting sites (Plates II and III).

The type of stream bed, predominant vegetation, weather conditions, depth, drainage, approximate velocity, turbidity and seasonal fluctuations were noted for each of the streams

(Table 1). No attempt was made to determine the pH of the streams or to analyze the water to determine mineral content. Since both were running streams, it was felt that there was no need to determine the oxygen content.

The collections and studies were made between August, 1944 and August, 1946.

## OBSERVATIONS

### Introduction

There are two river systems in Kansas, the Missouri and the Arkansas. Both of the streams studied belonged to the Arkansas system which drains roughly the southern half of the state. The South Ninnescah River joins the North Ninnescah River in the southwestern part of Sedgwick county and forms the Ninnescah proper which empties into the Arkansas River. Spring Creek is a small stream flowing into Fall River which empties into the Verdigris River, a tributary of the Arkansas (Fig. 1).

### Spring Creek

Spring Creek is a small permanent stream of the modified savannah type. It lies almost entirely within Greenwood County; the head being located in the eastern edge of Butler County in the vicinity of  $96^{\circ} 36'$  west longitude and  $37^{\circ} 47'$

north latitude. The junction with Fall River occurs one mile south of Eureka, Kansas in the vicinity of  $96^{\circ} 18'$  west longitude and  $37^{\circ} 49'$  north latitude (Fig. 2).

It originates in the pasture lands of the Flint Hills at an elevation of 1500 feet. It follows a slightly winding course at the base of a ridge of flint hills for about 17 or 18 miles and terminates at its junction with Fall River at an elevation of about 1040 feet. There is an approximate fall of 460 feet. The fall is quite abrupt at the head, becoming more gradual down stream. The stream proper flows east and slightly to the north.

The region the stream drains is rolling prairie of loamy soil covering approximately 90 square miles in area. At the head the area is used chiefly for pasturing cattle. Farms become more numerous and cultivated areas increase as the mouth is approached.

The upper end of Spring Creek is a series of small branches or ravines of very temporary existence carrying water only after rainfall. Downstream, it widens and becomes relatively permanent and possesses a definite channel. In this locality it is of continuous flow in spring because of the rains, later becoming a series of pools in the summer season. It becomes permanent in the vicinity west of Reece, Kansas, from there eastward the stream is continuous in flow with deeper pools and few riffles. Only in drought does this section become reduced to unconnected pools.

The source of water is the runoff from the surrounding area and from numerous springs. Many of the pools found in the stream are quite cool and rather clean due to the presence of springs. The stream during heavy rains does not flood any great territory as the banks usually accommodate the increased volume of water. Even in case of overflow, the area covered is usually not great.

A few low bridges across the stream are the only man made obstructions that might interfere with the flow of the stream or the movements of the fish.

The velocity of the stream varies considerably having as a rule a slow to moderate current. It is always moving so the stream is well aerated and oxygen content is rarely a factor except in stagnant pools or backwaters. Since the stream is used frequently as a watering place for livestock, some pollution does occur but not to any great extent.

The bed of the stream is usually gravel or rock covered with varying depths of mud. There is an abundance of decaying vegetable material such as leaves in certain areas.

The depth varies from shallow to depths of six or seven feet and occasionally deeper. There is usually a very pronounced bank, the upper portion being of soil and becoming more gravelly as the water line is approached.

Mineral content of the water was not determined but undoubtedly there is an abundance of minerals present since the stream flows through this limestone region. Reported chemical

analyses of rivers in this locality show considerable amounts of salts.

Because of the suspended material, the penetration of light is not great. The turbidity varies greatly; the stream not being muddy but somewhat murky except in winter when the water is very clear.

The stream is subjected to considerable temperature changes because of its nature and its locality.

This area is a bluestem or tall prairie grass region. The banks are usually heavily covered with vegetation which grows to and overhangs the water line. The predominant bank vegetation consists of vines, weeds, some grasses, and numerous species of trees. The stream is very well shaded except for some of the most extreme head branches. The most commonly found species of trees along the water's edge are elm, Ulmus sp., oak, Quercus sp., ash, Fraxinus sp., hackberry, Celtis sp., cottonwood, Populus deltoides, sycamore, Platanus occidentalis, walnut, Juglans nigra, and scattered clumps of willow, Salix sp. There is an abundance of smartweed, Polygonum sp., waterwillow, Dianthera americana, foxtail grass, Setaria sp., and other grasses. Poison ivy, Rhus toxicodendron, Virginia Creeper, Parthenocissus quinquefolia, wild grape, Vitis sp., gooseberry, Ribes sp., and sunflower, Helianthus sp. are found along the banks.

Many animals both terrestrial and aquatic are found along and in the stream. There is an abundance of insects, aquatic

and otherwise. Crayfishes are very plentiful. Leeches are present and a few species of snails have been observed. The water snake, Natrix sp., is very common. The snapping turtle, Chelydra serpentina, and soft shelled turtle, Trionyx sp., were observed. Cricket frogs, Acris gryllus, leopard frogs, Rana pipiens, and bull frogs, Rana catesbiana are common. Many birds live along the stream, these include several fish eaters. Fox squirrels, Sciurus niger rufiventer, raccoons, Procyon lotor hirtus, and muskrats, Ondatra z. zibethica are fairly common.

