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To the Graduate Council:

I am submitting herewith a thesis written by Wayne Calvin Starnes entitled "Fish Fauna of the Hatchie River System." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Zoology.

David A. Etnier
Major Professor

We have read this thesis
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FISH FAUNA OF THE HATCHIE RIVER SYSTEM

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Wayne Calvin Starnes

June 1973

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ABSTRACT

This thesis reports the findings of an ichthyofaunal survey of the Hatchie River system of northern Mississippi and southwestern Tennessee. This system represents the only drainage in that region which has not undergone large scale channelization, and it had previously been poorly collected. This survey was conducted mainly during August of 1972 with additional collections from other years also reported. Collections were made from the majority of streams in the entire drainage, and several methods were employed including seining, gill netting, trap nets, and the principal method, chemical application. A total of 108 collections is included, and the findings are presented in the annotated listing of species followed by a discussion of taxonomic and zoogeographical considerations. Of the 109 species speculated to occur in the system, 90 were substantiated by collection records. The results of this thesis revealed the presense of a rich Mississippi Valley fish fauna in the Hatchie River system which should remain as such if future channelization proposals and careless agricultural practices are suppressed.

TABLE OF CONTENTS

CHAPTER		PAGE
INTRODUCTION		1
I.	PROFILE OF THE RIVER	3
II.	SURVEY METHODS	8
III.	FISHES OF THE RIVER SYSTEM	10
IV.	DISCUSSION	36
BIBLIOGRAPHY		51
APPENDIX		54
VITA		67

INTRODUCTION

This thesis is written to report and discuss the findings of an ichthyofaunal survey of the Hatchie River system of northern Mississippi and southwestern Tennessee. The Hatchie River system is quite imposing and difficult to collect, with many areas of deep water, deep mud, detritus, cypress growth entanglement, and limited accessibiltiy; thus, it has been poorly collected in the past. Virtually no collection records have been published from the Hatchie system. Evermann (1915), who was a principal early collector of the southern region along with D. S. Jordan, reported no collection from the Hatchie for either himself or Jordan. Hay (1883) reported on fishes of the lower Mississippi drainage but collected no further north than the Tallahatchie system in Mississippi. Further survey of more recent literature and correspondence with investigators at institutions which conduct ichthyological work in the southern region revealed that most workers have none or, at most, one or two small collections from the Hatchie system.

The Hatchie River system is the only remaining unchannelized river system in West Tennessee. All neighboring systems have suffered large scale channelization accompanied by extensive habitat destruction. Thus, this survey represents a listing of the fish fauna of this river before it could be reduced by any future channelization efforts or by the deleterious effects of agricultural chemicals. It is hoped that the findings of this thesis will serve in aiding to deter any future plans concerning the channelization of the Hatchie

River or its tributaries and make known the rich fish fauna which could be endangered by continued careless employment of agricultural chemicals in the area.

CHAPTER I

PROFILE OF THE RIVER

I. GEOGRAPHY AND GEOLOGY

The Hatchie River system has its origins in the gentle rolling hills of northwestern Mississippi and flows generally northwestward across the lowlands of southwestern Tennessee to its confluence with the Mississippi River (Figure 1). Two major component tributaries, the upper Hatchie and the Tuscumbia River, combine to form the larger portion of the river. The Tuscumbia seems to be the slightly larger of the two rivers in volume of flow. From the confluence of the major headwater components, the main Hatchie flows generally westerly and enters the Mississippi River some 30 air miles north of Memphis, Tennessee. The entire Hatchie system is some 110 air miles in length, but the extreme meanderings of the larger portion of the river result in a system approximately 185 actual river miles in depth.

The origins of the Hatchie system lie upon the Owl Creek Formation (Figure 2), as does that portion of the drainage in McNairy County, Tennessee (Pond, 1933). This formation is chiefly sand and very hard clays with an average altitude of 500 ft. in the areas of stream origin. The Hatchie's northwestward course carries it down the slopes of the Owl Creek Formation and across the Wilcox Group (Figure 2). The eastward component of the group, the Holly Springs Formation composed of sandy clays, slopes westward at approximately 3 ft. per mile, dropping from 450 ft. to 300 ft. The western component, the Grenada Formation of silt and sandy clay, continues westward at a more gentle gradient of 1 ft. per mile and meets the Pleistocene loess deposits at an altitude

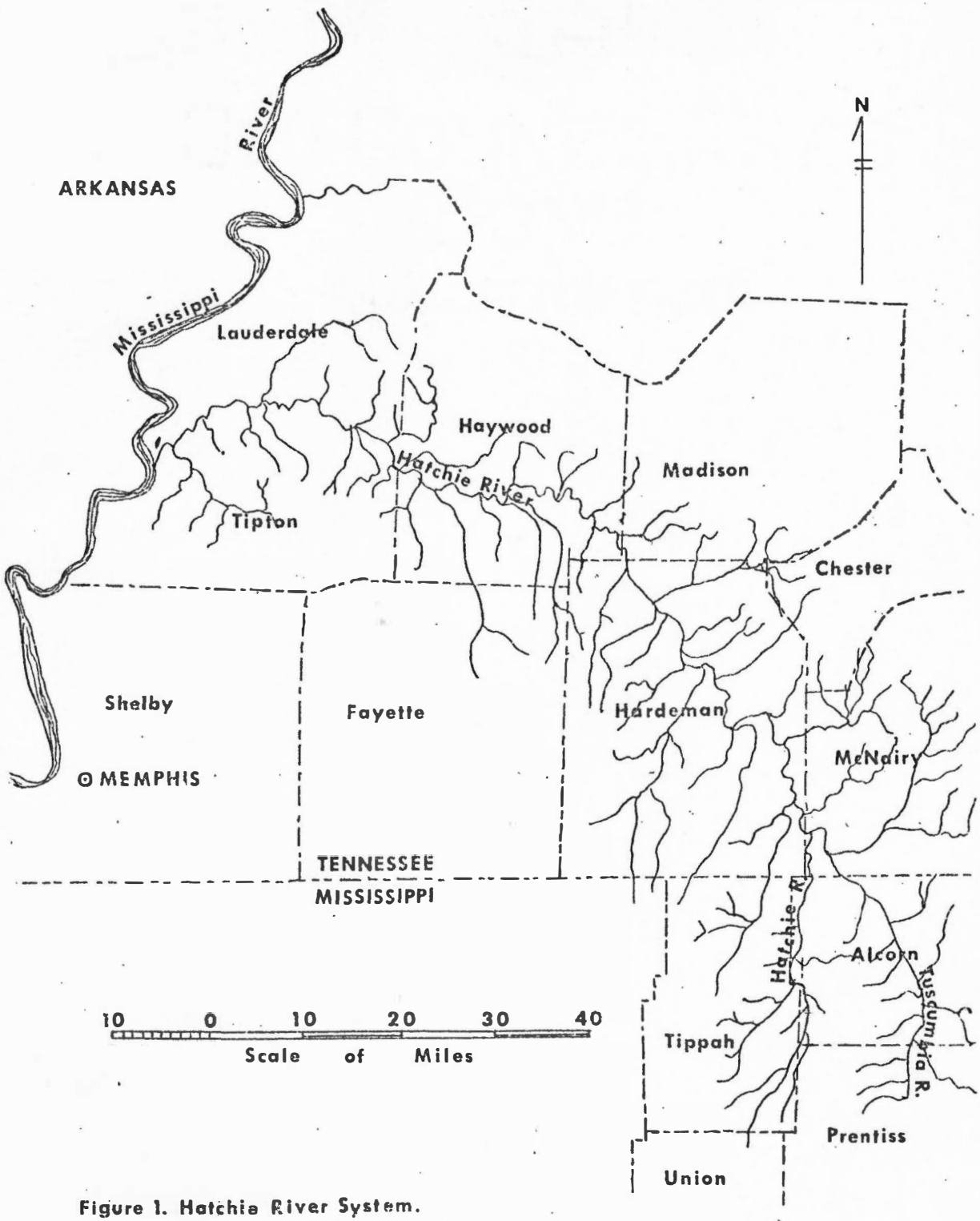


Figure 1. Hatchie River System.

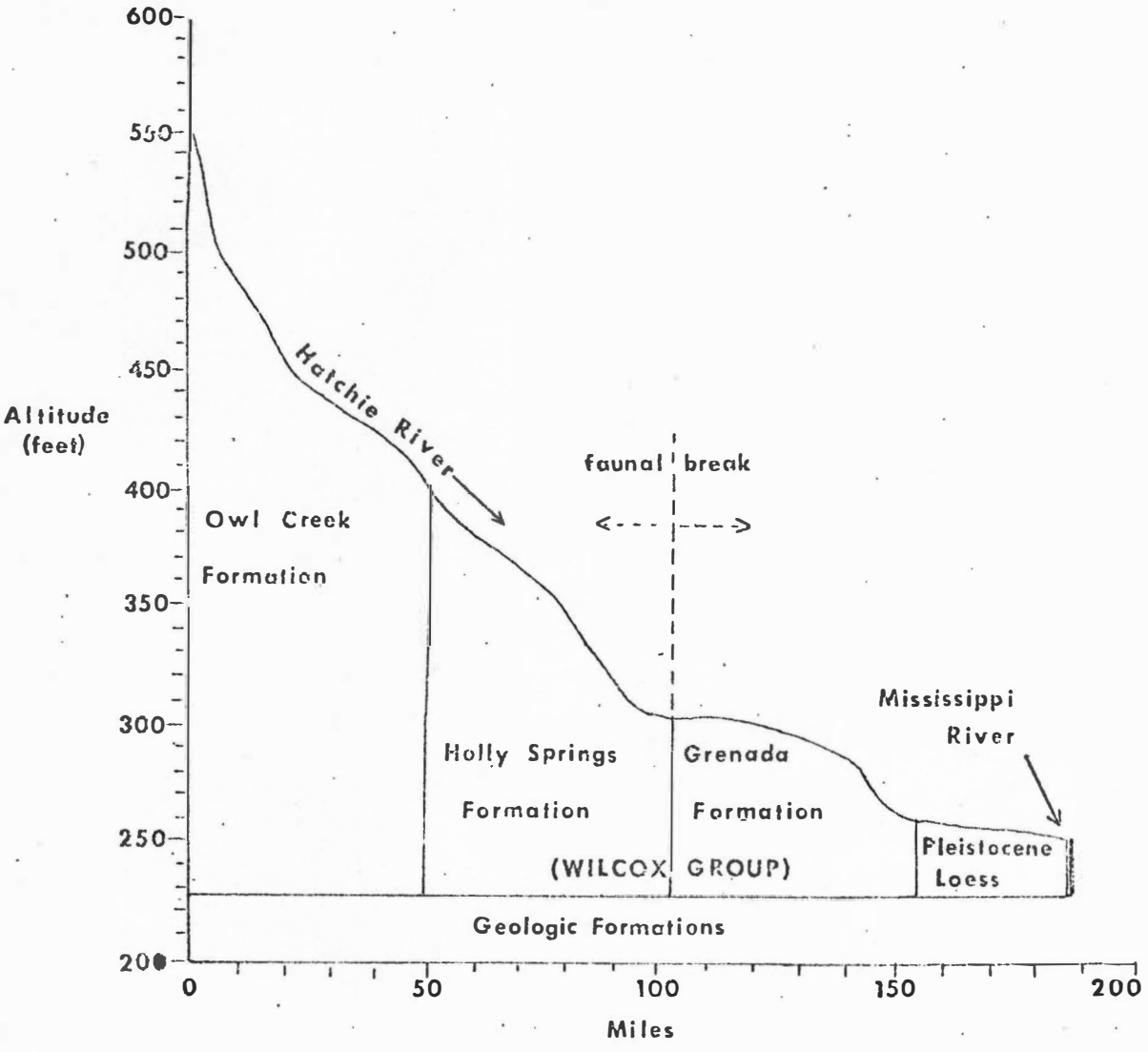


Figure 2. Geologic Drainage Profile of the Hatchie River System. (also showing faunal break)

of about 250 ft. (Figure 2); the loess continues the remaining 20 miles to the confluence with the Mississippi River at about 250 ft.

