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Ichthyofaunal Assemblages in Three Proximate but Ecologically Diverse Streams in Clark County, Arkansas

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Abstract.—Three tributaries to the Ouachita River in eastern Clark County, Arkansas, empty into the river within a collective distance of about 9 km. The streams drain basins derived from the Wilcox formation, partially overlain by terrace and alluvial deposits. Despite their proximity, the streams are very different: L'Eau Frais has a gravel substrate and was recognized by the French as a cool water stream, Tupelo Creek is a bottomland stream from which numerous Water Tupelo (*Nyssa aquatica*) emerge, and Saline Bayou was named due to its marked salinity. We studied the assemblages of fishes in these 3 very different drainages to evaluate the occurrence of species and the degree of similarity of the ichthyofaunas. L'Eau Frais differed from the other streams in a greater occurrence of lampreys (Petromyzontidae), including a disjunct population of *Lampetra appendix*, and suckers (Catostomidae), including the relatively uncommon Blacktail Redhorse (*Moxostoma poecilurum*). Tupelo Creek had an assemblage of species characteristic of a bottomland stream, and Saline Bayou had the least diverse fish fauna.

Key words:—Ichthyofaunas, Ouachita River, Clark County, Arkansas, L'Eau Frais, Tupelo Creek, Water Tupelo, *Nyssa aquatica*, Saline Bayou, Lampreys, *Lampetra appendix*, Blacktail Redhorse, *Moxostoma poecilurum*.

Introduction

A small portion of Clark County, Arkansas, lies east of the Ouachita River. The area is within the West Gulf Coastal Plain just south of the Ouachita Mountains natural division (Foti 1974). Geologically, the region is composed primarily of alluvium deposited during the Holocene by L'Eau Frais Creek, Tupelo Creek, and Saline Bayou. The latter 2 streams drain basins lying almost entirely within alluvial deposits. Alluvium forms the banks of L'Eau Frais, but much of its upper reaches drain exposed strata of the Wilcox group deposited during the Eocene (Haley 1993).

These 3 tributaries enter the Ouachita River within a distance of about 9 km along the river (Fig. 1). Despite their proximity, they are ecologically very different.

L'Eau Frais Creek was named by early French pioneers who noted the "cool (or fresh) water." At about 37 km in length, this stream is the longest of the 3 we studied, and it flows throughout the year. Habitats within the stream include pools and riffles that flow over a substrate of sand and gravel with scattered deposits of detritus and mud.

In contrast, Tupelo Creek represents a bottomland stream of about 14 km in length. It is named for the Water Tupelo (*Nyssa aquatica*) trees that are common along its banks. Pools and riffles occur in the stream, but summertime lows often reduce the flow to a trickle. The substrate is composed of mud and detritus with scattered gravel in riffle areas.

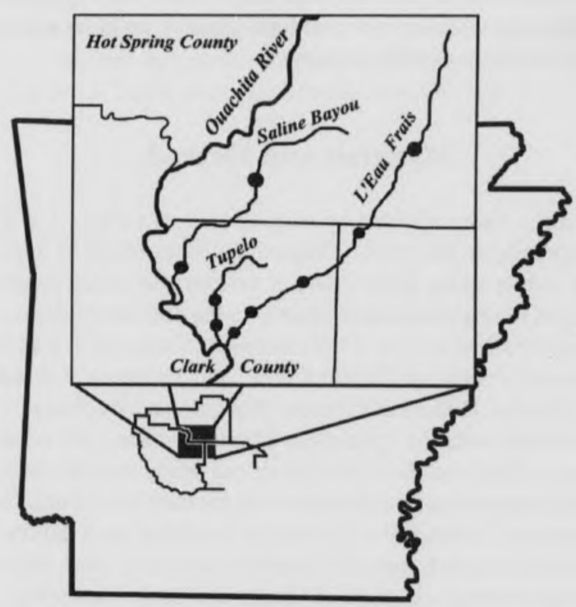

Fig. 1. Location of Saline Bayou, Tupelo Creek, and L'Eau Frais Creek in Clark and Hot Spring Counties, Arkansas. Dots along streams represent locations of sample sites.

Saline Bayou has a substrate of mud, gravel, sand, and detritus. It is about 18 km long and the stream looks somewhat similar to L'Eau Frais except for fewer sand bars. The stream has a long history as a source of salt. In the late 1700s, Louis Badins (2003) referred to the salty stream as *la petite saline,* which later became known as Saline Bayou. In 1804, William Dunbar obtained a sample of saline water after digging in the bed of a dry gully near Arkadelphia. Ten quarts of the water were evaporated, which produced a "saline mass weighing when dry 8 ounces" (Rowland 1930). One of the earliest salt works in Arkansas was established in 1811 at Blakelytown (near modern Arkadelphia) on a site along Saline Bayou where natives had made salt for years.