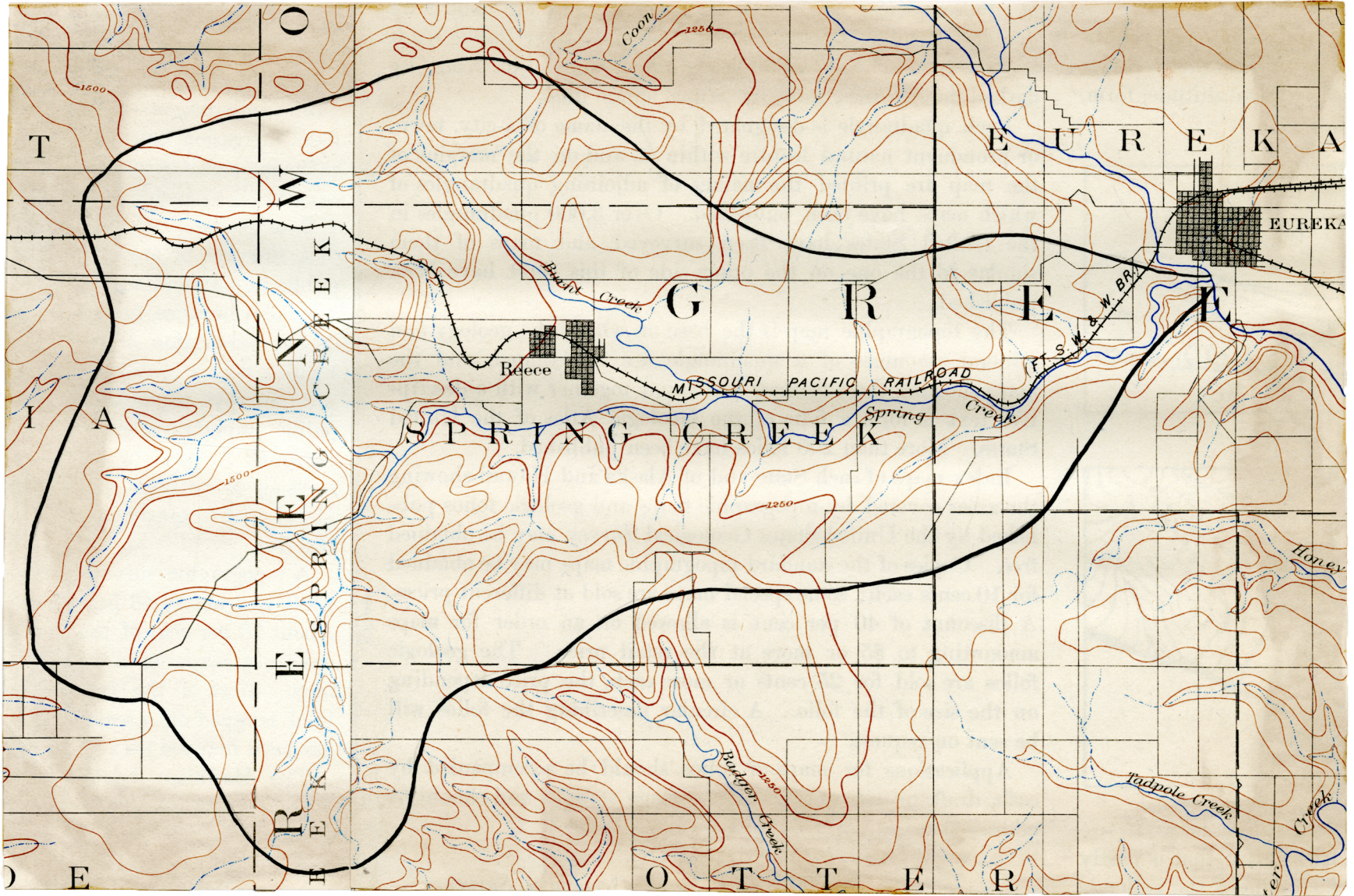


Fig. 2. A topographical map of Spring Creek showing physical features and drainage area (U. S. Geol. Sur. Map, 1925 and 1932).



### South Ninnescah

The South Ninnescah is a permanent stream of the prairie type. It joins the North Ninnescah forming the Ninnescah proper. The area of the stream studied was in the head regions where typical creek characteristics existed.

The Ninnescah arises in Pratt County in the vicinity of  $98^{\circ} 54'$  west longitude and  $37^{\circ} 39'$  north latitude and joins the North Ninnescah in the vicinity of southwestern Sedgwick County. The entire area was not studied (Fig. 3).

It originates in the gently rolling sandy prairies of short prairie grass west of Pratt, Kansas, at an elevation of 2040 feet. The portion of the stream surveyed extended about four or five miles east of Pratt where the elevation is 1780 feet. There is a fall of about 260 feet in about 16 miles of length. The area drained by the stream covers about 150 square miles.

Farming areas along the stream are not so heavily settled as such areas in eastern Kansas. Very few cultivated fields are found along the edges of the stream. It meanders largely through level pasture land.

The head streams are temporary, carrying water only at times of rainfall. The stream becomes permanent a few miles west of Pratt. The channel in this region is seldom very wide though within a few miles east of Pratt, the bed is quite wide and shallow with usually a small flowing stream of water

which widens considerably at times. The depth usually varies from a few inches to three or four feet. The velocity of the current in this area was usually moderate to swift, slowing as the stream widened.

The stream banks and bed are of sand. The center of the stream bed is kept quite clean of debris and quite barren of plants and decaying organic material. At the edges and in the sheltered, quiet recesses where the current is slow, there may be an accumulation of considerable organic matter. Vegetation in this area consists of trees, grasses, and weeds. The cottonwood tree, Populus deltoides, and willow, Salix sp., are quite common. The stream is well shaded in places but at other places is completely exposed. The grass grows down to the water level along much of the bank. Spirogyra and other algae grow in the stagnant pools. Occasionally a water plant may be found in the stream channel.

Down stream from the above area, the bank vegetation becomes predominantly grass with some weeds and sedges. The stream here is usually small and located in the bed so that there may be several feet of bare sand between the water and any vegetation. Trees appear in scattered clumps not infrequently some distance from the stream.

The banks are usually low; consequently, the stream is subject to flash flooding.

Pollution is not great as the stream flows through open prairie. The sewage from Pratt, however, is dumped into the

stream at the southeast edge of town.

There are two dams across the stream in the territory studied; one at the edge of Lemon's Park in the southeast part of Pratt. The other dam is about three miles east of Pratt below the State Fish Hatchery. This last dam forms the Veterans' Lake at the hatchery.

The size of the stream varies in fall and spring due to the rains and is reduced considerably during the summer dry season.

Some suspended material is carried by the stream, particularly at times of high water. At other times the water is clearer than that of the streams of eastern Kansas. This is explained by the type of region drained. The bottom of the channel is quite easily seen even through two feet of water.

Oxygenation is no problem as the stream flows constantly and the exposed water surface is considerable, since the stream is usually much wider than deep. No determination of the dissolved salts was made but reported chemical analysis of the stream indicated that there is an abundance. Light penetration of this stream is undoubtedly greater than in the other stream studied because of less suspended material.

The stream is exposed to a wide range of annual temperatures similar to those of eastern Kansas.

In the quieter areas, there is an abundance of insects. Of those present, adult and nymph dragonflies and damselflies, water striders, and whirligig beetles are very common.