II. ECOLOGICAL CONSIDERATIONS

The Hatchie River system must be considered a lowland drainage throughout its entire length, although the upper portions of the system offer habitats considerably varied from those of the lower part. Tributaries flowing over the hard clay and sand of the Owl Creek Formation tend to have a moderate current, clean substrates, and low turbidity except during periods of heavy rainfall. The Holly Springs Formation to the west has similar characteristics, and average stream gradient in tributaries flowing over both it and the Owl Creek Formation are greater than the main channel--about 15 ft. per mile. In contrast, the much flatter Grenada Formation and Pleistocene loess deposits are typified by very sluggish streams with a heavy silt load causing constant turbidity. Gradients of this area typically are less than 5 ft. per mile in the tributaries and 1 ft. per mile in the main river. The effects of these contrasting conditions on distribution of some fish species are pointed out in the discussion.

Fish species preferring medium to larger streams find habitat in the several larger tributaries in the Hatchie system. Cypress, Muddy, Rose, and Mosses Creeks of McNairy County, and Spring, Piney, and Clover Creeks of Hardeman County (Figure 1) are large tributaries which contribute significantly to this habitat. Of special note is Spring Creek which is the largest tributary in the central portion of the system and offers an extentive and varied habitat of completely unchannelized and unpolluted waters.

Scattered throughout the system along the main course of the river are several oxbow lakes. These lakes are found along the entire length of the main river from Champion Lake in western Lauderdale County to the lower Tuscumbia River in Alcorn County, Mississippi. These oxbows provide a rich habitat for species which prefer swampy conditions such as still water, detritus and mud bottom, and cypress growth.

Nearly all of the northward flowing tributaries in Haywood and Tipton Counties and the southward draining creeks of Lauderdale County (Figure 1, page 4) are intermittent above the level of the Hatchie floodplain. A few exceptions include the larger tributaries, Bear and Muddy Creeks of Haywood County and Cane Creek of Lauderdale County.

The Hatchie River has been spared the effects of industrial pollution thus far, as virtually no industry exists along its banks. However, agricultural chemicals are a constant pollution threat to the system, since the entire watershed is heavily cultivated for soybean and cotton production.

CHAPTER II

SURVEY METHODS

The ichthyofaunal survey for this thesis was conducted largely during August, 1972. A total of 85 personal collections was made from the Hatchie system. Field work was based from the University of Tennessee Ames Plantation at Grand Junction, Tennessee, or from sites along the river.

Collection sites were chosen through survey of Tennessee Highway Department county road maps. The Mississippi portion of the system was surveyed by the use of U.S. Geologic Survey Map NI 16-4 (Tupelo quadrangle).

Collection methods employed were seining, chemical applications, trap netting, and gill netting. Nearly all collections in the Tennessee portion of the system were conducted by application of sodium cyanide, since a great many habitats were of deep water and/or mud, filled with detritus and cypress growth, or of limited accessibility making them virtually impossible to collect effectively by conventional means. Thorough sampling of fishes which seek heavy cover, such as madtoms, and those larger more mobile species, such as suckers, would have been impossible without chemical applications.

All collections were preserved in formaldehyde and returned to the aquatic biology laboratory at the University of Tennessee for identification. Specimens were identified during the fall of 1972 with help from D. A. Etnier and assistants. Doubtful specimens were identified through the use of keys in Etnier (1970a, 1972a), Moore (1968), and Taylor (1969).

In addition to these collections, a survey of other institutions conducting ichthyological field work in the south yielded a small number of other collection records. These are included in the findings along with collection data from the Mississippi and Tennessee Game and Fish Commissions.

Collections from the lower portion of the Hatchie River were somewhat limited in this survey due to constant high water during the survey period. No collections were made downstream of the Tipton-Haywood County line in the main river due to high water in the Hatchie and Mississippi Rivers, inundating favorable collecting habitats. Therefore, it has been necessary to speculate somewhat on fish species which might have occurred therein. The upper portions of the main river and all tributaries were sampled quite thoroughly.

CHAPTER III

FISHES OF THE RIVER SYSTEM

Following is an annotated listing of all fish species which are known to occur, or thought to occur, for various reasons discussed in the annotations, in the Hatchie River system. These species are listed in the phylogenetic order set forth by Bailey, *et al.* (1970).

Family Petromyzontidae

Lampetra aepyptera (Abbott)--least brook lamprey. All lamprey specimens collected in the thesis survey were larval. Since all available keys are based on adult specimens, these were not identifiable to species. However three specimens of brook lamprey were present in 1970 collections from Spring Creek in Hardeman County (Etnier, 1971). Other lamprey species probably present are *Ichthyomyzon castaneus* Girard and *I. gagei* Hubbs and Trautman.

Scaphirhynchus platorynchus (Rafinesque)--shovelnose sturgeon. No specimens of sturgeon were collected. However, shovelnose sturgeon were reported by experienced commercial fishermen in the area and are presumed to exist in small numbers in the larger portion of the main river.

Family Polyodontidae

Polyodon spathula (Walbaum)--paddlefish. No specimens of paddlefish were collected. However, one small specimen was reported taken by a Tennessee Game and Fish officer while angling (personal communication, Everett Smith, Haywood County, 1972), and other records

were reported by commercial fishermen. Therefore, it is presumed that small numbers of this species share the larger river habitat of the shovelnose sturgeon.

Family Lepisosteidae

Lepisosteus oculatus (Winchell)--spotted gar. Specimens of spotted gar were collected only while gill netting in Champion Lake in Lauderdale County. This lake offered an environment of still water 4-6 ft. in depth containing heavy vegetation and cypress growth about the edges and open water in its center. This species is probably common in all such habitats throughout the system and possibly in the main river.

Lepisosteus osseus (Linnaeus)--longnose gar. The longnose gar was found to occur throughout the drainage in streams of all sizes. Several large specimens were collected while trap netting in the main river and smaller specimens were taken in the deeper areas of tributaries.

Lepisosteus platostomus Rafinesque--shortnose gar. Specimens of shortnose gar were taken while trap netting in the main river only. It is speculated that this species is common throughout the larger tributaries of the system and was not collected due to the fact that it does not easily succumb to collecting chemicals.

Lepisosteus spatula Lacepede--alligator gar. This large gar species was neither collected nor observed during the thesis survey. It is presumed to exist in small numbers in the lower reaches of the river based on reports of commercial fishermen that it was once

common in the lower main river, and a photograph of an 8 ft. specimen reportedly taken from the river was seen.

Family Amiidae

Amia calva Linnaeus--bowfin. Bowfin were collected and/or observed in all portions of the system from headwater tributaries in Mississippi to its lower reaches. This species seemed to prefer the still waters of oxbow lakes or the very sluggish pool areas of streams. The bowfin probably serves as one of the chief predatory species on smaller fishes in the system.

Family Anguillidae

Anguilla rostrata (Lasueur)--American eel. The American eel was not collected or reported from the Hatchie River. However, this system is tributary to the Mississippi drainage which is penetrated by this catadromous species (Eddy, 1969), and *Anguilla* surely enters this system.

Family Clupeidae

Dorosoma cepedianum (Lesueur)--gizzard shad. Gizzard shad were found to be common throughout the system. They were in great abundance in the oxbow lakes and were taken in moderate numbers while trap netting in the main channel. Occasional specimens were taken in smaller streams from the pool areas.

Dorosoma petenense (Gunther)--threadfin shad. One specimen of threadfin shad was present in a 1956 Game and Fish Commission survey collection from the main river in Haywood County, but none were

collected in the thesis survey. This species probably occurs in small numbers throughout the main river.

Alosa chrysochloris (Rafinesque)--skipjack herring. This larger river species was not present in any collection from the system, but is common throughout the larger tributaries of the Mississippi drainage (Moore, 1968 and Eddy, 1969). This species is probably present in the larger portion of the river.

Family Hiodontidae

Hiodon alosoides (Rafinesque)--goldeye. Fifteen specimens of goldeye were taken in a 1963 Game and Fish Commission survey of the main river in Haywood County. This species was not collected in the tributaries and is probably restricted to the main channel.

Hiodon tergisus Lesueur--mooneye. No specimens of mooneye were collected. Mooneye have been collected in the Mississippi River near the mouth of the Hatchie (Etnier, 1973) and are presumed to enter the main river channel.

Family Esocidae

Esox americanus Lesueur--grass pickerel. Grass pickerel were common throughout the entire system in small streams. This species was collected from the pool areas of these streams and probably serves as an important predator on small fishes.

Esox niger Lesueur--chain pickerel. This member of the pike family was observed to reach large size in the Hatchie system as evidenced by several 2 ft. specimens collected in the main river and in Champion Lake. Thus, the chain pickerel probably serves as one

of the largest predatory species in the system. This species was present throughout the system in moderate numbers, but was considerably outnumbered in the smaller streams by the grass pickerel.

Family Cyprinidae

Carassius auratus (Linnaeus)--goldfish. Two large specimens of goldfish were taken in a small unnamed tributary to the Hatchie in Hardeman County. It is presumed that this fish is introduced into the system from time to time as a discard from bait buckets and aquaria, but has established no large populations.

Cyprinis carpio Linnaeus--carp. The carp was present in considerable numbers in surveys conducted in the main river by the Tennessee Game and Fish Commission. It is probably very abundant in the main river and occurs to a lesser extent in the larger tributaries.

Hybognathus hayi Jordan--cypress minnow. Cypress minnows were collected in considerable numbers from a beaver-dammed tributary to Porter's Creek in Hardeman County and in Little Muddy Creek in Haywood County. In addition, a single specimen was recorded from Spring Creek and two specimens were taken from Magbee Branch in Hardeman County. A small number were taken in a Mississippi Game and Fish survey of an oxbow of the Tuscumbia River. Thus, this species appears to be widespread but rare in the system. It was collected from habitats of still to sluggish water over mud substrates with abundant vegetation and/or cypress root growth.

Hybognathus nuchalis Agassiz--silvery minnow. This cyprinid was widespread and abundant throughout the system in streams of all

sizes. It was abundant in the sluggish pool areas of small streams over sand or mud substrates and was common about the edges of deeper portions of the main river.

Hybopsis aestivalis (Girard)--speckled chub. No specimens of *H. aestivalis* were collected in the Hatchie system, but it has been collected in large numbers in the Mississippi River near the mouth of the Hatchie (Etnier, 1970b) and possibly enters the lower reaches, especially if the gravel substrates it prefers occur there.

Hybopsis storeriana (Kirtland)--silver chub. This large river species was not collected anywhere in the system, but it is present in large numbers in the Mississippi River near the mouth of the Hatchie (Etnier, 1970b) and presumably frequents the larger portions of the lower main channel where collections are lacking.

Notemigonus crysoleucas (Mitchell)--golden shiner. This minnow was common in pool areas of streams of all sizes throughout the system.

Notropis sp. (of *N. longirostris*). Large schools of this undescribed species were common in the shallow headwater streams of northern Mississippi and Hardeman County, Tennessee. They were always collected in areas of moderate current and depth 1 ft. or less over sand substrates. This species appeared to be in full spawning colors in August.

Notropis amnis Hubbs and Greene--pallid shiner. This shiner species was present only in collections taken from the main river and larger tributaries in McNairy and Hardeman Counties. *N. amnis* was present in moderate numbers in collections from the larger portions of the Hatchie but was rare in upstream collections. It was always

collected in areas of moderate current, 3 or more feet in depth, over sand substrates.

Notropis atherinoides Rafinesque--emerald shiner. The emerald shiner was taken sporadically in collections from all portions of the main river in areas of moderate current and depth 3 or more feet over sand or mud substrates. It is presumed common throughout the main river and larger tributaries where depth affords suitable habitat.

Notropis camurus (Jordan and Meek)--bluntface shiner. The bluntface shiner was found to be extremely abundant in the small to medium sandy streams of the upper and central portions of the system but was not present in collections from the low lying sluggish streams west of Hardeman County. Few specimens were present in the main river samples.

Notropis cornutus (Mitchell)--common shiner. The common shiner was abundant in collections from the smaller headwater tributaries of the system in Mississippi and in McNairy and Hardeman Counties in Tennessee. This species was usually taken in pool areas fed by moderate current having either mud or sand substrates. It was not present in the lower gradient streams of the lower half of the system.

Notropis blennius (Girard)--river shiner. This large river species was not collected in the Hatchie system but has been collected near the mouth in the Mississippi River (Etnier, 1971) and thus is presumed to enter the lower reaches of the river.

Notropis buchanani Meek--ghost shiner. Like *N. blennius*, this shiner was not collected other than in the Mississippi River (Etnier, 1972b) but is presumed to enter the lower portions of the Hatchie.

Notropis emiliae (Hay)--pugnose shiner. This minnow was present in moderate numbers in collections taken from the sluggish creeks of the lower half of the system and in those backwater portions of the main river lacking current. It was very rare in the moderately flowing upper portions of the system with only a single specimen being taken in the Tuscumbia River.

