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Ichthyofaunal Diversification and Distribution In The Big Creek Watershed, Craighead and Greene Counties, Arkansas

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ABSTRACT

Big Creek is a relatively small deltaic stream, in northeastern Arkansas, in an area of intense cultivation. Recently it has been dredged in the interest of flood control. Lost Creek and Mud Creek are the major tributaries of Big Creek and collectively drain the Big Creek watershed. The streams were found to have relatively low alkalinity, moderate carbon dioxide, adequate oxygen values, and relatively high turbidity. Channeling of Big Creek and Lost Creek has effectively destroyed distinct pool-riffle biocies and reduced the number of acceptable spawning areas. Lost Creek, also, receives effluent from residential dwellings, a secondary treatment sewage plant, and a meat rendering plant. Mud Creek, in the absence of channeling and deleterious effects of effluents, provided a relatively greater diversity of habitat than did Big Creek or Lost Creek.

A total of 21 species were collected in the streams. Big Creek supported 17 species while Mud Creek and Lost Creek supported 14 and 11 species, respectively. Five of the 11 species collected in Lost Creek are characteristic of streams with plentiful organic debris and were not collected, in numbers, at any other station in the watershed.

Of the 2,209 fishes collected, **Notropis umbratilis, Fundulus olivaceous,** and **Leomis cyanellus** made up 63% of the total and were procured from all sations. Their relative abundance is supported by their ability to withstand high turbidity and limited competition due to depth effect.

Limited species included **Ictalurus natalis, Aphredoderus sayanus,** and **Etheostoma gracile** in Mud Creek; **Dorsoma cepedianum** in Lost Creek; and the headwater species, **Semotilus atromaculatus,** in Big Creek and Mud Creek. **Cyprinus carpio, Ictalurus melas, Gambusia affinis,** and **Notemigonus crysoleucas** were also limited, in relative numbers, to Lost Creek.

INTRODUCTION

Big Creek is a relatively small deltaic stream, in northeastern Arkansas, in an area of intense cultivation. Recently it has been dredge in the interest of flood control for surrounding farm land. Lost Creek and Mud Creek are the major tributaries of Big Creek and collectively drain the Big Creek watershed.

It is the purpose of this study to determine the qualitative variation of fish populations in the Big Creek watershed and the co-existing physicochemical conditions. Further, the effect of effluents from the Jonesboro Sewage Treatment Plant and Broadaway Meat Packing Company (Lost Creek) and intensive cultivation (the entire watershed) on the fish population will be observed.

The major soils immediately adjacent to the streams of the Big Creek watershed are of the Falaya-Collins association. These are deep, poorly to moderately well drained, moderately permeable, silty bottomed and soils washed from loess. The poorly drained Falaya soils