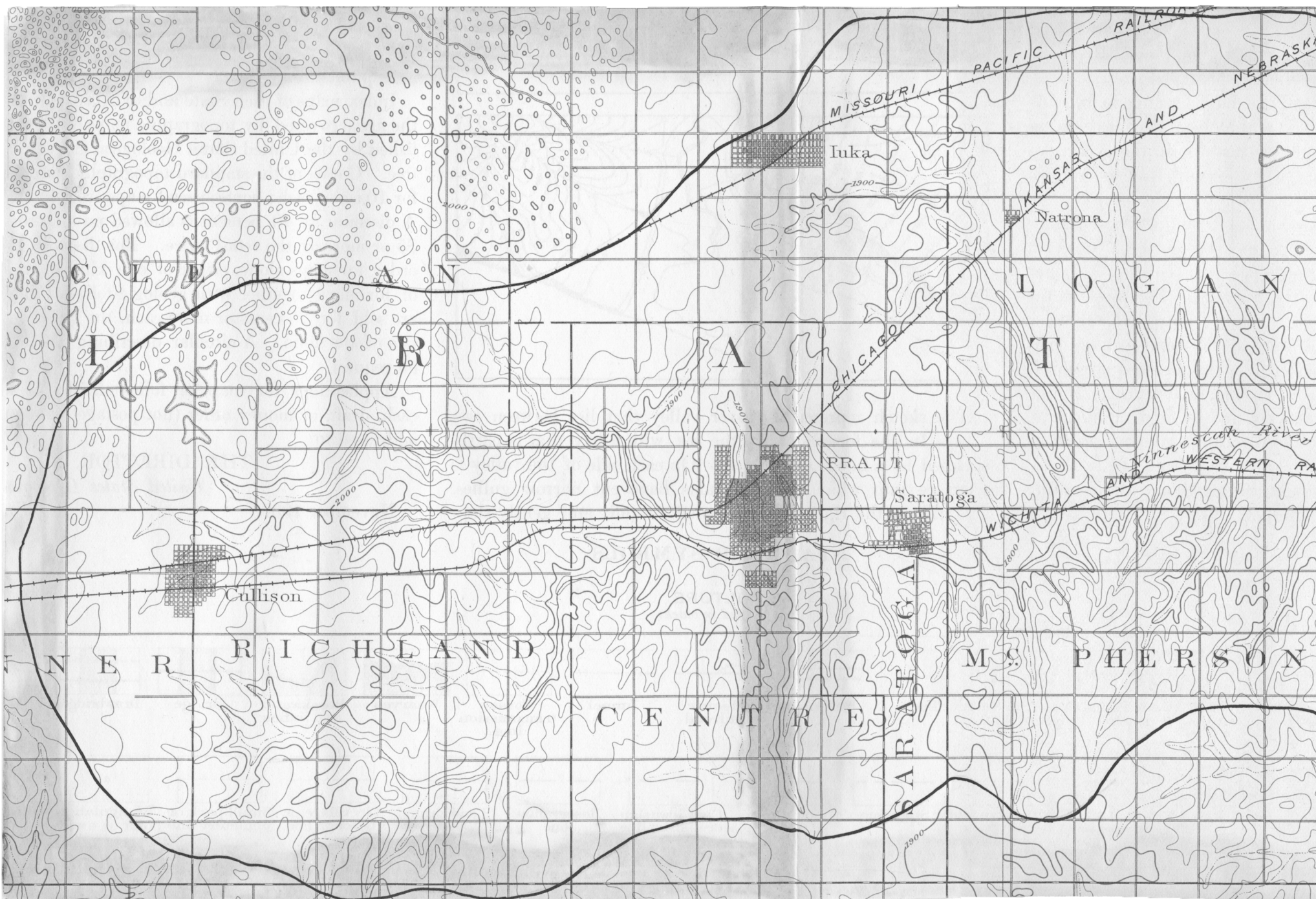


Fig. 3. Topographical map of South Minnescah showing area studied and drainage area (U. S. Geol. Sur. Map, 1945).

## EXPLANATION OF PLATE I

- Fig. 4. South Ninnescah, southeast edge of Pratt, showing the bank and bed characteristics.
- Fig. 5. South Ninnescah, east of Pratt, showing the bank and bed characteristics.
- Figs. 6 and 7. Spring Creek, showing bank and bed characteristics.