Notropis fumeus Evermann--ribbon shiner. The ribbon shiner was taken in considerable numbers in streams of all sizes throughout the system. It was present in a variety of habitats including moderately flowing or sluggish streams of varying depths and substrates, and it is one of the most common and universally distributed cyprinids in the system.

Notropis lutrensis (Baird and Girard)--red shiner. Collections of the red shiner were taken only from small tributaries to the lower Hatchie on the Mississippi flood plain. This species was collected only in the Indian Creek system of Tipton County and in Cane Creek in Lauderdale County. Both streams are sluggish, 2-5 ft. deep (Cane Creek has recently undergone complete channelization), and have a mud and detritus substrate.

Notropis maculatus (Hay)--taillight shiner. Specimens of *N. maculatus* were present only in collections taken from oxbow lakes in Lauderdale and Haywood Counties in Tennessee and Alcorn County, Mississippi, and were also present in a beaver-dammed tributary to Porter Creek in Hardeman County. The taillight shiner was collected in still waters in areas of dense vegetation 1-4 ft. deep, and it is probably limited to those localities in the system where such habitat is afforded, chiefly the oxbows.

Notropis shumardi (Girard)--silverband shiner. The silverband shiner, which has been collected with *N. blennius* in the Mississippi River (Etnier, 1972b), may enter the lower Hatchie River.

Notropis umbratilis (Girard)--redfin shiner. This shiner species was widespread but not abundant throughout the small tributaries of the entire system. It was usually collected in pool areas of sluggish current, two or more feet in depth, and over mud bottom.

Notropis venustus (Girard)--blacktail shiner. The blacktail shiner was common only in collections taken from the Tuscumbia River portion of the upper Hatchie system, and few specimens were taken in collections from the main river in the central portion of the drainage; furthermore, this species was usually collected in water 3 or more feet in depth, over sand substrates, and with sluggish to moderate current.

Notropis volucellus (Cope)--mimic shiner. This cyprinid was not collected in the system but is presumed to enter the lower Hatchie due to its occurrence in the Mississippi River (Etnier, 1972b) near the mouth of the system.

Phenacobias mirabilis (Girard)--suckermouth minnow. The suckermouth minnow was present in a single collection taken from Frog Branch of the Indian Creek system in Tipton County, and an additional specimen was present in a 1963 Mississippi Game and Fish survey collection from the Tuscumbia River. Frog Branch is a small stream with mud and rubble substrates and moderate current, while the Tuscumbia offered a habitat of moderate current over sand bottom

and 2 foot depth. These records indicate that this species is probably widespread but rare in streams of moderate current throughout the system.

Pimephales notatus (Rafinesque)--bluntnose minnow. This minnow was common in collections from small and medium tributaries throughout the system wherever moderate current and sand substrates were present. Its only occurrence in the lower portion of the system was in Frog Branch in Tipton County which offered a habitat more similar to the upland streams. *P. notatus* was also taken rarely in main river collections where it was far outnumbered by its relative, *P. vigilax*.

Pimephales vigilax (Baird and Girard)--bullhead minnow. The bullhead minnow was common in collections from the main river throughout the length of the system but was not present in tributary collections and apparently is restricted to moderately flowing areas over sand or mud substrates in the main river.

Semotilus atromaculatus (Mitchell)--Creek chub. Creek chubs were very common in collections from smaller tributaries throughout the system wherever some current existed, being taken chiefly from the deeper pool areas.

Family Catostomidae

Carpiodes carpio (Rafinesque)--river carpsucker. The river carpsucker was taken in a single collection from Indian Creek in Tipton County. It is also reported to be often taken in the main river by commercial fishermen, and is presumed common throughout the main river and larger tributaries.

Carpiodes cyprinus (Lesueur)--quillback carpsucker. The quillback carpsucker was taken in large numbers in a 1963 Tennessee Game and Fish survey of the Hatchie River in Haywood County and, though it was not collected in the thesis survey, is presumed to be common in the main river.

Cycleptus elongatus (Lesueur)--blue sucker. No specimens of blue sucker were collected. However, nine specimens were taken in the Tennessee Game and Fish survey of the main river in Haywood County in August, 1963. Commercial fishermen report blue sucker runs occur in the river each February. Thus, this species must occur in moderate numbers in the main river.

Erimyzon oblongus (Mitchell)--creek chubsucker. Chubsuckers were present in considerable numbers in collections taken from the tributary creeks having moderate current and sand substrates in the upper half of the system. *E. oblongus* was also present in Indian Creek collections from Tipton County in the lower portion of the system where similar habitat was afforded.

Hypentelium nigricans (Lesueur)--northern hogsucker. Hogsuckers occurred in small numbers in collections from the larger sandy tributaries in Hardeman County, principally Spring Creek, and from one collection in the main river in McNairy County. This species seemed to be limited to streams of considerable size and to areas of moderate current over sand substrate 2 or more feet in depth in the central portion of the system.

Ictiobus bubalus (Rafinesque)--smallmouth buffalo. Specimens of smallmouth buffalo were present in the 1963 Game and Fish Commission

survey collection from the main river in Haywood County and are reported to be common by commercial fishermen. This species is probably restricted to the larger portions of the main river.

Ictiobus cyprinellus (Valenciennes)--bigmouth buffalo. A single bigmouth buffalo specimen from the main river was obtained from a commercial fisherman in Haywood County, and the species is reported taken frequently in trap nets. The distribution of this fish probably closely approximates that of *I. bubalus* in the main river.

Ictiobus niger (Rafinesque)--black buffalo. No specimens of black buffalo were collected, but it was reported to be present in the river by commercial fishermen. The Hatchie system lies well within the range of this river species (Moore, 1968), and it has been collected by the author in the nearby Obion system. Thus it is presumed to be present in the main river.

Minytrema melanops (Rafinesque)--spotted sucker. Spotted suckers were present in collections from the deeper pools of small to medium creeks in McNairy and Hardeman Counties. This sucker was not present in main river collections but probably occurs there.

Moxostoma erythrurum (Rafinesque)--golden redhorse. A tuberculate specimen of golden redhorse was taken in Muddy Creek, an eastern tributary to the Hatchie in McNairy County, in an April, 1971, University of Connecticut collection (personal communication, W. R. Whitworth, University of Connecticut, 1973). This single representation of this species suggests that it is rare in the system as much redhorse habitat yielded only the related species, *M. poecilurum*.

In the area of collection, Muddy Creek is a small stream of average depth of 1 to 2 feet and moderate current over sand substrates. The presence of *erythrurum* in this small stream habitat is almost certainly attributable to spawning activity.

Moxostoma poecilurum (Jordan)--blacktail redhorse. The blacktail redhorse was collected in the larger tributaries of Hardeman County and in the main river in McNairy County. In each case, this sucker species was taken from pools being fed by moderate current with sand substrates and is presumed to be present where these conditions exist throughout the main river and larger tributaries.

Family Ictaluridae

Ictalurus furcatus (Lesueur)--blue catfish. Although no specimens of blue catfish were taken in the thesis survey, 231 specimens were taken in the 1963 Game and Fish Commission survey of the main river in Haywood County, and they are also reported to be common in commercial fishermen's catches. This species is probably restricted to and common in the main river, as it was not collected in any tributaries, and is probably far outnumbered in the system by its near relative, *I. punctatus*, which was abundant in many collections.

Ictalurus melas (Rafinesque)--black bullhead. This bullhead species was found in small tributaries thoughout the system, usually in areas 1 or more feet in depth with mud bottoms. No specimens were present in main river collections, and it was rare in larger tributaries.

Ictalurus natalis (Lesueur)--yellow bullhead. The yellow

bullhead was common in collections from streams of all sizes throughout the drainage being taken from pool areas or deep runs with sluggish current. It was much more common in larger tributaries than *I. melas*, and it was present in main river collections.

Ictalurus punctatus (Rafinesque)--channel catfish. Channel catfish were abundant in all collections from the main river and from Champion Lake; in addition, young of the year specimens were also recorded from scattered larger tributary localities. This desirable food species seems to flourish in the system.

Noturus gyrinus (Mitchell)--tadpole madtom. Occurrence of this madtom was largely restricted to the sluggish tributaries of the lower portion of the system and to the oxbow lakes. However, two specimens were collected in the Tuscumbia portion of the main river in McNairy County. Those collections from the oxbows and sluggish streams were from still water 1 or more feet in depth, having mud bottom and much detritus.

Noturus hildebrandi (Bailey and Taylor)--least madtom. Specimens of this small madtom were in collections from the upper portion of the main river and from larger tributaries, chiefly Spring and Piney Creeks. It was frequently found associated with vegetation in areas of moderate current over sand substrates and 1 to 2 ft. depths.

Noturus miurus (Jordan)--brindled madtom. The brindled madtom occurred in small numbers in collections from the upper portion of the main river and larger tributaries, and it was common only in collections from Spring Creek in Hardeman County. It was usually

collected from small aggregations of detritus in areas of moderate current over sand bottom 1 or more feet in depth.

Noturus nocturnus Jordan and Gilbert--frecklebelly madtom. Specimens of the frecklebelly madtom were confined to one collection from Piney Creek in Hardeman County with the exception of a single specimen from the Tuscumbia River in McNairy County. This madtom was plentiful in Piney Creek and was collected from areas of sparse cover such as clumps of detritus and slightly undercut banks. This stream has a sand bottom with moderate current and it 1 to 2 ft. deep.

Noturus phaeus Taylor--brown madtom. This madtom species was very abundant in the smaller tributaries of the upper and central portions of the system. *N. phaeus* was considerably less common in collections from the larger streams of the same area, and very few were taken in main river samples. No specimens were taken in the lower portion of the system west of Short Creek in Hardeman County. This madtom was usually taken in areas of sparse cover or undercut banks in a foot or less of water in streams of moderate current and sand substrates.

Noturus stigmosus Taylor--northern madtom. This large and striking madtom was common in collections from the main river and larger tributaries of the system. It was always collected from areas of massive cover such as log jams or greatly undercut banks, and the streams at these points were usually 3 or more feet in depth with moderate to sluggish current flowing over sand and detritus.

Pylodictus olivaris (Rafinesque)--flathead catfish. Specimens

of flathead catfish from the main river were obtained from a fisherman in Tipton County, and a large number were present in a 1963 Game and Fish Commission survey collection from the main river in Haywood County. No specimens of flathead catfish were present in tributary collections, so this species appears to be largely restricted to the main river.

Family Aphredoderidae

Aphredoderus sayanus (Gilliams)--pirate perch. The pirate perch was very common in collections from streams of all sizes throughout the system. It was generally collected in the sluggish pool areas of streams over substrates of all types.

Family Cyprinidontidae

Fundulus notatus (Rafinesque)--blackstripe topminnow. The blackstripe topminnow was plentiful in the tributaries and oxbows of the lower portion of the drainage west of Hardeman County. It was present only in a beaver-dammed tributary to Porter Creek, Spring Creek, and Piney Creek in the higher portion of the drainage. It was always collected in the quiet water of pools or in the backwaters of larger streams and was common about the edges of oxbow lakes, especially where cover was afforded.

Fundulus notti (Agassiz)--starhead topminnow. Specimens of the starhead topminnow were collected only from Champion Lake in Lauderdale County. Here they were taken from areas of dense vegetation in water 3 to 4 feet in depth. This species appears to be restricted to this lake in the extreme lower part of the system.

Fundulus olivaceus (Storer)--blackspotted topminnow. The blackspotted topminnow was restricted to streams in the central and upper portions of the system. It was present in the quieter areas of moderately flowing streams. This species was rare in main river collections.

Family Poeciliidae

Gambusia affinis (Baird and Girard)--mosquitofish. Mosquitofish were common in the quieter shallow areas of streams of all sizes throughout the drainage. However, it was seemingly outnumbered in most localities by other top dwelling species of the killifish family (Cyprinidontdae).

Family Atherinidae

Labidesthes sicculus (Cope)--brook silverside. Occasional specimens of the brook silverside were present in collections from streams of all sizes throughout the system, but this species was abundant only in Champion Lake in Lauderdale County. It was usually collected from the sluggish pool areas of streams and in the oxbows from areas 2 to 4 ft. in depth about the vegetation and cypress growth.

Menidia audens Hay--Mississippi silverside. This silverside species was not collected in the system, but has been collected in considerable numbers in the Mississippi River near the mouth of the Hatchie (Etnier, 1972) and is presumed to enter into and frequent the main channel of the lower river.