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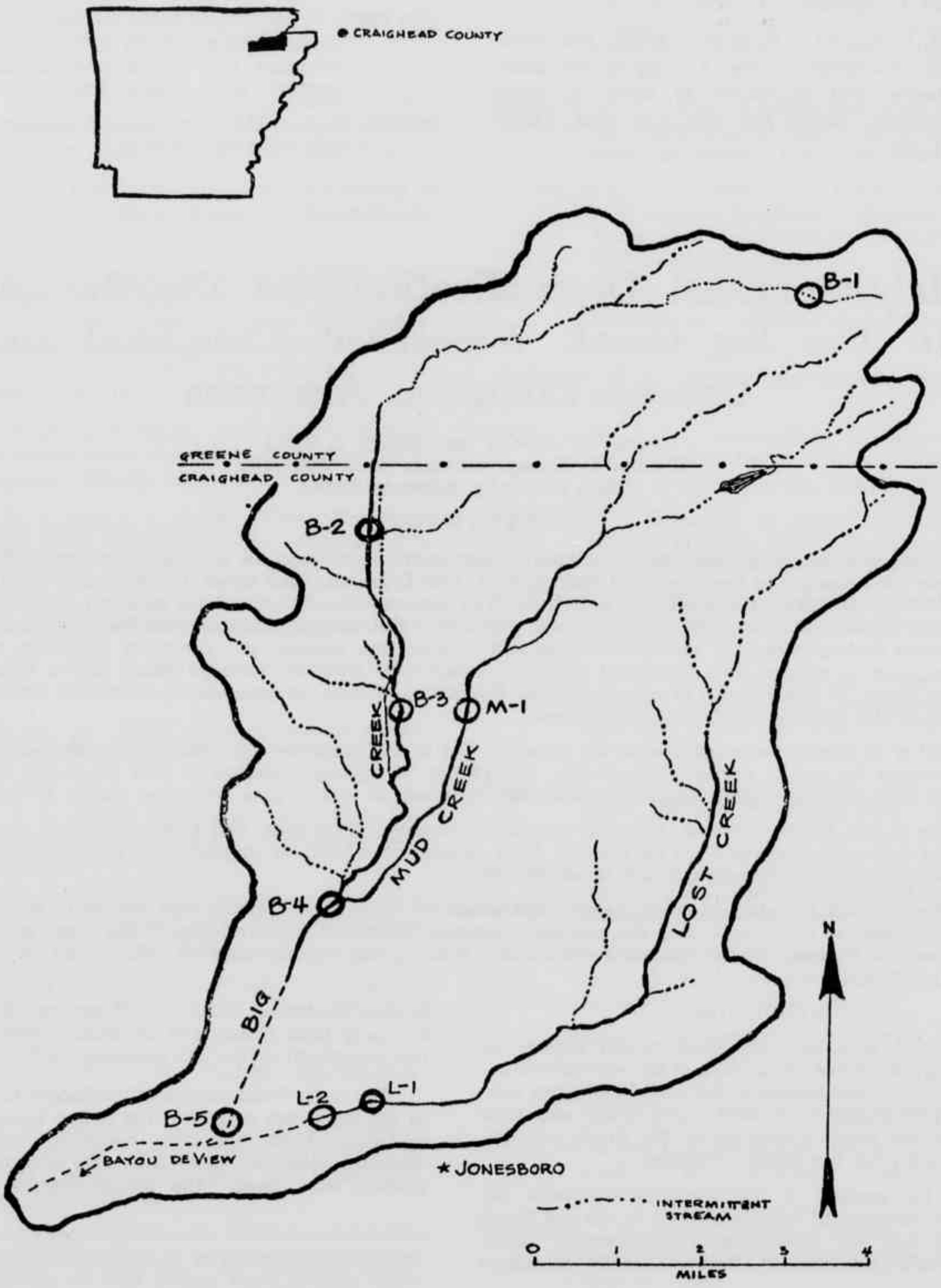
FIGURE I. BIG CREEK WATERSHED



have grayish-brown silt loam surface soil over gray and in the lower part of the subsoil. This association is brown or yellowish-brown silt loam that is mottled gray used mainly for cotton, soybeans, small grains, and pastures in Craighead County (Soil Conservation Service, 1962).

Big Creek arises four miles SE of Walcott, Greene County, Arkansas. It flows 23 miles through Craighead County, Arkansas, in a valley of Crowley's Ridge and becomes Bayou DeView Ditch five miles E of Cash, Craighead County, Arkansas. Elevation drops from 460-270 feet during its course, with a mean gradient of 8.3 ft/mi.

The channel averaged 21 feet in width; had high, steep banks; a substrate of mud, sand + gravel; or hard packed clay; and, in several areas, was littered with debris. Water depth ranged from 6 inches in the riffles to 5 feet in the pools. The stream banks were alternately lined by cultivated fields and mixed forests, the latter consisting primarily of oaks, willows, birch, and sweetgum. A few specimens of **Typha latifolia** were present at one station (B-3). No other rooted aquatic vegetation was noted.

Mud and Lost Creek watersheds physically typify the larger Big Creek watershed. Mud Creek arises 2.5 miles south of the origin of Big Creek, flows 7.5 miles to its confluence with Big Creek 3 miles north of Jonesboro, Craighead County, Arkansas, and has a mean gradient of 8 ft/mi.

Lost Creek arises 4.5 miles south of the origin of Big Crek, flows 10 miles SW to its confluence with Big Creek 2 miles WSW of Jonesboro, and has a mean gradient of 9 ft/mi.

MATERIALS AND METHODS

To provide the necessary data, eight stations were established. Five stations were selected on Big Creek, two on Lost Creek, and one on Mud Creek. Each station was spaced appropriately for adequate coverage of the watershed (Figure 1). Exact locations are as follows:

Big Creek

- B-1 SE¼, SW¼, Sec. 23, T 16N, R 4 E, Greene County, Arkansas. Elevation 460 feet.
- B-2 SE¼, SW¼, Sec. 1, T 15 N, R 3 E, Craighead County, Arkansas. Elevation 340 feet.
- B-3 SE¼, SW¼, Sec. 13, T 15 N, R 3 E, Craighead County, Arkansas. Elevation 320 feet.
- B-4 SE¼, NW¼, Sec. 35, T 15 N, R 3 E, Craighead County, Arkansas. Elevation 300 feet.
- B-5 NE¼, SE¼, Sec. 16, T 14 N, R 3 E, Craighead County, Arkansas. Elevation 270 feet.

Lost Creek

- L-1 SW¼, SW¼, Sec. 7, T 14 N, R 4 E, Craighead County, Arkansas. Elevation 300 feet.
- L-2 NW¼, NW¼, Sec. 13, T 14 N, R 3 E, Craighead County, Arkansas. Elevation 290 feet.