PLATE I



Fig. 4



Fig. 5



Fig. 6

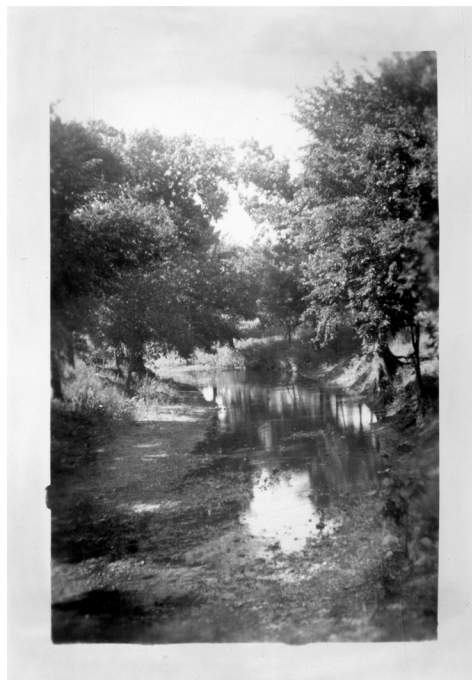


Fig. 7

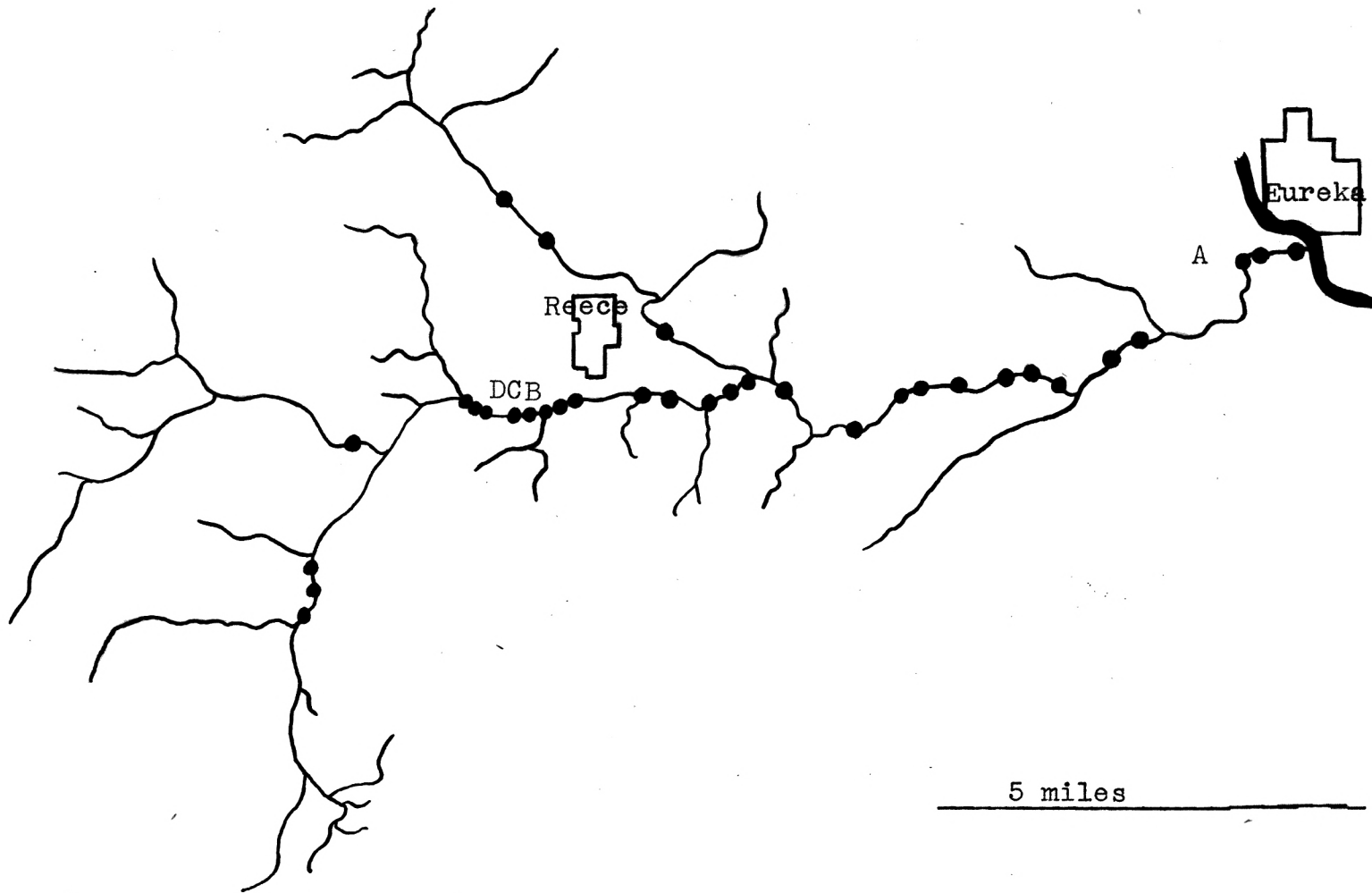


Fig. 8. Map showing course of Spring Creek and the locations of collecting sites.

## EXPLANATION OF PLATE II

Fig. 9. Collecting site A on map (Fig. 8) of Spring Creek.

Fig. 10. Collecting site B on map (Fig. 8) of Spring Creek.

Fig. 11. Collecting site C on map (Fig. 8) of Spring Creek.

Fig. 12. Collecting site D on map (Fig. 8) of Spring Creek.



## PLATE II



Fig. 9



Fig. 10



Fig. 11



Fig. 12

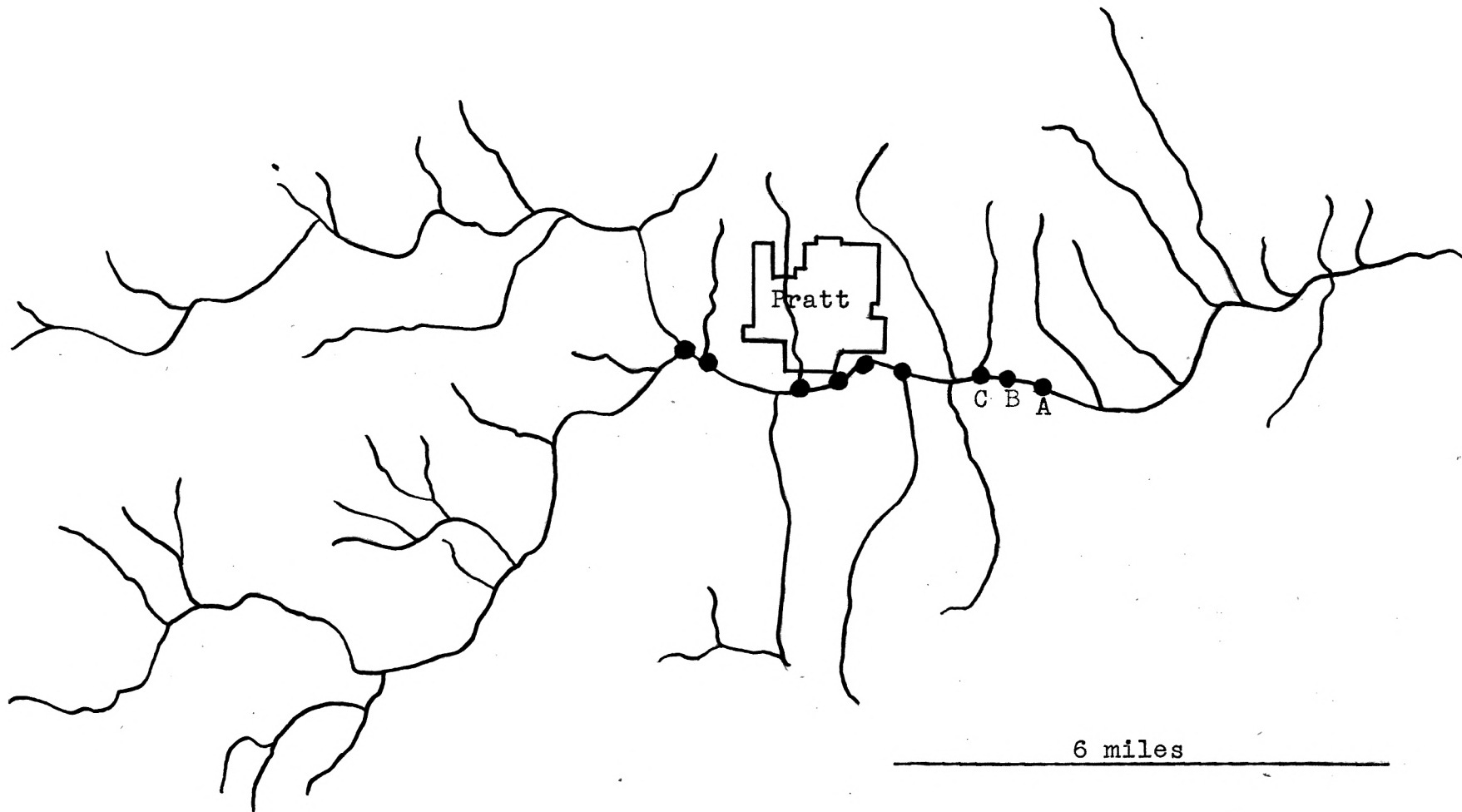


Fig. 13. Map showing the course of the studied area of the South Ninescah and the locations of the collecting sites.