Family Percichthyidae

Morone chrysops (Rafinesque)--white bass. A single white bass

was present in a 1956 Game and Fish Commission survey of the main river in Haywood County. This species was not collected in the thesis survey but is speculated to be present in at least small numbers in the main channel and has probably avoided capture due to its deeper water habitat.

Morone mississippiensis Jordan and Eigenmann--yellow bass. No yellow bass were collected in the system, but it is common throughout the Mississippi Valley (Moore, 1968). Therefore, it probably enters the system and penetrates for a considerable distance, since its habitat probably approximates that of *chrysops*, which has been collected several miles upstream of the mouth.

Family Centrarchidae

Centrarchus macropterus (Lacepede)--flier. Fliers were present in collections from several scattered small stream localities in the central portion of the drainage in Hardeman and McNairy Counties with a single specimen recorded from a larger stream, Spring Creek. This sunfish was collected from the deeper pool areas of streams where cover was afforded.

Elassoma zonatum Jordan--banded pigmy sunfish. Pigmy sunfish occurred in collections from quiet water areas of the central portion of the drainage in Haywood, Hardeman, and McNairy Counties. They were restricted to pool areas of sluggish low lying creeks on the Hatchie flood plain and to the oxbow lakes, with the exception of two specimens from the Tuscumbia River in McNairy County.

Lepomis auritus (Linnaeus)--redbreast sunfish. No specimens of

redbreast sunfish were collected in the thesis survey and it probably does not naturally occur in the system. However, it has been introduced into farm ponds in the area (personal communication, Eugene Cobb, Tennessee Game and Fish, 1972) and almost certainly has escaped these to enter the system during times of flooding.

Lepomis cyanellus Rafinesque--green sunfish. Green sunfish were abundant in streams of all sizes throughout the system and were very common in the oxbow lakes. They were taken from the pool areas of streams where little current existed. This species was less abundant in the main river, but, on a system-wide basis, seems to be the most abundant contrarchid.

Lepomis gulosus (Culvier)--warmouth. The warmouth was common in collections from streams of all sizes and was very common in the oxbow lakes. It was taken from pool areas wherever cover was provided in the streams.

Lepomis humilis (Girard)--orangespotted sunfish. Collections of this sunfish were limited to a beaver-dammed tributary to Porter Creek in Hardeman County and to Champion Lake in Lauderdale County. Both localities offered a habitat of quiet, vegetation-filled, shallow water from which *humilis* was collected.

Lepomis macrochirus Rafinesque--bluegill. Bluegills were common in streams of all sizes throughout the system and were usually taken from the pool areas wherever cover was provided.

Lepomis marginatus (Holbrook)--dollar sunfish. Specimens of sunfish determined to be dollar sunfish were taken from Spring and Marshall Creeks in Hardeman County, a tributary to Carters Creek in

Haywood County, Nail and Rose Creeks in McNairy County, and Rocky Branch in Tipton County. These specimens were taken from typical sunfish habitat in the pool areas of these streams.

Lepomis megalotus (Rafinesque)--longear sunfish. The longear sunfish was abundant in collections from streams of all sizes throughout the drainage, but was not present in the oxbow lakes. This species was usually present in pools fed by at least sluggish if not moderate current.

Lepomis microlophus (Gunther)--redear sunfish. Redear sunfish were taken from Champion Lake in Lauderdale County and in a Mississippi Game and Fish survey collection from an oxbow in Alcorn County, Mississippi. These collections from localities at the extremes of the Hatchie system suggest that this species is probably widespread but not common in the system.

Lepomis punctatus (Valenciennes)--spotted sunfish. Occasional specimens of spotted sunfish were present in collections from scattered localities in the central and lower portions of the system including tributaries, the main river in McNairy County, and Champion Lake in Lauderdale County. It was usually collected from deep pool areas having little or no current and heavy cover.

Lepomis symmetricus Forbes--bantam sunfish. This diminutive sunfish was present only in samples from Champion Lake in Lauderdale County where it was collected from areas of dense vegetation and cypress growth in 3 to 4 feet of water. This species may be restricted to this locality in the system.

Micropterus punctulatus (Rafinesque)--spotted bass. The spotted

bass was collected in small numbers in the 1956 and 1963 surveys of the main river conducted by the Tennessee Game and Fish Commission in Haywood County. A large specimen was also taken and released during the thesis survey. This species is probably widespread but not common in the main river and larger tributaries of the system.

Micropterus salmoides (Lacepede)--largemouth bass. The largemouth bass was common though not abundant in collections from the main river and larger tributaries of the system, and juveniles were often taken in smaller streams. The adults were collected from the deeper pool areas of streams while juveniles were taken from shallower pools having cover provided. This species probably serves as an important fish predator in the system.

Pomoxis annularis (Rafinesque)--white crappie. Though the white crappie was taken only while gill netting in Champion Lake during the thesis survey, it was present in collections of the main river conducted by the Tennessee Game and Fish Commission in 1956 and 1963. This open water species is probably common throughout the larger portion of the main river and in the oxbow lakes.

Pomoxis nigromaculatus (Lesueur)--black crappie. The black crappie was collected in Champion Lake in Lauderdale County and in Short Creek in Hardeman County. Both collections were from still waters with abundant vegetation and cypress growth 3 to 4 ft. in depth. This species is probably widespread and common throughout the system where such habitat is provided and appears to avoid the open waters frequented by *annularis*, as no specimens were present in main river samples.

Family Percidae

Ammocrypta beani Jordan--naked sand darter. Darters of the Genus *Ammocrypta* were collected from but two localities in the system, the main river in Tipton County and Spring Creek in Hardeman County. The naked sand darter was present in small numbers in both localities. In order to collect this species, it was necessary to pull the lead line of a seine hard through the sand substrates so as to dredge up its surface and dislodge the partially buried sand darters from their habitat.

Ammocrypta vivax Hay--scaly sand darter. This sand darter species was also present in small numbers in collections from both the main river in Tipton County and Spring Creek. These darters were collected from areas 2 to 3 ft. in depth nearer the edges of these streams where current was sluggish over shifting sand substrates, and it was necessary to dredge seine them in the same manner used for *beani*.

Etheostoma asprigene (Forbes)--mud darter. Single specimens determined to be mud darters were taken in Wesley Lake and from the main river in Haywood County. The oxbow lake offered a habitat of quiet water, 2 to 5 ft. in depth, with a mud bottom covered heavily with detritus; and the river habitat was one of moderate current flowing over a shifting sand substrate. These varied habitats suggest that this darter is probably widespread in the larger river and oxbows but is restricted thereto, as it was not present in any of the numerous tributary collections.

Etheostoma chlorosomum (Hay)--bluntnose darter. The bluntnose

darter was present in collections from streams of all sizes. It was present in both flowing and quiet water areas of depths a foot or more over either sand or mud substrates. It was not present in oxbow lake samples.

Etheostoma fusiforme (Girard)--swamp darter. Swamp darters were present in moderate numbers in samples from but two oxbows. Champion Lake of Lauderdale County, and another of which the name is not known near the Haywood-Tipton County line. These lakes afforded habitats of quiet water 2 to 5 ft. in depth with abundant vegetation and/or detritus with mud substrates.

Etheostoma gracile (Girard)--slough darter. Slough darters were common in collections from streams of all sizes throughout all but the uppermost portion of the system. They were present in samples from areas of sluggish to moderate current over sand or mud substrates, though it was more abundant where associated with mud.

Etheostoma histrio Jordan and Gilbert--harlequin darter. The harlequin darter was rare in collections from the system, with single specimens recorded from the main river in Haywood County, the Tuscumbia River in McNairy County, and Piney Creek in Hardeman County. Each of these localities afforded a habitat of moderate current flowing 3 to 4 ft. deep over shifting sand substrates. This species is apparently widespread but not common in the larger streams of the system where similar habitat is provided.

Etheostoma parvipinne Gilbert and Swain--goldstripe darter. Widely distributed throughout the system, the goldstripe darter was common in collections from many tributaries. It was generally collected

in areas of moderate current less than 2 ft. in depth over sand and/or hard mud substrates. It was not present in main river samples.

Etheostoma proeliare (Hay)--cypress darter. Cypress darters were present from tributaries in Hardeman and McNairy Counties and from Wesley Lake of Haywood County in the central portion of the system. These localities offered varying habitats from moderate current flowing over sand substrates in the streams to the quiet detritus-filled waters of the lake. No cypress darters were present in samples from oxbow lakes in the lower portion of the system.

Etheostoma stigmaeum (Jordan)--speckled darter. Confined mostly to the central portion of the system, collections of the speckled darter were all from the main river and larger tributaries in Hardeman and McNairy Counties with the exception of a single specimen from an unnamed tributary to the Tuscumbia in Alcorn County, Mississippi. This darter was collected from areas of sluggish to moderate current over sand or mud and cypress root bottoms.

Etheostoma (Oligocephalus) sp. This ally of *Etheostoma swaini* (Jordan) was very common in collections from the central and upper portions of the system, but was not present in samples taken west of Hardeman County. This species was common in streams of all sizes being taken from the shallow areas of less than a foot depth with moderate current over sand in streams where this situation existed. It was also present in the low lying mud bottom streams of the Hatchie flood plain in Hardeman County.

Etheostoma zonale (Cope)--banded darter. Occasional banded darter specimens were present in collections from streams of all

sizes in the central and upper portions of the system. They were most common in the medium to large tributaries and were usually found associated with vegetation in areas of moderate current 1 to 2 ft. in depth.

Etheostoma (Ulocentra) sp. Specimens of this undescribed snubnose darter were collected only in the adjacent Spring and Pleasant Creek systems in Hardeman County. These streams afforded a habitat of moderate current over shifting sand substrates 1 to 2 ft. in depth.

Percina maculata (Girard)--blackside darter. The blackside darter was of common occurrence in collections from streams of all sizes in the upper and central portions of the system, and it was present in the main river at the downstream most point collected at the Haywood-Tipton County line. It was found in water of greatly varied depth of from 1 to 4 ft. but was always in areas of moderate current and sand or gravel substrates.

Percina sciera (Swain)--dusky darter. Dusky darters occurred regularly in collections from the main river and larger tributaries in the central and upper Hatchie. Its habitat preference seemed to be sand substrates overflowed by moderate current 1 to 2 ft. in depth.

Percina shumardi (Girard)--river darter. A single small specimen of the river darter was present in a 1972 University of Tennessee Ichthyology Class collection from the main river in Tipton County. It was not present in main river samples from the central and upper portions of the system. However, this species probably occurs in moderate numbers throughout the larger portion of the main river. It

was collected in an area of shifting sand with water 3 to 4 ft. deep flowing at a moderate rate.

Percina uranidea (Jordan and Gilbert)--stargazing darter. Collections of this darter were confined to the main river and Tuscumbia River with the exception of a single occurrence in Mosses Creek in McNairy County. It was present in moderate numbers in areas of moderate current over sand and/or gravel with depths 1 to 3 ft. deep.

Family Sciaenidae

Aplidinotus grunniens Rafinesque--freshwater drum. A single specimen of drum was taken in the Tuscumbia River, but this river species is probably common throughout the main river and lower reaches of large tributaries.

CHAPTER IV

DISCUSSION

I. TAXONOMIC CONSIDERATIONS

Further discussion is necessary here to clarify the position of certain species collected from the Hatchie River system. Some of these species are of uncertain taxonomic status at this writing, while others have recently been resolved and thus may be frequently referred to in the literature by other nomenclature. Also mentioned are species for which subspecies names seem appropriate.

An undescribed ally of *Notropis longirostris* (Hay) was quite common in headwater collections from small sandy tributaries. This minnow is a member of a related group containing *N. longirostris*, *N. sabinae* Jordan and Gilbert, and probably other undescribed forms and is presently under study by Dr. R. D. Suttkus and students at Tulane University (personal communication, B. A. Thompson, Tulane University, 1973). Even superficial examination of specimens from the Hatchie reveal differences when compared with *N. longirostris* from the Escambia drainage of Alabama. Scales are noticeably larger on the Hatchie River form, usually 33-34 in the lateral-line as compared to 36-38 in *longirostris*, and it is considerably stockier. *N. sabinae*, of the Gulf Coast drainages of Texas and Louisiana, generally has lateral-line scales 32-33 (Moore, 1968).

Gibbs (1961) recorded no collection of *Notropis camurus* from the Hatchie system, but gave records (1963) of a closely related

form, *Notropis whipplei* (Girard), from the neighboring Loosahatchie and Forked Deer systems. These records indicate that Gibbs felt that West Tennessee forms were *whipplei* rather than *camurus*. It seems likely that Gibbs' records of *whipplei* from the Loosahatchie and Forked Deer are misidentifications of *N. camurus*.