The substrates of the streams are strongly related to the soils within their basins. Sardis-Guyton-Ouachita soils form the alluvium through which the streams flow. These are flood-plain soils of silty clay loam. Upper slopes of the basins drained by Saline Bayou and Tupelo Creek have Gurdon-Stough-Amy soils, which also are of silty clay loam. Higher slopes of the drainage of L'Eau Frais Creek have Saffell-Sacul-Pikeville soils, which are deep gravelly and sandy loam soils (Hoelscher 1987).

Questions concerning the diversity of fish species in these tributaries arose after the discovery of an isolated population of the American Brook Lamprey (*Lampetra appendix*) in L'Eau Frais Creek (Tumlison and Tumlison 1999). This is a northeastern species formerly known to occur no farther south than the White River in Arkansas (Robison and Buchanan 1988). Cool, clear streams with gravelly substrates are required by *L. appendix*, and those conditions are met only in L'Eau Frais. We began surveys to determine whether other unique species or associations of species occurred in these streams.

Materials and Methods

Fishes were collected by seining (3.2 mm mesh, 1.2 X 3 m net) throughout the year. Collections were made at available access points along Hwy 7 and at bridges for minor roads. We attempted to sample proportionately to the number of access sites and made collections on 25 occasions at 5 sites on L'Eau Frais, 16 times at 2 sites on Tupelo Creek, and 10 times at 2 sites on Saline Bayou. Historical records (Robison and Buchanan 1988) are included with the specimens obtained during the course of this study. Because the objective of our study was to determine species composition, we did not count the numbers of individuals encountered. Instead, we focused on sampling each habitat type encountered in each stream. Voucher specimens were deposited in the vertebrate collections at Henderson State University.

Because some species of fishes (e.g., suckers) tend to enter tributaries of rivers for spawning, we tested water quality during the spring and late summer to determine whether variation among streams was consistent between high and low flow periods. We measured temperature, pH, salinity and conductivity because these parameters are related. Saline waters, expected to occur in Saline Bayou, tend to have a high pH and high conductivity. The level of tolerance by fishes to these parameters would likely affect their likelihood of occurrence among the streams.

Species with low tolerance to change best serve as indicators of environmental degradation and pollution. Because most of the species found in our study occur in Oklahoma, we used the classification of Jester et al. (1992) to evaluate the composition of fish communities found during our study. Chi-square tests were used to compare the frequencies of species within tolerance levels between pairs of streams.

Results and Discussion

A total of 64 species, representing 13 families, was collected during the study (Table 1). The samples included several cosmopolitan species with a mixture of upland (Ouachita Mountains) and lowland (Gulf Coastal Plain) components. L'Eau Frais and Tupelo Creeks each had 47 species, but we found only 36 species in Saline Bayou. L'Eau Frais and Tupelo shared 37 species in common, L'Eau Frais and Saline shared 27 species, and Tupelo and Saline shared 28 species. The lower number of shared species between Saline and the other streams likely reflects the lower number of species found in Saline.

Twenty-six species (40.6%) were shared by all streams, which likely means that those species are tolerant of the range of conditions present in all 3 streams. However, 24 species (37.5%) were unique to 1 of the 3 streams. Of these, 9 species were collected only from L'Eau Frais Creek, 8 species only from Tupelo Creek, and 7 species only from Saline Bayou.

The most important observation was the occurrence of *Lampetra appendix* in L'Eau Frais because it represents a southwestern extralimital population of a northeastern species. Interestingly, 3 of the 4 species of lampreys found in Arkansas were collected from L'Eau Frais. Most species of lampreys require gravel riffles for spawning, and the ammocoete larvae need silty to sandy areas with detritus in which to feed and grow (Robison and Buchanan 1988). Both species of *Ichthyomyzon* also were found in Tupelo Creek, but no species of lamprey was taken from Saline Bayou.

L'Eau Frais also had the richest diversity (4 species) of catostomids, 3 of which were unique to the stream. Tupelo Creek had 2 species of suckers, 1 of which was unique, but no suckers were found in Saline Bayou. Most species of suckers prefer relatively clear streams with gravelly or sandy substrates (Robison and Buchanan 1988), which explains the distribution we observed. We note that the specimens of *Minytrema melanops* and both species of *Moxostoma* were small and likely represent spawn within the streams.