EXPLANATION OF PLATE III

- Fig. 14. Collecting site A on map (Fig. 13)  
of the South Ninnescah.
- Fig. 15. Collecting site B on map (Fig. 13)  
of the South Ninnescah.
- Fig. 16. Collecting site C on map (Fig. 13)  
of the South Ninnescah.

PLATE III



Fig. 14

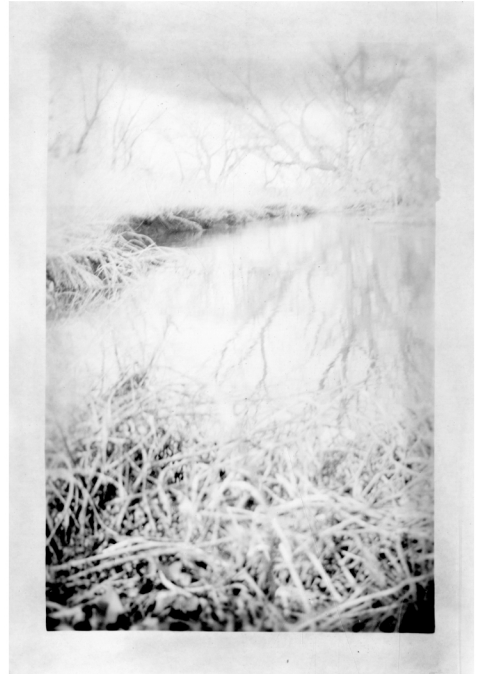


Fig. 15



Fig. 16

Table 1. Comparison of streams.

Characteristic	: South Ninnescah (area studied)	: Spring Creek
1. Water source	Springs & runoff from sandy prairie.	Springs & runoff from Flint Hills & loamy soils.
2. Depth	Shallow to 3-4 feet, rarely deeper.	Shallow to 6-7 feet, occasionally deeper.
3. Type	Prairie.	Modified savannah.
4. Pollution	Slight.	Slight - more than Ninnescah.
5. Bed	Sand, silt covered in places.	Gravel or rock, silt or mud covered, usually.
6. Banks	Sandy, not prominent.	Gravelly, clay & loam. Usually quite pronounced.
7. Turbidity	Some.	Usually more.
8. Velocity	Moderate to swift.	Slow to moderate.
9. Organic material	Considerable.	Abundant.
10. Exposure	Shaded to complete exposure.	Well shaded.
11. Bank vegetation	Not heavy, short & grassy.	Heavier, taller & more rank.
12. Temperature	About the same as Spring Creek.	About the same as Ninnescah.
13. Flooding	Flash flooding.	Bank usually retains water.
14. Salts	Abundant.	Abundant, more lime & carbonates.
15. Oxygen	Well aerated.	Well aerated.
16. Width	Narrow stream of water.	Varies considerably. Wider than the area of Ninnescah studied.

Several species of snails were observed. Crayfishes were abundant in many places. Leopard and bull frogs were plentiful in the quieter recesses and still pools.

#### Fishes and Habitats

Collections of fishes were made at designated stations (Figs. 8 and 13). Data were recorded concerning the physical and biological features of the collecting sites at the time of collection. The specimens were identified later in the laboratory. Tables were compiled from the data showing the habitats in which the particular species were found. The following habitat characteristics were considered: the type of bottom, depth, turbidity, current, exposure, and vegetation.

Bottom types were considered as rocky, sandy, muddy and weedy; depths as shallow (a few inches to one and one-half feet), moderate (one and one-half to four feet), and deep (four feet and deeper); turbidity as clear or turbid; current as swift, slow to moderate or still; and exposure as out in the stream or protected (under stones, debris and bank ledges). Table 3 is a compilation of the data. The hauls taken directly up the middle of the stream in the Ninnescah were usually extremely meager, only occasional strays or perhaps moving schools were caught. This was somewhat the same situation in Spring Creek. The most satisfactory col-

lections were made by seining along the banks and in the quieter recesses of the streams. Backwashes and ponds often had considerable numbers of fishes that had been trapped by receding high waters. Darters were nearly always secured from riffles.

There were no rocks in the section of the Ninnescah where collections were made and very few weeds. On the other hand, Spring Creek was very rocky and in places was invaded by vegetation.

Fishes seemed to be more numerous in Spring Creek than in the Ninnescah. Hauls from Spring Creek not infrequently would contain several hundred specimens while hauls from the Ninnescah yielded fewer than this number.

Several species of fishes have been introduced into Kansas streams. Some of these were collected in the Ninnescah, probably because of its proximity to the State Fish Hatchery. Goldfish, Carassius auratus, and carp, Cyprinus carpio, were observed. The goldfish probably had escaped from the ponds of the hatchery. Though carp were not found in Spring Creek, it is not improbable that they are present. Though Kansas is ordinarily regarded as beyond the northern range of the top minnow, Gambusia a. affinis, this species was collected in the Ninnescah. It escaped from the hatchery after having been brought there to be tried as a forage fish. The Ninnescah proved to be a favorable habitat and the species became established.

Additional data (Table 2) were compiled showing the relative frequency of the species in the streams. Frequencies were indicated as common, frequent and infrequent. If only one or a few specimens of a species were secured, the number of specimens taken was indicated.

Fishermen have reported several fishes present in these streams that were not secured in the present survey. Those reported from Spring Creek were buffalo, Ictiobus sp., eel, Anguilla bostoniensis, bluegill, Lepomis macrochirus, crappie, Pomoxis, probably annularis, perch which were probably sunfishes, Lepomis sp., and blue cat, Ictalurus furcatus (?). Those reported from the South Ninnescah were flat heads, probably shovelhead catfish, Pilodictis olivaris, drum, Aplodinotus grunniens, buffalo, Ictiobus sp., and suckers.

Study of distribution maps indicates the possible presence of several species of small fishes as well as the larger fishes.

#### Fishes Found in Both Streams

*Notropis l. lutrensis* (Baird and Girard)  
*Ictalurus lacustris punctatus* (Rafinesque)  
*Ameiurus melas catulus* (Girard)  
*Poecilichthys spectabilis pulchellus* (Gir.)  
*Lepomis cyanellus* Raf.  
*Lepomis humilis* (Gir.)