Another cyprinid of uncertain taxonomic status at this writing is the Hatchie representative of the common shiner here referred to in the annotated listings as *Notropis cornutus*. The form which is distributed in the Gulf Coast drainages from the Red River of Louisiana to the Mobile Basin was recognized as a distinct subspecies and described as such by Hubbs and Brown in 1927 (Gilbert, 1964). This subspecies name, *isolepis*, withstands regardless of the species name under which it is placed, and it is this form which occurs in the headwaters of the Hatchie system. There are two prevalent opinions as to the nomenclature of this minnow and its close relatives. Gilbert (1961) elevated a former subspecies name, *chrysocephalus*, which applied to the forms found in the central and southcentral United States, to full species status thus placing *isolepis* as a subspecies under *N. chrysocephalus*. This opinion has been challenged (Miller, 1968) and an alternate position advanced that *chrysocephalus* should remain at the subspecies level due to lack of conclusive evidence of species status; thus, *isolepis* is placed on an equal level with *chrysocephalus* and *N. c. cornutus*, the northern form, and becomes known as *N. cornutus isolepis*. It appears that much further research will have to be performed to resolve the problem concerning the species name or names of the common shiner and thus the species name

under which *isolepis* ultimately will be placed. The common shiner of the Hatchie is referred to herein as *N. cornutus isolepis* in the belief that the original scheme of nomenclature should apply until there is sufficient evidence to resolve these arguments.

Notropis emiliae has recently been placed in that genus, and its former generic name, *Opsopoeodus*, has accordingly been relegated to subgeneric position under *Notropis* (Gilbert, 1972). However, the generic name *Opsopoeodus* will probably continue to appear frequently in the literature, and the fish referred to therein will be synonymous with *N. emiliae* of the Hatchie.

The three subspecies of *Notropis venustus* have been discussed by Gibbs (1957). No collections from the Hatchie or other western Tennessee rivers were examined by Gibbs, but examination of material from the Hatchie and comparison with descriptions and ranges given by Gibbs indicate that the subspecies involved is *N. v. venustus*. This examination was conducted, however, to preclude the possibility that *N. v. stigmaturus* (Jordan) might have entered the system through headwater exchange between the Tuscumbia River and the closely adjacent Tombigbee system, especially since *N. venustus* was much more common in the Tuscumbia portion of the system.

The Hatchie system contains 11 species of the family Ictaluridae, including 6 madtoms. Two of these are worthy of note due to recent taxonomic developments. Taylor (1969) described *Noturus phaeus* from the lower Mississippi drainage through Tennessee, and this species is very abundant in the headwaters of the Hatchie. This madtom was recognized as distinct from *N. funebris* of the Gulf Coast drainages,

with which it had long been synonymized. Thus, even very recent literature may refer to specimens of this madtom from Mississippi drainages, such as the Hatchie, as *N. funebris* Gilbert and Swain, rather than *phaeus* when, in fact, they are allopatric species.

A second madtom to consider is *Noturus hildebrandi*, for which Taylor (1969) described a new subspecies, *N. h. lautus*. Taylor's investigation into the distribution of *N. h. lautus*, *N. h. hildebrandi*, and intergrade forms revealed that *N. h. hildebrandi* and intergrade forms were distributed northward in the Mississippi drainage through the Loosahatchie system which is adjacent to the Hatchie. From the Hatchie northward, however, *N. h. lautus* is the form present. Examination of specimens from the Hatchie system collected in this thesis survey corroborate Taylor's findings.

Of note now are the findings of researchers regarding the taxonomic status of the closely related killifish species *Fundulus olivaceus* and *Fundulus notatus* (Cyprinidontidae), both of which were found to be common in the Hatchie system. In an attempt to dispel the beliefs of some researchers that these species are conspecific, Thomerson (1966) found through hybridization experiments that, though *olivaceus* and *notatus* are completely interfertile, they maintain separation in nature due to differences in ecological preferences, thus rarely hybridizing, and should be regarded as separate species based on this relationship. Braasch and Smith (1965) found many further instances of this habitat separation in nature. The findings of this thesis survey certainly substantiate further these theories on ecological rather than genetic separation of these species, as a

very definite habitat separation between these topminnows evidenced itself in the Hatchie system and will be discussed more fully under zoogeographical considerations.

A darter closely related to *Etheostoma swaini* occurs in the Hatchie system and is presently in an unsettled taxonomic state, or at least this seems to be the case after examination of material. The darter in question is common throughout the headwaters and central portion of the Hatchie system. Comparison of specimens from the Hatchie with meristic data from *E. swaini* used by Ramsey and Suttkus (1965) in their description of a related form, *E. ditrema*, and with that used by Howell and Caldwell (1965) in their description of *E. nuchale* reveals drastic differences in some characters, chiefly lateral scale row counts. Ramsey and Suttkus' *swaini* series had a mean row count of 43.9, while Howell and Caldwell's material had a mean of 39.8. These figures reflect the great variability within the species even within a single drainage, since both series were from the Mobile Basin. Twenty specimens from the Hatchie had a mean total lateral scale row count of 48.2, pointing to the obvious fact that scales are considerably smaller on the Hatchie form than on those from the Mobile drainage. These specimens will be identified as *E. asprigene* with the use of existing published keys. The pigmentation and habitat differences between this form and the few specimens of typical *E. asprigene* from the lower portion of the system indicate that two taxa are involved.

The occurrence of *Etheostoma stigmaeum* in the Hatchie system has been noted in this survey and from earlier collections by W. R.

Taylor of the U.S. National Museum (personal communication, Taylor, 1973). W. M. Howell of Cornell University is currently investigating the systematics of *E. stigmaeum* and its subspecies (personal communication between W. M. Howell and D. A. Etnier, University of Tennessee, 1972). At this date, Howell agrees with researchers from the University of Tennessee Zoology Department that the Hatchie form is *E. stigmaeum stigmaeum*, which is also found in the Gulf drainages and elsewhere in the Mississippi but differs from forms found in portions of the Tennessee and Cumberland systems.

A last darter of note is *Etheostoma fusiforme*. The form occurring in the Hatchie, other Mississippi tributaries, and the Gulf drainages was originally described as *E. barratti* (Holbrook). This form has since been determined to be a subspecies of the more easterly *E. fusiforme* (Collette, 1962).

II. ZOOGEOGRAPHICAL CONSIDERATIONS

There is a definite faunal break which is evidenced by the distribution of several fish species within the system. A number of species are confined to the headwaters or upper half of the system based on collection data. A lesser number is confined to the lower portion of the system. Among those species confined to the upper portion of the system were *Notropis* sp. (of *N. longirostris*), *Notropis camurus*, *Notropis cornutus*, *Hypentelium nigricans*, *Notorus hildebrandi*, *Notorus phaeus*, *Fundulus olivaceus*, and *Etheostoma swaini*. Those which exhibited exclusively lower system distributions were *Notropis lutrensis*, *Fundulus notatus*, *Fundulus notti*, *Lepomis symmetricus*, and *Etheostoma fusiforme*. Examination of the distribution of these two

groups roughly plotted on a drainage map reveals a very definite break which can be delineated in the vicinity of the Haywood-Hardeman County line. Further examination of geologic maps (Pond, 1933) reveals that this line very closely approximates the division between the two geological components of the underlying Wilcox Group, the Grenada and the Holly Springs sandy clay formations. West of this line, as discussed in the river profile, the Grenada Formation and the Pleistocene loess deposits extend in a broad flat plain to the Mississippi River. Since all species considered here are typically smaller stream inhabitants, it is of concern here that tributary creeks flowing across these formations have an average gradient of approximately 4.5 ft. per mile. Upstream of the faunal break, the Holly Springs Formation inclines to meet the considerably higher Owl Creek Formation in McNairy County which underlies most of the headwaters (see drainage profile, Figure 2, page 5), and tributaries flowing across these formations typically have steeper average gradients of about 15 ft. per mile. The result of this topography is that tributaries downstream of the break are characteristically very sluggish while those upstream of the break have moderate current. Therefore, it seems obvious that the faunal division of the two groups of fish is directly correlated to the rather abrupt increase in stream gradients and rates of flow of tributaries in the vicinity of the break. Another factor is the relative turbidities of streams in the upper and lower portions of the system. Streams in the upper portion of the system flowing upon the sand and hard clay substrates of the Owl Creek and Holly Springs Formations are much less turbid on the average than

those of the lower portion. The sluggish current of the low gradient streams below the faunal break coupled with the higher silt composition of the Grenada Formation and Pleistocene loess deposits results in high turbidity throughout the year. These substrate compositions just discussed are a third characteristic difference in the two areas which probably have considerable bearing on those species which are restricted to them. Therefore, it is apparent that species which restrict themselves above or below the faunal break do so in preference to contrasting habitats of moderate current over sand and hard clay substrates and lower average turbidity in the upper portion of the system as compared to sluggish current, mud substrates, and constant high turbidity in the lower portion. However, many lowland species not listed above may be found above the break. They are restricted to the sluggish creeks which meander across the 3-mile wide flood plain of the Hatchie, which extends upstream to the confluence of the Tuscumbia and upper Hatchie Rivers.

An excellent case in point concerning the faunal break situation is the distribution of the closely related killifish species, *Fundulus olivaceus* and *Fundulus notatus*. The distribution of these species adheres very closely to the faunal break scheme with *olivaceus* being restricted above the break and *notatus* below; however, three aberrant populations of *notatus* did occur above the break, but these were in habitats much more typical of lowland situations. This distribution corroborates the findings of Braasch and Smith (1965) concerning the habitat separation of these species in the upper Mississippi Valley. It is this typical habitat separation which strengthens the specific

status of these interfertile fish species as was discussed under taxonomic considerations.

A considerable number of species is probably added to the lower reaches of the Hatchie River by the infiltration of larger river species from the Mississippi River. Speculated to probably enter the mouth of the Hatchie from the Mississippi River proper are the following: *Alosa chrysochloris*, *Hiodon tergisus*, *Hybopsis aestivalis*, *Hybopsis storeriana*, *Notropis blennius*, *Notropis buchanani*, *Notropis shumardi*, *Notropis volucellus*, and *Menidia audens*. All of these species have been collected from the Mississippi River 3 miles downstream from the Hatchie confluence over sand and gravel substrates (Etnier, 1972b). Examination of the U.S. Geologic Survey Map of the area (NI 16-1) reveals that a sand and/or gravel bar extends some 2 miles up into the Hatchie River's mouth, and it probably provides very similar habitat to that in the main channel of the Mississippi. Thus, these nine species probably freely enter the system's mouth and ascend it for possibly several miles. These assumptions will, however, have to remain speculative for the present, since the entire area in question was deeply inundated by high river stages of the Mississippi throughout the time the thesis survey was conducted and therefore was rendered uncollectable.

Some individual species to be considered zoogeographically because of noteworthy relationships are the darters *Ammocrypta beani*, *Ammocrypta vivax*, *Etheostoma fusiforme*, *Etheostoma proeliare*, and *Etheostoma nigrum*. It appears that the only extant Tennessee populations of darters of the genus *Ammocrypta* occur in the Hatchie system.

Extensive efforts to collect these darters elsewhere in the state by members of the University of Tennessee Zoology Department have met with futility over the past few years. The occurrence of *A. beani* and *A. vivax* in the Hatchie probably indicates that these fishes once had a distribution throughout western Tennessee, but the extensive channelization and resultant habitat destruction in the neighboring Forked Deer, Obion, and Loosahatchie systems has probably largely or totally eliminated them from those systems. These species were observed to actually live in the sand substrates and probably are physically removed from streams during dragline operations in channelization. The effects of replacing their required sand substrates with mud for a long period of time surely eliminates or drastically reduces reproduction. Thus the unchannelized Hatchie system probably offers a last refuge in Tennessee for these darter species.

Etheostoma fusiforme and *Etheostoma proeliare* showed an interesting distributional relationship in the drainage. Though these species prefer seemingly identical swampy habitats, *E. fusiforme* was confined to collections from Champion Lake in Lauderdale County and another oxbow in Haywood County in the lower portion of the system, while *E. proeliare* was collected from Wesley Lake in Haywood County and in some streams. Thus, in no case, were these darters collected sympatrically suggesting the possibility of some rather strong ecological competition occurring between these species in the system.