The 2 bottomland species *Elassoma zonatum* and *Aphredoderus sayanus* were taken from all streams. We observed that both species were more common in Tupelo Creek; the most bottomland in nature of the streams sampled. Further, the species *Fundulus dispar*, *Lepomis marginatus*, *Notropis maculatus*, and '*teronotropis hubbsi* were found only in Tupelo Creek. These ɔecies prefer mud and detritus bottoms (Robison and Buchanan 988), which is consistent with the habitat of Tupelo.

The 2 species collected only in Saline Bayou, *Menidia ɪeryllina* and *Lepisosteus osseus*, are of interest because they ɪre tolerant of brackish water and occur in coastal estuarine ;ituations (Robison and Buchanan 1988).

In L'Eau Frais and Tupelo Creeks, the majority of species (68%) were intolerant to changes in water quality (combining categories of intolerant and moderately intolerant, Table 2). In contrast, the majority of species in Saline Bayou (55.6%) were tolerant of change. Chi-square analysis indicated no significant difference ($P > 0.05$) between L'Eau Frais and Tupelo Creeks in tolerance of the species to changes in water quality, but comparison of Tupelo and Saline, and L'Eau Frais and Saline, indicated that tolerances of species present were significantly different ($P < 0.001$).

In all streams, most species were somewhat intolerant of habitat change, with the species in Saline Bayou averaging most tolerant. Chi-square analysis indicated no difference between species in L'Eau Frais and Tupelo Creeks in tolerance to change in habitat ($P > 0.05$), but comparisons between L'Eau Frais and Saline, and Tupelo and Saline, were significantly different ($P < 0.001$).

Parameters of water quality do seem to explain the differences found among streams. Monthly temperatures of all streams from February through April of 2006 were within 2°C of each other, increasing from about 10°C to 21°C. After diminished flow during summer, temperatures on 16 September 2006 remained about the same for L'Eau Frais (22°C), but had climbed in Tupelo (25°C), and Saline (27°C).

On 24 April 2006, pH of all streams ranged from 6.2-6.5. On 16 September 2006 pH had increased slightly in L'Eau Frais (6.7) and Tupelo (6.9), but markedly in Saline (9.2). With higher flow on 24 April, salinity was 0 in the former two streams and only 0.1 % in Saline Bayou, but on 16 September only Saline Bayou had increased – to a salinity of 1%. Patches of salt were evident at that time along dried sections of the stream.

Conductivity remained under 120 μmhos on 24 April and 16 September for both L'Eau Frais and Tupelo. In contrast, conductivity in Saline Bayou was measured as 180 μmhos on 24 April and increased to 1,900 μmhos on 16 September.

The increase in salt content of water in Saline Bayou explains the basic pH and the high conductivity. The lower diversity of species in that stream likely resulted from conditions that seasonally exceed tolerances of many freshwater species of fishes (Moyle and Cech 2004).

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Table 1. Occurrence (X) of species of fishes in three proximate tributaries to the Ouachita River, Clark County, Arkansas. Tolerance indicate (tolerance to change in water quality, tolerance to change in habitat), where I = intolerant, MI = moderately intolerant, MT = moderately tolerant, and T = tolerant (tolerance data from Jester et al. 1992).

	Tolerance	L'Eau Frais	Tupelo	Saline
Family: Petromyzontidae				
Ichthyomyzon castaneus	(MI, I)	X	X	0
Ichthyomyzon gagei	(I, I)	X	X	0
Lampetra appendix	(I, I)	X	0	0
Family: Lepisosteidae				
Lepisosteus osseus	(T, T)	0	0	X
Family: Esocidae				
Esox americanus	(MI, MI)	X	X	X
Family: Cyprinidae				
Campostoma anomalum	(MI, MI)	X	X	X
Luxilus chrysocephalus	(MI, MI)	X	X	X
Lythrurus umbratilis	(MI, MI)	X	X	X
Notemigonus crysoleucas	(T, T)	X	0	0
Notropis boops	(MI, I)	0	X	0
Notropis maculatus	(MI, I)	0	X	0
Pteronotropis hubbsi	(I, I)	0	X	0
Cyprinella venusta	(MT, MT)	X	X	X
Cyprinella whipplei	(MI, MI)	X	X	X
Opsopoeodus emiliae	(MI, MI)	X	X	0
Pimephales notatus	(MT, MT)	X	0	X
Semotilus atromaculatus	(MI, MI)	X	0	0
Family: Catostomidae				
Erimyzon oblongus	(MI, I)	X	0	0
Hypentilium nigricans	(I, I)	0	X	0
Minytrema melanops	(MI, I)	X	0	0
Moxostoma erythrurum	(MI, MI)	X	0	0
Moxostoma poecilurum	(MI, MI)	X	X	0
Family: Ictaluridae				
Ameiurus natalis	(T, MT)	0	0	X
Noturus eleutherus	(I, I)	X	0	0
Noturus gyrinus	(MI, I)	0	X	X
Noturus miurus	(I, I)	X	X	0
Noturus nocturnus	(MI, MI)	X	X	0
Family: Aphredoderidae				
Aphredoderus sayanus	(MT, MI)	X	X	X
Family: Fundulidae				
Fundulus catenatus	(MI, I)	0	X	0
Fundulus chrysotus	(MI, I)	0	0	X
Fundulus dispar	(T, I)	0	X	0
Fundulus notatus	(MT, MI)	X	X	X
Fundulus olivaceous	(MT, MI)	X	X	X