## Fishes Found in Spring Creek

Lepisosteus species

Moxostoma erythrurum (Raf.)

Notropis u. umbratilis (Gir.)

Notropis species

Notropis volucellus subspecies

Notropis camurus

Phenacobius mirabilis (Gir.)

Hyborhynchus notatus (Raf.)

Ceratichthys t. tenellus

Campostoma anomalum pullum (Agassiz.)

Ameiurus n. natalis (Le Sueur)

Pilodictis olivaris (Raf.)

Percina caprodes carbonaria (Hubbs and Greene)

Hadropterus phoxocephalus (Nelson)

Micropterus p. punctulatus (Raf.)

Lepomis megalotis breviceps (B. and G.)

## Fishes Found in the South Ninnescah

Dorosoma cepedianum (Le S.)  
Cyprinus carpio Linnaeus  
Carassius auratus (Linn.)  
Notemigonus crysoleucas auratus (Raf.)  
Notropis deliciosus missuriensis (Cope)  
Ceraticthys perspicuus (Gir.)  
Pimephales promelas confertus  
Campostoma anomalum: plumbeum x pullum  
Plancterus kansae (Garman)  
Gambusia a. affinis (B. and G.)  
Huro s. salmoides (Lacepede)  
Lepomis m. macrochirus Raf.  
Pomoxis annularis Raf.

Table 2. Occurrence and frequency of species.\*

Species	:Ninnescah	:Spring Creek
Lepisosteus sp.	-	(obs.)
Dorosoma cepedianum (Le S.)	I	-
Moxostoma erythrurum (Raf.)	-	F
Cyprinus carpio Linn.	F & (obs.)	-
Carassius auratus (Linn.)	(obs.)	-
Notemigonus crysoleucas auratus (Raf.)	(2)	-
Notropis u. umbratilis (Gir.)	-	C
Notropis species**	-	C
Notropis l. lutrensis (B. and G.)	C	C
Notropis volucellus subspecies	-	F
Notropis deliciosus missouriensis (Cope)	C	-
Notropis camurus	-	F
Phenacobius mirabilis (Gir.)	-	F
Hyborhynchus notatus (Raf.)	-	F
Ceratichthys perspicuus (Gir.)	I	-
Ceratichthys t. tenellus	-	I
Pimephales promelas confertus	C	-
Campostoma anomalum pullum (Ag.)	-	C
Campostoma anomalum: plumbeum x pullum	C	-
Ictalurus lacustris punctatus (Raf.)	F	I
Ameiurus melas catulus (Gir.)	(1)	(4)
Ameiurus n. natalis (Le S.)	-	(1)
Pilodictis olivaris (Raf.)	-	(1)
Plancterus kansae (Gar.)	C	-
Gambusia a. affinis (B. and G.)	C	-
Percina caprodes carbonaria (H. and G.)	-	(2)
Hadropterus phoxocephalus (Nel.)	-	(1)
Poecilichthys spectabilis pulchellus (Gir.)	F	F
Micropterus p. punctulatus (Raf.)	-	F
Huro s. salmoides (Lacepede)	C	-
Lepomis cyanellus Raf.	C	C
Lepomis humilis (Gir.)	C	(1)
Lepomis megalotis breviceps (B. and G.)	-	F-C
Lepomis m. macrochirus Raf.	F	-
Pomoxis annularis Raf.	(1) & (obs.)	-

\* I = infrequent; F = frequent; C = common; (obs.) = observed; number = specimens taken when number was very small.

\*\* Has not been named.

Table 3. Habitats of the South Ninnescah (N) and Spring Creek (S) in which species were found.

Species	Depth		Bottom						Turbidity				Exposure		Current				
	:Mod-:		:Rocky-:		:Mud-:		:				: Pro-:		:Slow -:		:				
	:Shallow:	:erate:	:Deep:	:gravel:	:Sand:	:silty:	:Weedy:	:Clear:	:Turbid:	:Open:	:ected:	:mod.:	:Swift:	:Stagnant:					
	: N : S	: N : S	: N : S	: N : S	: N : S	: N : S	: N : S	: N : S	: N : S	: N : S	: N : S	: N : S	: N : S	: N : S	: N : S	: N : S			
Lepisosteus sp. (observed)		x		x					x			x							
Dorosoma cepedianum (Le.S.)		x							x			x							x
Moxostoma erythrurum (Raf.)		x		x		x			x			x			x				x
Cyprinus carpio Linn.		x				x			x			x			x				x
Carassius auratus (Linn.)		x				x			x			x			x				
Notemigonus crysoleucas auratus (Raf.)		x				x			x			x			x				
Notropis u. umbratilis (Gir.)		x		x		x			x			x			x				
Notropis species		x		x		x			x			x			x				x
Notropis l. lutrensis (B. & G.)	x	x	x	x		x	x		x	x	x	x			x	x			x
Notropis volucellus subspecies		x				x			x			x			x				
Notropis deliciosus missouriensis (Cope)	x		x			x			x			x			x				x
Notropis camurus		x		x		x			x			x			x				
Phenacobius mirabilis (Gir.)		x		x		x			x			x			x				x
Hyborhynchus notatus (Raf.)		x		x		x			x			x			x				
Ceratichthys perspicuus (Gir.)	x		x			x			x			x			x				x
Ceratichthys t. tenellus		x		x		x			x			x			x				
Pimephales promelas confertus	x		x			x			x			x			x				x
Campostoma anomalum pullum (Ag.)		x		x		x			x			x			x				x
Campostoma anomalum: plumbeum x pullum	x		x			x			x			x			x				x
Ictalurus lacustris punctatus (Raf.)		x		x		x			x			x			x				x
Ameiurus melas catulus (Gir.)		x		x		x			x			x			x				x
Ameiurus n. natalis (Le.S.)																			
Pilodictis olivaris (Raf.)																			
Plancterus kansae (Gar.)	x		x			x			x			x			x				x
Gambusia a. affinis (B. & G.)	x		x			x			x			x			x				x
Percina caprodes carbonaria (H. & G.)						x			x			x			x				
Hadropterus phoxocephalus (Nel.)		x				x						x			x				x
Poeciliichthys spectabilis pulchellus (Gir.)	x		x			x			x			x			x				x
Micropterus p. punctulatus (Raf.)						x			x			x			x				
Huro s. salmoides (Lac.)	x		x			x			x			x			x				
Lepomis cyanellus Raf.	x		x			x			x			x			x				x
Lepomis humilis (Gir.)			x			x			x			x			x				
Lepomis megalotis breviceps (B. & G.)		x				x			x			x			x				
Lepomis m. macrochirus Raf.			x			x			x			x			x				
Pomoxis annularis Raf.						x			x			x			x				

## DISCUSSION

The environments observed in this study are lotic. These differ considerably from other environments because their ecological factors vary more rapidly and extremely. At one time a certain area of a stream may possess the characteristics of one type of habitat and then very shortly become quite different. These variations may be due to drought, floods, extreme warm or cold spells or may be produced artificially by man.