Etheostoma nigrum was not collected in the Hatchie system but

was, in fact, a notable exception. This species is quite common in collections from neighboring systems such as the Wolf (Medford and Simco, 1971), Loosahatchie (Etnier, 1970b), and Obion (Etnier, 1970b). There is no evidence to explain its absence from the Hatchie. There are no grounds to consider competitive exclusion as the explanation, since no possibly competitive species exist in areas of favorable habitat in the Hatchie which do not exist in neighboring systems where *nigrum* abounds. It is very unlikely that the species has totally avoided introduction into the system in numbers sufficient to assure reproductive success, since it occurs in systems on either side of the Hatchie and probably dispersed through it at some time. The absence of this species poses a noteworthy problem which should warrant further consideration by investigators in the future.

Next to be discussed are the possibilities of ichthyofaunal exchange between the Hatchie River system and the adjacent systems. Of first consideration is the fact that the vast majority of species found in the system also occur in neighboring systems, such as the Wolf, Loosahatchie, Obion, and possibly the Forked Deer, which also flow westward into the Mississippi. Thus it must be assumed that lateral faunal exchange has occurred between these systems with species dispersing freely through them northward or southward as the case may be. Several modes could account for this including stream capture in the headwaters of lateral tributaries, common flooding of tributary headwaters, and dispersal through the often flooded lowlands or through the Mississippi River itself.

There are, however, two species present in the upper portion of

the Hatchie system which apparently did not reach it through lateral dispersal, since they have not been collected in neighboring Mississippi tributaries such as the Wolfe River (Medford, 1969). These minnow species, *Notropis* sp. (of *N. longirostris*) and *Notropis cornutus isolepis*, may have entered the system through headwater exchange between the Hatchie and Tallahatchie drainages in Tippah County, Mississippi, or through exchange between the Tuscumbia and Tombigbee headwaters which interdigitate in Prentiss County, Mississippi. Gilbert (1964) has recorded *N. c. isolepis* from both the Tallahatchie and Tombigbee systems and corroborates its occurrence only in the Hatchie system in the Mississippi tributaries of western Tennessee. These species are the sole evidence that any exchange has actually occurred between these systems as other species common to all of them are also found in interlying drainages. Furthermore, the headwater habitat preferences of the undescribed *Notropis* and *N. c. isolepis* have apparently prevented them from descending far enough down the system to easily undergo lateral dispersion into other systems, thus restricting their occurrence to the Hatchie.

Concrete evidence of exchange between the Hatchie and Tennessee River systems is nonexistent, since there are no species peculiar to the two systems which do not also occur in other Mississippi tributaries. However, there is a distinct possibility that headwater exchange could have occurred at times in the past between the headwaters of the Hatchie and Tennessee tributaries in eastern McNairy County, Tennessee, since they do lie in close proximity.

Last to be discussed is the situation concerning the northward

flowing tributaries of Haywood and Tipton Counties and the southward draining creeks of Lauderdale County. As discussed in the profile of the river, all but the largest of these streams are intermittent, drying up in the summer. Thus a large area almost devoid of small stream habitat and those species which prefer them is present in that portion of the system and is interrupted only by Bear and Muddy Creeks in Haywood County and Cane Creek in Lauderdale County which flow throughout the year. Cane Creek, however, has recently been rechannelized, and the only other continually flowing stream, Town Creek in Tipton County, is heavily polluted from the effluent of the sewage treatment facilities in Covington. Therefore, virtually no small stream habitat exists between Haywood County and the Indian Creek system in Tipton County at the extreme lower end of the system.

III. CONCLUSIONS

The fish fauna of the Hatchie River has been found to be quite rich. Approximately 109 species are thought to exist in the drainage with 90 of these having been actually substantiated by collection records. Others are included for various reasons discussed in the annotated listings.

It is evident then that the Hatchie River system represents the fauna that probably abounded throughout this region of the lower Mississippi Valley before stream channelization drastically altered the habitats of neighboring systems. Particularly noteworthy are the 11 ictalurid species, which are probably unsurpassed in terms of numbers of species anywhere else in North America. The

Hatchie is also rich in sunfish fauna (16 species), and has an excellent representation of lowland cyprinid and percid faunas.

The effects of channelization upon the Hatchie system as a whole to date have apparently been localized. Those portions of the system that have been channelized 30 to 50 years ago, chiefly the headwaters in Mississippi and some of the larger tributaries in Tennessee, apparently have recovered to the point that nearly all original fish species are again present. However, fish population densities were observed to be drastically reduced in these streams as compared to natural habitats with the notable exception of two Hardeman County creeks. Clover and Piney Creeks apparently have managed to recover substantially due to the abundant sand in the area which has restored the substrates to near normal conditions, and these streams now support large fish faunas. It will be interesting to observe the fish fauna of recently channelized Cane Creek in Lauderdale County as it recovers from channelization. This stream was dredged less than two years prior to collection, and the only species present were those which recently have invaded from the main river, chiefly carp and catfish. Recovery of streams such as Cane Creek in the lower portion of the system will probably be slow or nonexistent, because heavy silt runoff from area soils prevents restoration of suitable substrates, and there has been extensive loss of natural cover such as brush and cypress root growth.

The greatest threat to the rich fish fauna of the Hatchie River system comes at present from agricultural practices. Great amounts of insecticides and chemical fertilizers are added to soils in

the area, as much of the watershed is under cultivation for soya bean and cotton production. These chemicals enter area streams during periods of runoff from heavy rains and also are sprayed directly into streams by crop-dusting aircraft. An actual fish kill was observed in Tarebreeches Creek in Alcorn County, Mississippi, following a heavy rain, and this occurrence is probably commonplace in those portions of the system which are heavily cultivated. Thus far, the effects of farm chemicals seem to be restricted to the smaller streams with the main river escaping any serious consequences due to adequate dilution of these chemicals. It is hoped that area crop producers will become more aware in the future of the effects of agricultural chemicals on aquatic life and will curb these practices before widespread destruction of fish and other aquatic life can occur in the Hatchie, or that legislation will be passed governing these practices.

In conclusion, the Hatchie River system represents a refuge for lowland species which cannot withstand the effects of massive habitat destruction, and the rich fauna of the system should remain as such and provide invaluable material for future ichthyofaunal studies of the Mississippi Valley if channelization and careless agricultural practices are curbed in the near future.

BIBLIOGRAPHY

BIBLIOGRAPHY

Bailey, R. M., J. E. Fitch, E. S. Herald, E. A. Lachner, C. C. Lindsey, C. R. Robins, W. B. Scott. 1970. A list of common and scientific names of fishes of the United States and Canada. American Fisheries Society Special Publication N. 6:1-149.

Braasch, M. E., and P. W. Smith. 1965. Relationships of the Topminnows *Fundulus notatus* and *Fundulus olivaceus* in the Upper Mississippi Valley. Copeia 1965 (1):46-53.

Collette, B. B., and R. W. Yerger. 1962. The American Percid Fishes of the Subgenus *Villora*. Tulane Studies in Zoology 9(4):213-230.

Eddy, S. 1969. How to Know the Freshwater Fishes. Wm. C. Brown Co., Dubuque, Iowa. 286 pp.

Etnier, D. A. 1970a. Key to the Family Cyprinidae in Tennessee. Unpublished Manuscript. Pp. 1-23.

_____. 1970b. Summary of Fish Collections in Tennessee for the Year 1969. Unpublished Report. Pp. 1-11.

_____. 1971. Summary of Fish Collections in Tennessee for the Year 1970. Unpublished Report. Pp. 1-6.

_____. 1972a. Key to the Percidae of Tennessee. Unpublished Manuscript. Pp. 1-22.

_____. 1972b. Summary of Fish Collections in Tennessee for the Year 1971. Unpublished Report. Pp. 1-6.

_____. 1973. Summary of Fish Collections in Tennessee for the Year 1972. Unpublished Report.

Evermann, B. W. 1915-1916. The Fishes in Kentucky and Tennessee: A Distributional Catalog of the Known Species. Document no. 858. Issued Jan. 10, 1918. Bulletin of the U.S. Bureau of Fisheries 35:293-268.

Gibbs, R. H. 1957. Cyprinid Fishes of the Subgenus *Cyprinella* of *Notropis*. III. Variation and Subspecies of *Notropis venustus* (Girard). Tulane Studies in Zoology 5(8):175-203.

_____. 1961. Cyprinid Fishes of the Subgenus *Cyprinella* of *Notropis*. IV. The *Notropis galacturus-camurus* Complex. American Midland Naturalist 66(2):337-354.

_____. 1963. Cyprinid Fishes of the Subgenus *Cyprinella* of *Notropis*. The *Notropis whipplei-analostamus-chloristius* Complex. Copeia 1963 (3):511-528.

Gilbert, C. R. 1961. Hybridization versus Intergradation: An Inquiry into the Relationship of Two Cyprinid Fishes. Copeia 1961 (2):181-192.

_____. 1964. The American Cyprinid Fishes of the Subgenus *Luxilus* (Genus *Notropis*). Bulletin of the Florida State Museum 8(2):1-194.

_____, and R. M. Bailey. 1972. Systematics and Zoogeography of the American Cyprinid Fish *Notropis (Opsopoeodus) emiliae*. Occasional Papers of the Museum of Zoology, University of Michigan, No. 664.

Hay, O. P. 1883. On a Collection of Fishes from the Lower Mississippi Valley. Bulletin U.S. Fishery Commission 2:57-75.

Howell, W. M., and R. D. Caldwell. 1965. *Etheostoma (Oligocephalus) nuchale*, a New Darter from a Limestone Spring in Alabama. Tulane Studies in Zoology 12(4):101-108.

Medford, D. W., and B. A. Simco. 1971. The Fishes of the Wolf River, Tennessee and Mississippi. Journal of the Tennessee Academy of Science 41(4):121-123.

Miller, R. J. 1968. Speciation in the Common Shiner: An Alternate View. Copeia 1968(3):641-647.

Moore, G. E. 1968. Fishes. In Blair, W. F. *et al*. Vertebrates of the United States. McGraw-Hill, Inc., New York. 616 pp.

Pond, W. F. 1933. Geologic Map of Tennessee. Tennessee Education Association, Division of Geology.

Ramsey, J. S., and R. D. Suttkus. 1965. *Etheostoma ditrema*, A New Darter of the Subgenus *Oligocephalus* (Percidae) from Springs of the Alabama River Basin in Alabama and Georgia. Tulane Studies in Zoology 12(3):65-77.

Taylor, W. R. 1969. A Revision of the Catfish Genus *Noturus* Rafinesque with an Analysis of Higher Groups in the Ictaluridae. Bulletin 282 U.S. National Museum. 315 pp.

Thomerson, J. E. 1966. A Comparative Biosystematic Study of *Fundulus notatus* and *Fundulus olivaceus* (Pisces: Cyprinidontidae). Tulane Studies in Zoology 13(1):29-47.