able 1. (cont.)

		Tolerance	L'Eau Frais	Tupelo	Saline
Family:	Poeciliidae				
	Gambusia affinis	(T, T)	X	X	X
Family:	Atherinidae				
	Labidesthes sicculus	(MT, MI)	X	X	X
	Menidia beryllina	(T, MT)	0	0	X
Family:	Centrarchidae				
	Centrarchus macropterus	(I, I)	X	0	0
	Lepomis cyanellus	(T, T)	X	X	X
	Lepomis gulosus	(MT, MT)	X	X	X
	Lepomis macrochirus	(MT, MT)	X	X	X
	Lepomis marginatus	(MT, MI)	0	X	0
	Lepomis megalotis	(MT, MT)	X	X	X
	Lepomis microlophus	(MT, MT)	0	0	X
	Lepomis punctatus	(MT, I)	X	X	X
	Lepomis symmetricus	(I, I)	0	X	X
	Micropterus punctulatus	(MI, MI)	X	0	0
	Micropterus salmoides	(MT, MT)	X	X	X
	Pomoxis annularis	(T, MT)	0	0	X
	Pomoxis nigromaculatus	(MT, MT)	0	0	X
Family:	Elassomatidae				
	Elassoma zonatum	(I, I)	X	X	X
Family:	Percidae				
	Ammocrypta vivax	(MI, I)	X	X	0
	Etheostoma blennioides	(I, I)	X	X	X
	Etheostoma chlorosomum	(MI, I)	X	X	X
	Etheostoma collettei	(MI, I)	X	X	X
	Etheostoma gracile	(MT, I)	X	X	X
	Etheostoma parvipinne	(I, I)	X	X	0
	Etheostoma proeliare	(MI, I)	X	X	X
	Etheostoma radiosum	(MI, MI)	X	X	X
	Etheostoma stigmaeum	(MI, MI)	X	X	0
	Etheostoma whipplei	(MI, MI)	X	X	X
	Etheostoma zonale	(I, I)	X	X	0
	Percina copelandi	(MI, I)	0	X	0
	Percina maculata	(MI, I)	X	X	0
	Percina sciera	(MI, MI)	X	X	X

Table 2. Frequencies of fish species in L'Eau Frais Creek, Tupelo Creek, and Saline Bayou in relation to their tolerance of changes in habitat and water quality. Tolerance assignments were based on Jester et al. (1992). Total numbers of fishes (n) and their distribution among categories are given. The percent of fishes in each category are shown parenthetically. T = tolerant, MT = moderately tolerant, MI = moderately intolerant, and I = intolerant.

Tolerance to changes in water quality	T (%)	MT (%)	MI (%)	I (%)
L'Eau Frais (n = 47)	3 (6.4)	12 (25.5)	23 (48.9)	9 (19.1)
Tupelo (n = 47)	3 (6.4)	12 (25.5)	24 (51.1)	8 (17.0)
Saline (n = 36)	6 (16.7)	14 (38.9)	13 (36.1)	3 (8.3)

Tolerance to changes in habitat	T (%)	MT (%)	MI (%)	I (%)
L'Eau Frais (n = 47)	3 (6.4)	6 (12.8)	19 (40.4)	19 (40.4)
Tupelo (n = 47)	2 (4.3)	5 (10.6)	17 (36.2)	23 (48.9)
Saline (n = 36)	3 (8.3)	11 (30.6)	12 (33.3)	10 (27.8)