Both streams are favorable for aquatic life and are capable of supporting considerable fish life. Observations indicate that Spring Creek has a greater abundance of fishes than the Ninnescah. This might be accounted for in part by the following factors: (1) the velocity of the Ninnescah is, on the whole, greater than that of Spring Creek, thus reducing the number of aquatic plants and animals inhabiting the stream; (2) the sandy nature of the stream bed of the Ninnescah precludes established habitats; and (3) the soils and drainage areas of the streams are different in texture and chemical nature.

These two streams may be considered as fairly typical of their class; even though they possess in common certain characteristics such as: similar water sources, springs and rainfall run-off. Both streams are well aerated and are subjected to extremes of temperature and seasonal fluctuations

of water volume. Neither is subject to extensive pollution and both possess some man-made obstructions such as low bridges and dams.

In determining the distribution of stream animals, Shelford (1913) has stated that the factors of greatest importance are current and type of bed. These two major factors are determined by the physiographic features of the stream such as the age, length and slope of the stream.

The nature of the current and stream bed are major factors of distribution as they directly or indirectly influence aquatic and shore vegetation and animals, dissolved salts, gases, light penetration and temperature. These more specific factors plus that of current and kind of bed characterize the habitats.

The significance of these factors varies in lotic environments. Some are of much greater importance than others. Both streams are running streams and, except in cases of backwaters and stagnant pools, aeration or oxygen content is not a problem of great importance. Not too much is known about the carbon dioxide pressure but many believe it to be an important feature. Shelford and Allee (1912) are of the opinion that the carbon dioxide content of water is probably the best single index of the suitability of that water for fishes. Pearse (1939) states that poor circulation of water causes higher carbon dioxide pressure. Since these streams are running and the surface area is large, the carbon dioxide

pressure is probably no problem. In streams such as these, the inhabitants are subjected to great fluctuations of temperatures. Therefore, temperature itself is not of much significance except when it is associated with such conditions as drought or prolonged severe winter seasons. These factors may then result in a reduced population or exterminated species which will return only gradually and over a period of time.

Many experiments and investigations have been made in respect to the chemical nature of water and its influence upon fish distribution. Jewell and Brown (1924) concluded that fishes react to hydrogen ion concentration and that it is an important factor in the economy of aquatic animals. Wells (1915), in his study, found that fishes preferred slightly acid or alkaline conditions to neutrality and that species of fishes differ in degree of reaction to pH. Shelford (1923) found that pH was a factor governing the movement and distribution of fishes and was probably as important as many of the other more widely known factors. Also, he observed that each species seemed to have a definite range of preference though it is rather wide. No pH determination was made in this study but most of the streams in this part of the United States are alkaline. Pearse (1939) gives the range of ordinary fresh water as a pH of 6.5 to 8.5.

Examination of charts published by Clarke (1924) on the composition of river waters, reveals that the water of the

Ninnescah contains less carbonates, sulfates, calcium and magnesium, but more chlorine, sodium, silicates and a bit more aluminum and iron than the rivers in the vicinity of Spring Creek. The salinity of the streams in the region of the Ninnescah is greater than that of the streams in the vicinity of Spring Creek. According to Clarke, the composition of the tributaries of the Arkansas River system is apparently greatly affected by local conditions.

Hankinson (1910) mentions the importance of various barriers in distribution and lists the drying of riffles, leaf and limb barriers, and a natural fall as important. To these should be added man-made barriers such as low bridges and dams. These barriers may prevent seasonal migrations though most of the species present in these two streams do not migrate to any great extent. Two dams are located in the Ninnescah while several low bridges cross Spring Creek. These may serve as migrational barriers or might in the case of the dams prevent the migration or succession of new species up stream.

Though the exact or direct effect of current upon fish themselves is not known, Hankinson (1910) points out that many fish choose shallow places or shoals where the current is swift to spawn. It is recognized, however, that most fish prefer the more quiet areas of the stream. The current indirectly affects fish by changing the stream bottom by moving sand bars and covering or exposing the bottom. In Spring Creek, it is not unusual to find the nature of the stream



greatly altered in the interval of a year or even a season. Deep holes have been completely filled and new ones formed. Prominent gravel and sand bars have been completely moved. The most extreme changes occur during the heavy rains, especially in the spring. Such is true in the Ninnescah to a certain extent. Pearse (1939) states that current is a factor affecting the amount of food, chemical content and suspended detritus.

Floods have an influence upon the presence of fishes in streams because of the sudden increase of water volume bringing an increased amount of suspended material and increased current. In the Ninnescah and Spring Creek, floods probably are minor factors for the increase in volume is of short duration and the suspended materials soon settle. They may temporarily displace the fish.

Light penetration which will indirectly influence distribution of fishes depends upon the amount of suspended organic and inorganic material, the surface disturbance and the amount of shading of the stream by vegetation. Normally, penetration is greater in the South Ninnescah because of the relatively clear water due to the sandy nature of the drainage area.

Bottom types of streams are ecologically important since they determine the extent of aquatic vegetation and thus the numbers of aquatic animals present.

Another factor of considerable importance in fish dis-

tribution is food. Most authorities agree that fish are not indiscriminate feeders but select certain foods from those available. Forbes (1884-1888) observed that the food consumed by a fish is largely determined by the feeding structures and habits of the fish. Since the fish is limited in its consumption of food by these factors, it must seek a place where suitable food may be found. Whether a fish is a vegetarian, carnivore or mud eater will partially determine the location of the species as the limits of certain plants or animals will establish limits for the species. Perhaps the most important food of fishes is plankton since it is used directly as food by smaller fishes or certain species of larger fishes which may in turn be consumed by the large carnivorous species. According to Forbes (1914), part of the importance of plankton is that it is almost the sole food of about all the young fresh water fishes. Rich organic material must be present for an abundance of plankton. Both of the streams studied have considerable amounts of dissolved organic substances which come from the dissolved substances in run off water and from the decomposition of vegetable and animal material in the stream. Spring Creek has a greater abundance of organic material for several reasons: heavier, more profuse growth of bank vegetation, slower current and greater silting. Current also has an influence upon the presence of plankton. Observers have noted that plankton is usually more abundant in streams of

slower current.