APPENDIX

Table I

Species Collection Summary[a]

Species	Collection Number
Lampetra aepyptera	6,7,8,17
Lepisosteus oculatus	20,66,86
Lepisosteus osseus	22,60,62,103
Lepisosteus platostomus	103
Amia calva	20,22,23,25,66,76,86
Dorosoma cepidianum	12,20,21,22,23,26,60,62,66,67,86,93,94,98
Dorosoma petenense	23
Hiodon alosoides	22,23
Esox americanus	1,2,3,4,8,12,13,14,25,26,33,39,41,42,46,48, 55,59,60,63,72,76,78,88,89,101,104
Esox niger	14,20,55,56,65,66,80,86
Carasius auratus	61
Cyprinis carpio	20,21,22,23,83,102
Hybognathus hayi	20,46,52,55,62,65,76
Hybognathus nuchalis	4,5,6,7,8,9,11,12,17,18,21,24,31,41,46,60, 63,65,67,77,103,107
Notemigonus crysoleucas	1,6,11,13,16,20,24,25,26,27,28,29,43,47,49, 51,52,53,54,55,60,62,63,65,68,72,75,76,78, 79,88,89,93,94,95
Notropis sp. (of *N. longirostris*)	5,7,9,17,18,19,24,25,26,30,31,32,34,35,37,38, 38,39,40,41,42,46,57,59,63,67,92,93,99,102
Notropis amnis	1,5,11,12,14,17,18,60,67,100
Notropis atherinoides	11,12,17,18,30,39,77,98,100
Notropis camurus	1,2,5,6,7,9,10,17,18,31,34,37,38,39,40,41,43, 46,48,49,50,57,59,60,67,68,74,97,98,102
Notropis cornutus	5,13,15,16,17,18,19,24,25,26,27,31,33,35,36, 40,41,42,43,57,59,63,64,67,87,79,90,94,95, 97,102
Notropis emiliae	1,4,11,17,18,54,60,62,65,66,74,76,100,102
Notropis fumeus	1,4,5,6,7,9,10,11,14,17,18,25,26,30,32,40,42, 43,46,47,48,49,56,57,59,60,65,66,67,68,72,77, 94,98,100,102,108

Table I (continued)

Species	Collection Number
Notropis lutrensis	83,107,108
Notropis maculatus	20,54,62,74,81
Notropis umbratilis	3,5,6,7,12,17,27,29,35,41,42,46,47,59,60,63, 67,72,89,91,93,95,97,104,108
Notropis venustus	4,10,11,14,17,18,31,32,60,77,98,100,102,103
Phenacobias mirabilis	21,108
Pimephales notatus	4,5,7,10,13,16,17,18,19,25,26,27,29,30,31,34, 35,38,39,41,43,48,45,46,50,51,57,59,60,67, 68,89,92,93,94,97,100,102,108
Pimephales vigilax	4,7,8,11,12,14,17,21,30,31,60,65,67,77,98, 100,102,103
Semotilus atromaculatus	9,13,16,17,18,19,24,25,27,29,34,35,37,40,41, 42,43,44,48,44,49,53,61,63,64,65,67,78,79, 87,92,95,96,107,108
Carpiodes carpio	22,23,25,107
Carpiodes cyprinus	22
Cycleptus elongatus	22,23
Erimyzon oblongus	13,19,25,33,34,42,45,52,59,61,63,67,68,78,87, 88,89,90,93,107,108
Hypentelium nigricans	7,17,18,45,46,47,48,59,67,68,98
Ictiobus bubulus	22,23
Ictiobus cyprinellus	84
Minytrema melanops	14,59,66,88,89,91
Moxostoma erythrurum	16
Moxostoma poecilurum	6,17,46,48,59,63,98,100
Ictalurus furcatus	22,23
Ictalurus melas	26,28,32,34,41,52,61,63,71,73,75,78,79,83, 88,93,94,105
Ictalurus natalis	2,19,20,25,26,37,39,40,52,55,60,63,65,66,67, 68,72,74,75,78,79,80,81,83,98,102,104,105, 107,108
Ictalurus punctatus	5,11,12,17,18,20,21,22,23,39,41,57,60,65,67, 83,98,102
Noturus gyrinus	4,20,50,55,56,57,62,63,66,71,72,74,75,99, 102,104,107

Table I (continued)

Species	Collection Number
Noturus hildebrandi	6,7,8,10,11,30,31,39,41,43,46,48,60,67,68, 98,102
Noturus miurus	7,10,11,14,17,18,46,60,66,67,68,98,102
Noturus nocturnus	14,67,102
Noturus phaeus	6,7,8,9,13,17,18,30,33,40,42,43,44,45,46,48, 52,53,59,60,63,64,66,67,68,78,87,89,97,98
Noturus stigmosus	11,12,17,30,48,60,65,67,98,100,102
Pylodictus olivaris	22,23,40,84
Aphredoderus sayanus	4,5,7,8,12,13,14,17,30,33,44,45,46,50,52,55, 56,59,60,62,63,64,65,66,67,68,70,72,74,79, 81,85,87,88,93,104,107
Fundulus notatus	2,3,11,43,46,54,62,63,66,67,69,72,73,74,75, 79,80,81,85,98,103
Fundulus notti	81,85
Fundulus olivaceus	4,5,6,7,8,9,13,15,17,19,20,21,25,26,27,28, 29,30,31,33,35,38,39,42,44,47,50,52,53,55, 56,59,60,61,63,64,65,66,68,87,88,89,93,97,102
Gambusia affinis	2,3,4,5,9,11,19,25,26,28,31,34,35,43,55,57,62, 63,66,67,68,69,72,73,75,76,78,80,81,83,85,88, 104,107,108
Labidesthes sicculus	11,21,25,30,54,55,56,62,66,78,77,80,81,85,99
Morone chrysops	23
Centrarchus macropterus	20,48,52,55,66,76,88,89,90,95,97
Elassoma zonatum	55,56,62,65,66,74,80,98,102
Lepomis cyanellus	5,6,9,11,13,14,24,25,27,28,29,30,31,34,35,37, 38,40,41,42,44,53,54,55,56,57,59,60,61,63, 64,65,66,67,68,73,74,75,78,79,80,83,94,102
Lepomis gulosus	4,7,10,17,20,21,25,40,41,46,50,52,54,55,59,62, 63,65,66,67,68,70,74,76,78,80,81,85,88,89, 91,97,99
Lepomis humilis	54,62,85
Lepomis macrochirus	4,5,7,8,12,13,14,17,18,20,21,22,23,25,27,29, 30,32,34,38,39,42,44,46,52,54,56,57,59,60, 62,65,69,70,71,72,74,78,81,85,88,78,99,104
Lepomis marginatus	13,45,47,79,88,95,105
Lepomis megalotus	5,6,11,12,17,18,22,23,26,27,28,32,33,46,48,52, 55,60,63,64,65,66,70,72,73,77,78,83,87,89,94, 95,96,77,102,105,107

Table I (continued)

Species	Collection Number
Lepomis microlophus	20,21,85
Lepomis punctatus	59,66,81,85,89,98
Lepomis symmetricus	85
Micropterus punctulatus	11,22,23,86
Micropterus salmoides	7,11,17,19,20,21,31,38,46,52,54,57,59,60,62,63,68,78,81,89,97,98,100,102
Pomoxis annularis	11,12,20,22,23,86
Pomoxis nigromaculatus	7,66,81,85
Ammocrypta beani	7,11,12,17,18
Ammocrypta vivax	7,11,12,18,46,103
Etheostoma asprigene	11,74
Etheostoma chlorosomum	4,5,7,8,11,12,13,18,26,28,32,47,50,55,57,59,60,66,75,76,77,89,99,100,102,104
Etheostoma fusiforme	80,81,85
Etheostoma gracile	4,5,7,13,28,30,32,48,52,56,60,66,69,75,78,88,90,100,102,104
Etheostoma histrio	5,6,11,12,17,18,67,100
Etheostoma parvipinne	2,9,13,42,44,61,64,78,90,92,93,108
Etheostoma proeliare	4,17,52,62,68,74
Etheostoma stigmaeum	7,10,17,18,27,66,68,91
Etheostoma (Oligocephalus) sp.	4,5,6,8,9,10,13,17,18,31,32,33,39,41,44,45,46,47,48,52,55,56,59,60,63,64,67,68,89,90,91,94,97,98,100
Etheostoma zonale	6,7,8,10,27,31,42,45,46,48,68,102
Etheostoma (Ulocentra) sp.	7,8,43,44,45,47,49
Percina maculata	8,9,10,12,13,14,16,18,31,33,46,57,60,63,66,89,90,95,98,100,103
Percina sciera	6,7,8,9,10,11,17,18,30,39,40,41,42,45,46,47,48,49,50,59,60,67,97,100
Percina shumardi	12
Percina uranidea	11,12,17,18,31,67,98,100,102
Aplidinotus grunniens	22,23,100,102

[a]See Table II for localities.

Table II

Collection Data

Number	Locality	Date	Collectors
1	Piney Creek at county road 8198, Hardeman Co., Tenn.	June 11, 1967	Jenkins, Snelson (Cornell Univ.)
2	Stream just south of Shandy on Tenn. 18, Hardeman Co., Tenn.	July 18, 1968	Smythe, Mackiewicz, Etnier
3	Hatchie River at Tenn. 18, Hardeman Co., Tenn.	July 18, 1968	Smythe, Etnier
4	Hatchie River at Tenn. 57, Hardeman Co., Tenn.	Oct. 18, 1968	Reese, Comiskey, Etnier
5	Piney Creek at county road 8198, Hardeman Co., Tenn.	Oct. 18, 1968	Reese, Comiskey, Etnier
6	Spring Creek at Tenn. 125, Hardeman Co., Tenn.	Oct. 18, 1968	Reese, Comiskey, Etnier
7	Spring Creek at county road 8158, Hardeman Co., Tenn.	Oct. 30, 1970	Gregory, Henson, Erickson, Etnier
8	West Fork Spring Creek 6.8 air miles northeast of Grand Junction on unnamed road, Hardeman Co., Tenn.	Oct. 30, 1970	Gregory, Henson, Erickson, Etnier
9	Cub Creek at county road 8158, Hardeman Co., Tenn.	Oct. 29, 1970	Gregory, Henson, Erickson, Etnier
10	Mosses Creek 1.3 miles north of Tenn. 57, McNairy Co., Tenn.	Oct. 30, 1970	Gregory, Henson, Erickson, Etnier
11	Hatchie River at Tenn. 54, Tipton Co., Tenn.	Oct. 17, 1971	Perry, Starnes, Oakberg, Henson, Saylor, Etnier
12	Hatchie River at Tenn. 54, Tipton Co., Tenn.	Aug. 12, 1972	U.T. Ichthyology Class
13	Unnamed tributary to Hatchie River, west edge of Hornsby on U.S. 64, Hardeman Co., Tenn.	April 19, 1969	Gilbert, Seaman, Hastings (University of Florida)
14	Hatchie River at U.S. 70-79, Haywood Co., Tenn.	June 14, 1968	Suttkus, Marynick (Tulane Univ.)
15	Creek 10 mi. east of Grand Junction on Tenn. 57, Hardeman Co., Tenn.	April 6, 1971	Schmidt, Brommer (Univ. of Conn.)

Table II (continued)

Number	Locality	Date	Collectors
16	Muddy Creek at Tenn. 57, McNairy Co., Tenn.	April 6, 1971	Schmidt, Brommer (Univ. of Conn.)
17	Spring Creek at Tenn. 125, Hardeman Co., Tenn.	Sept. 1, 1959	Taylor, Kanazawa (U.S. Natl. Mus.)
18	Mosses Creek at 1.3 mi. north of Tenn. 57, McNairy Co., Tenn.	Aug. 31, 1959	Taylor, Kanazawa (U.S. Natl. Mus.)
19	Tributary on west edge of Hornsby at U.S. 64, Hardeman Co., Tenn.	Sept. 1, 1959	Taylor, Kanazawa (U.S. Natl. Mus.)
20	First oxbow lake (of Tuscumbia R.) south of Smith Bridge Rd., Alcorn Co., Miss.	Sept. 17, 1963	Mississippi Game and Fish Comm.
21	Tuscumbia River at U.S. 72, Alcorn Co., Miss.	Sept. 18, 1963	Mississippi Game and Fish Comm.
22	Hatchie River at U.S. 70, Haywood Co., Tenn.	Aug. 21, 1963	Tennessee Game and Fish Comm.
23	Hatchie River at U.S. 70, Haywood Co., Tenn.	Sept. 27, 1956	Tennessee Game and Fish Comm.
24	Tarebreeches Creek at U.S. 72, Alcorn Co., Miss.	July 30, 1972	Starnes, Nagy, Saylor
25	Cane Creek at U.S. 72, Alcorn Co., Miss.	July 30, 1972	Starnes, Nagy, Saylor
26	Bridge Creek at U.S. 72, Alcorn Co., Miss.	July 31, 1972	Starnes, Nagy, Saylor
27	Second creek east of Corinth at U.S. 72 (1.5 mi. east of Bridge Creek), Alcorn Co., Miss.	July 31, 1972	
28	Creek .7 mi. south of Parmicha Creek at U.S. 45, Alcorn Co., Miss.	July 31, 1972	Starnes, Nagy, Saylor
29	Hinkle Creek at U.S. 45, Alcorn Co., Miss.	July 31, 1972	Starnes, Nagy, Saylor
30	Hatchie River at first bridge south of U.S. 72, Alcorn Co., Miss.	Aug. 22, 1972	Starnes, Nagy, Saylor
31	Tuscumbia River at mouth of first creek south of Parmicha Creek, Alcorn Co., Miss.	Aug. 22, 1972	Starnes, Nagy
32	Tuscumbia River at first bridge north of U.S. 72, Alcorn Co., Miss.	Aug. 22, 1972	Starnes, Nagy

Table II (continued)