Numerous insects were present in and around both streams. Many insect larvae were found around rocks in Spring Creek and dragonfly nymphs were found in the Ninnescah. Some snails were present and crayfishes were numerous in both streams, particularly Spring Creek. Of course, smaller fishes serve as food for the larger ones; the minnows, especially, serve as food for game and carnivorous fishes, Forbes (1884-1888).

Vegetable matter consumed by fishes consists chiefly of filamentous and non-filamentous algae, diatoms and seeds. Mann (1921) claims that diatoms are the greatest fundamental food supply of the aquatic world. They are the "grass of the sea". They are highly nutritious and are easily utilized because of their minute size. Various species are found in practically every type of habitat.

Mud eaters like the gizzard shad may ingest a third of their food as mud or it may be entirely lacking. Tiffany (1921) points out that mud consumption is incidental. It is ingested in order to secure the nutritive elements present.

Since the age of the fish determines its eating habits, younger individuals of a species may be found in quest of food in a habitat different from that of the adult.

Breeding habits also influence the distribution of fishes seasonally; Shelford (1910) says that breeding habits and distribution of breeding places are the first factors in the distribution and succession of fishes.

Presence of fishes not native is due to the introduction of these species by some agency such as the State Fish and Game Commission or by individuals. The most outstanding of these species collected or observed were carp, goldfish, and the top minnow. Native game fishes have been used to restock streams, lakes and ponds and have been planted in some streams so that natural distributional limits or ranges within the state can no longer be determined. The channel catfish, Ictalurus lacustris punctatus, is an excellent example of this (Breukelman, 1940a).

All the species known to be present in each stream were not secured but the major number of them were collected. The deepest holes were investigated only by hook and line. The shyness of some of the fish and the presence of hiding places in the shallower areas often enabled them to elude the collector.

It is difficult to determine specific habitats because of the variations in the distribution of fishes at different times. It has been suggested by Forbes (1914) that these variations may be accounted for largely by the locomotive ability of fishes and also by their migratory habits.

The material revealed that most of the fishes were not very specific in the selection of their habitats. For example, the green sunfish, Lepomis cyanelus, occurred commonly in both streams and was widely distributed within each stream. The same was true of Campostoma anomalum pullum though it was not so widely distributed within each stream but showed pref-

erence for certain areas. The long eared sunfish, Lepomis megalotis breviceps, was never collected from the Ninnescah but was quite common in Spring Creek. Percina caprodes carbonaria was collected in Spring Creek but none was taken from the Ninnescah. Darters were collected from the riffles in Spring Creek and from the shallow, swift clear places in the Ninnescah.

Though a species was widespread in the stream, it was interesting to note that usually a habitat preference could be detected. The green sunfish could be secured in Spring Creek in almost any place except in very shallow water and riffles. The hauls made through areas of at least one and one-half to two feet of depth, having moderate to slow current, silty bottoms and slightly turbid water contained a greater percentage of sunfishes. In many instances, fish species present in collecting areas could be predicted to a fair degree of accuracy.

Following are the preferred habitats of the collected species as indicated by the collection data.

Family Lepisosteidae garpikes.

Gars were observed in moderate to deep areas of turbid slow-moving water over mud and silty bottoms.

Family Clupeidae, herrings.

The gizzard shad was found in only one collecting site, that of a small isolated stagnant pool of very turbid water; the bottom was deeply covered with silt and decaying

vegetable material.

Family Catostomidae, suckers.

Moxostoma was taken from an area of moderate depth, rocky, silt covered bottom and slow moving water.

Family Cyprinidae, minnows.

Small Cyprinidae. The majority of "minnows" preferred slow to moderate moving, slightly turbid water in shallow depths over rocky, gravelly, sandy and not infrequently silty bottoms. Some of these fishes were found in about any type of habitat.

Large Cyprinidae. Most of these preferred quiet water, mud bottoms and areas of abundant organic material.

Family Ameiuridae, catfishes.

Nearly all except the smallest individuals were found in moderate depths of quiet turbid waters over mud or silt bottoms; not infrequently under bank ledges.

Family Cyprinodontidae, killifishes.

These small fishes were extremely common in slow to moderate moving, slightly turbid water over a sandy bottom.

Family Poeciliidae, top minnows.

Gambusia, though not native, was extremely abundant in warmish, turbid, slow to stagnant water of shallow to moderate depth over a silty bottom.

Family Etheostomidae, darters.

Except for the log perch, Percina caprodes carbonaria, which was found in fairly deep, quiet waters, the darters

were found to frequent swift moving, clear, shallow water over gravel or sand bottoms.

Family Centrarchidae, basses and sunfishes.

Basses, large mouth and Kentucky, were found in moderate to deep holes, slow-moving, turbid water over a muddy bottom. The young were found in shallower and swifter water and weedy areas.

Nearly all the sunfishes showed a preference for moderate to deep areas of slow-moving slightly turbid water over silty bottoms. The group as a whole was fairly widespread.

In the identification of fishes collected from these streams, difficulty was encountered particularly in the determination of some species and subspecies. In Kansas, there are present several intergrades of Campostoma and Pimephales (Breukelman, 1940a). Also there are variations between the northern and southern forms of the same species, thus rendering recognition difficult.

## SUMMARY

Fishes were collected from the South Ninescah River and Spring Creek between August, 1944 and August, 1946. Ecological studies were made at the time of collections. A preliminary determination of species present in these streams was made. Preferred habitats of the fishes present were determined by the compilation of the data secured from ecological studies of the streams.

Thirty-five species and subspecies of fishes were collected representing 23 genera and nine families. Of these, six were found in both streams, 16 occurred only in Spring Creek and 13 were found only in the South Ninescah.

The South Ninescah River was found to be a fairly typical prairie stream and Spring Creek was found to possess the characteristics of a modified savannah stream. In both streams there were habitats that were similar but each had some very widely differing habitats. Both streams support an abundance of fishes. Probably the most important ecological factors in these streams determining fish distribution were the nature of bed and banks, the exposure of the stream and the current.

Most of the fish species showed a preference as to habitat, some rather specifically, while other species were quite widespread. When only one or two specimens of a species were taken, however, a habitat preference could scarcely be shown.



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