Number	Locality	Date	Collectors
33	Tributary to Hatchie River 2 mi. east of Bridge Creek, Alcorn, Miss.	Aug. 27, 1972	Starnes, Wyatt
34	Pollys Creek at U.S. 45, Prentiss Co., Miss.	July 31, 1972	Starnes, Nagy, Saylor
35	King Creek at U.S. 45, Prentiss Co., Miss.	July 31, 1972	Starnes, Nagy, Saylor
36	Moore Creek at county road 4 mi. east of Tuscumbia River, Prentiss Co., Miss.	July 31, 1972	Starnes, Nagy, Saylor
37	Hurricane Creek at Miss. 15, Tipton Co., Miss.	Aug. 20, 1972	Starnes, Nagy
38	Owl Creek .8 mi. north of Miss. 4, Tippah Co., Miss.	Aug. 20, 1972	Starnes, Nagy
39	Little Hatchie River at Miss. 2, Tippah Co., Miss.	Aug. 20, 1972	Starnes, Nagy
40	Hatchie River at first county road south of Miss. 4, Tippah Co., Miss.	Aug. 20, 1972	Starnes, Nagy
41	Muddy Creek on county road 1 mi. east of Walnut, Tippah Co., Miss.	Aug. 27, 1972	Starnes, Wyatt
42	Hatchie River at first county road south of Tippah County line, Union County, Miss.	Aug. 20, 1972	Starnes, Nagy
43	East Fork Spring Creek at Tenn. 57, Hardeman Co., Tenn.	Aug. 3, 1972	Starnes, Nagy, Saylor
44	Saulsbury Creek at county road 2 mi. south of Tenn. 57, Hardeman Co., Tenn.	Aug. 3, 1972	Starnes, Nagy, Saylor
45	West Fork Spring Creek on county road 4 mi. north of Saulsbury, Hardeman Co., Tenn.	Aug. 3, 1972	Starnes, Saylor, Nagy
46	Spring Creek at county road 8158, Hardeman Co., Tenn.	Aug. 3, 1972	Starnes, Nagy, Saylor
47	Marshall Creek at county road 3 mi. south of Van Buren, Hardeman Co., Tenn.	Aug. 3, 1972	Starnes, Nagy, Saylor

Table II (continued)

Number	Locality	Date	Collectors
48	Spring Creek at Tenn. 125, Hardeman Co., Tenn.	Aug. 4, 1972	Starnes, Nagy, Saylor
49	Pleasant Creek at mouth of Potters Creek, Hardeman Co., Tenn.	Aug. 4, 1972	Starnes, Nagy, Saylor
50	Clear Creek at U.S. 64, Hardeman Co., Tenn.	Aug. 4, 1972	Starnes, Nagy, Saylor
51	Mill Creek 1 mi. above mouth near Toone, Hardeman Co., Tenn.	Aug. 4, 1972	Starnes, Nagy, Saylor
52	Grays Creek at Tenn. 18, Hardeman Co., Tenn.	Aug. 4, 1972	Starnes, Nagy, Saylor
53	Cub Creek at Tenn. 125, Hardeman Co., Tenn.	Aug. 5, 1972	Starnes, Nagy, Saylor
54	Slough tributary to Porter Creek .2 mi. south of Porter Creek and 1.5 mi. south of Nebron, Hardeman Co., Tenn.	Aug. 5, 1972	Starnes, Nagy, Saylor
55	Magbee Branch .4 mi. above mouth, Hardeman Co., Tenn.	Aug. 5, 1972	Starnes, Nagy, Saylor
56	Cypress Creek 1.7 mi. south of Lacy, Hardeman Co., Tenn.	Aug. 5, 1972	Starnes, Nagy, Saylor
57	Muddy Creek .2 mi. northwest of Pocahontas, Hardeman Co., Tenn.	Aug. 5, 1972	Starnes, Nagy, Saylor
58	Sandy Creek 2 mi. west of Tenn. 18, Hardeman Co., Tenn.	Aug. 8, 1972	Starnes, Nagy, Saylor
59	Clover Creek at Tenn. 18, Hardeman Co., Tenn.	Aug. 8, 1972	Starnes, Nagy, Saylor
60	Hatchie River at Tenn. 18, Hardeman Co., Tenn.	Aug. 8, 1972	Starnes, Nagy, Saylor
61	Second creek north of Lacy, Hardeman Co., Tenn.	Aug. 13, 1972	Starnes, Nagy, Bouchard
62	Slough tributary to Porter Creek .2 mi. south of Porter Creek and 1.5 mi. south of Hebron, Hardeman Co., Tenn.	Aug. 13, 1972	Starnes, Nagy, Bouchard

Table II (continued)

Number	Locality	Date	Collectors
63	Lane Branch at Tenn. 125, Hardeman Co., Tenn.	Aug. 13, 1972	Starnes, Nagy, Bouchard
64	Grays Creek .7 mi. east of Willoughby, Hardeman Co., Tenn.	Aug. 13, 1972	Starnes, Nagy, Bouchard
65	Cut-off of Hatchie River and mouth of Pleasant Creek 1 mi. north of Tenn. 18, Hardeman Co., Tenn.	Aug. 14, 1972	Starnes, Nagy, Bouchard, Cobb
66	Short Creek at Tenn. 100, Hardeman Co., Tenn.	Aug. 14, 1972	Starnes, Nagy, Bouchard
67	Piney Creek at county road 5 mi. southeast of Willoughby, Hardeman Co., Tenn.	Aug. 18, 1972	Starnes, Nagy, Bouchard
68	Spring Creek and adjacent pool .7 mi. south of Hamer Creek, Hardeman Co., Tenn.	Aug. 24, 1972	Starnes, Nagy
69	Slough tributary to Bear Creek 1.5 mi. west of Hillville, Haywood Co., Tenn.	Aug. 7, 1972	Starnes, Nagy, Saylor
70	Jeffers Creek .7 mi. above mouth, Haywood Co., Tenn.	Aug. 7, 1972	Starnes, Nagy, Saylor
71	Tributary to Lagoon Creek 1 mi. south of St. Peter Chapel, Haywood Co., Tenn.	Aug. 8, 1972	Starnes, Nagy, Saylor
72	Cypress Creek at county road .5 south of Tenn. 54, Haywood Co., Tenn.	Aug. 8, 1972	Starnes, Nagy, Saylor
73	Little Muddy Creek at U.S. 79, Haywood Co., Tenn.	Aug. 8, 1972	Starnes, Nagy, Bouchard
74	Wesley Lake off U.S. 70-79, Haywood Co., Tenn.	Aug. 11, 1972	Starnes, Nagy, Saylor
75	Lagoon Creek off Tenn. 19, south of Nutbush, Haywood Co., Tenn.	Aug. 16, 1972	Starnes, Nagy, Bouchard
75	Little Muddy Creek at county road 8052. Haywood Co., Tenn.	Aug. 17, 1972	Starnes, Nagy, Bouchard
76	Little Muddy Creek at county road 8052, Haywood Co., Tenn.	Aug. 17, 1972	Starnes, Nagy, Bouchard

Table II (continued)

Number	Locality	Date	Collectors
77	Hatchie River at U.S. 70-79, Haywood Co., Tenn.	Aug. 17, 1972	Starnes, Nagy, Bouchard
78	Sugar Creek at county road 1.5 mi. west of Sunny Hill, Haywood Co., Tenn.	Aug. 17, 1972	Starnes, Nagy, Bouchard
79	Western tributary to Carter Creek 3.5 mi. east of Sunny Hill, Haywood Co., Tenn.	Aug. 17, 1972	Starnes, Nagy, Bouchard
80	Horseshoe Lake near Haywood-Tipton Co. line, Haywood Co., Tenn.	Aug. 12, 1972	Starnes, Nagy, U.T. Ichthyology Class
81	Champion Lake off Tenn. 87, Lauderdale Co., Tenn.	Aug. 16, 1972	Starnes, Nagy, Bouchard
82	Cane Creek at old U.S. 51 north of Ripley, Lauderdale Co., Tenn.	Aug. 16, 1972	Starnes, Nagy, Bouchard
83	Cane Creek 1 mi. southeast of Lightfoot, Lauderdale Co., Tenn.	Aug. 18, 1972	Starnes, Nagy, Bouchard
84	Hatchie River near Rialto, Lauderdale Co., Tenn.	Aug. 15, 1972	(Obtained from fishermen)
85	Champion Lake off Tenn. 87, Lauderdale Co., Tenn.	Oct. 9, 1972	Etnier, Starnes, Perry, Henson, Oakberg, Dickinson
86	Champion Lake off Tenn. 87, Lauderdale Co., Tenn.	Oct. 10, 1972	Etnier, Starnes, Perry, Henson, Oakberg, Dickinson (Gill Netting)
87	Second creek above Nail Creek (tributary to Mosses Creek), McNairy Co., Tenn.	Aug. 1, 1972	Starnes, Nagy, Saylor
88	Nail Creek between county roads 8199 and 8159, McNairy Co., Tenn.	Aug. 1, 1972	Starnes, Nagy, Saylor
89	Mosses Creek off 8159 1.3 mi. southwest of Thompson Branch, McNairy Co., Tenn.	Aug. 1, 1972	Starnes, Nagy, Saylor

Table II (continued)

Number	Locality	Date	Collectors
90	Reedy Branch at county road 1 mi. north of Tenn. 57, McNairy Co., Tenn.	Aug. 1, 1972	Starnes, Nagy, Saylor
91	Boles Creek at county road 3 mi. south of Tenn. 57, McNairy Co., Tenn.	Aug. 1, 1972	Starnes, Nagy, Saylor
92	Muddy Creek at county road 1 mi. south of Tenn. 57, McNairy Co., Tenn.	Aug. 2, 1972	Starnes, Nagy, Saylor
93	Muddy Creek at U.S. 45, McNairy Co., Tenn.	Aug. 2, 1972	Starnes, Nagy, Saylor
94	Cypress Creek at county road .3 mi. west of Falcon, McNairy Co., Tenn.	Aug. 2, 1972	Starnes, Nagy, Saylor
95	Rose Creek 2 mi. above mouth of Wilson Creek, McNairy Co., Tenn.	Aug. 2, 1972	Starnes, Nagy, Saylor
96	Kise Creek at county road 8082, McNairy Co., Tenn.	Aug. 2, 1972	Starnes, Nagy, Saylor
97	Little Hatchie Creek at county road .3 mi. above Swain Creek, McNairy Co., Tenn.	Aug. 2, 1972	Starnes, Nagy, Saylor
98	Hatchie River on county road .2 mi. east of Hardeman Co. line near Pocahontas, McNairy Co., Tenn.	Aug. 6, 1972	Starnes, Nagy, Saylor
99	Slough .3 mi. east of Tuscumbia River and Watson Bridge, McNairy Co., Tenn.	Aug. 5, 1972	Starnes, Nagy, Saylor
100	Tuscumbia River southeast of Pocahontas at Ooten Bridge, McNairy Co., Tenn.	Aug. 10, 1972	Starnes, Nagy, Saylor
101	Muddy Creek at county road 8086, McNairy Co., Tenn.	Aug. 19, 1972	Starnes, Nagy, Bouchard
102	Tuscumbia River west of Chewalla at Watson Bridge, McNairy Co., Tenn.	Aug. 19, 1972	Starnes, Nagy, Bouchard
103	Hatchie River at Tenn. 54, Tipton Co., Tenn.	Aug. 8, 1972	Starnes, Nagy, Saylor

Table II (continued)

Number	Locality	Date	Collectors
104	Coal Creek at county road 8193, Tipton Co., Tenn.	Aug. 11, 1972	Starnes, Nagy, Bouchard
105	Rocky Branch at county road 8193, Tipton Co., Tenn.	Aug. 12, 1972	Starnes, Nagy, Bouchard
106	Stream on county road 8193 1.1 mi. east of Detroit, Tipton Co., Tenn.	Aug. 15, 1972	Starnes, Nagy, Bouchard
107	Indian Creek at county road 8193, Tipton Co., Tenn.	Aug. 15, 1972	Starnes, Nagy, Bouchard
108	Frog Branch at U.S. 51, Tipton Co., Tenn.	Aug. 15, 1972	Starnes, Nagy, Bouchard

VITA

Wayne Calvin Starnes was born in San Bernadino, California, on October 13, 1945. He resided there until 1950, moving to Natchez, Mississippi, and subsequently moving to Dickson, Tennessee, in 1954 and to Knoxville later the same year. He attended schools in Mississippi and Tennessee and was graduated from Farragut High School of Knox County in June 1964. He entered the University of Tennessee in September 1964 and received the Bachelor of Science degree in Business Administration with a major in Transportation in March 1969. He then served as an officer in the U.S. Army in Baltimore, Maryland, and Vietnam, returning to the University of Tennessee in Zoology in March 1971. He entered the Graduate School in March 1972 and received the Master of Science degree with a major in Zoology in June 1973.