Mud Creek

- M-1 SW¼, SW¼, Sec. 18, T 15 N, R 4 E, Craighead County, Arkansas. Elevation 320 feet.

Station B-4 corresponds with Case's (1970) Station 1, stations L-1 and L-2 correspond with those of Jackson (1966) and station B-5 is at one point of Abernathy and Osoinach's (1969) sampling.

Each station was sampled four times between 22 February 1970 and 10 June 1970.

On each sampling date, the following determinations were conducted at each station: dissolved oxygen determination by the sodium azide modification of the Winkler method (AHPA, 1960), alkalinity and carbon dioxide content by standard limnological procedures (Welch, 1948), hydrogen ion concentration by Beckman pH meter, turbidity by the Jackson turbidimeter, air and water temperature by a thermistor thermometer or a centigrade thermometer, light penetration by Secchi disc, and current by timing a floating disk over a known distance.

Fish samples were procured using a 30 ft x 6 ft seine with 3/16 inch mesh. The collected specimens were preserved temporarily in 10% formalin. After several days they were washed in water, subsequently identified, and preserved in 40% isopropyl alcohol. Riffle and pool areas were sampled.

PHYSICOCHEMICAL CHARACTERISTICS

Streams of the Big Creek watershed were found to have relatively low alkalinity, moderate carbon dioxide, and adequate oxygen values (Table 1).

Alkalinity values increased from February through June at most stations. The lowest value, 13.0 ppm, was recorded on 7 March 1970 and highest value, 100.0 ppm, on 1 June 1970.

Dissolved carbon dioxide fluctuated from 0.0 - 26.5 ppm. Of the eight stations sampled, only B-5 showed relatively uniform values throughout the four sampling dates.

Dissolved oxygen varied only slightly from station to station. Mean values varied from 7.7 - 11.8 ppm. There was a general decrease in dissolved oxygen content from February to June.

The pH values were normally alkaline to slightly acid. The range for all stations was 6.1 - 9.7, with a mean value of 7.4.

Light penetration and turbidity fluctuated greatly depending on water velocity; however, in early spring, while the entire stream systems waters were moving, tudbidity increased and light penetration decreased from headwaters to lower stations.

Water temperature, in most instances, was directly proportional to air temperature.

TABLE 1. Range and mean values of selected physicochemical characteristics for four monthly visits, Big Creek watershed, Craighead and Greene counties, Arkansas, March - June, 1970.

Characteristics	STATION							
	B-1	B-2	B-3	B-4	B-5	M-1	L-1	L-2
Alkalinity, ppm	13-25 (17)	22-100 (67)	30-96 (60)	20-65 (53)	17-65 (7)	20-90 (17)	16-48 (5)	19-35 (7)
Carbon Dioxide, ppm	7.5-24 (14)	10-14 (13)	0-10 (7)	12-22 (17)	6-7.7 (9.9)	10-26.5 (9.2)	0-9 (11.8)	5.5-11 (9.8)
Oxygen, ppm	5.1-10.2 (7.7)	8.8-10.4 (9.3)	6.2-13.2 (10.0)	7.5-12.2 (8.8)	7.6-12.2 (7.8)	4.6-12.8 (7.3)	7.7-17 (7.8)	8.8-11.1 (7.2)
pH	6.1-7.0 (6 6)	6.9-7.4 (7.2)	7.4-9.7 (8.2)	6.9-7.1 (7.0)	7.3-8.3 (69)	6.7-8.3 (76)	7.0-8.7 (131)	6.5-8.5 (202)
Turbidity, ppm	25-400 (125)	25-153 (57)	25-68 (39)	25-157 (88)	25-98 (7)	25-235 (18)	53-335 (7)	53-350 (5)
Light penetration, inches	4-39 (18)	4-44 (28)	6-26 (16)	4-30 (11)	5-13 (0.6)	4-36 (0.3)	4-10 (0.1)	4-10 (0.4)
Current, ft/sec	0-0.3 (0.1)	0-2.1 (0.5)	0-0.4 (0.2)	0-1.0 (0.3)	0.1-13 (9.9)	0.1-0.8 (9.2)	0-0.1 (11.8)	0-1.0 (9.8)

Stream flow was normally moderate, ranging from negligible to 2.1 ft/sec with a mean value of 0.4 ft/sec.

ICHTHYOFAUNA

A total of 2,209 fishes comprising 21 species were recorded from the collection . Predominant forms included **Notropis umbratilis** (Girard), **Fundulus olivaceous** (Storer), and **Lepomis cyanellus** (Rafinesque).

Species diversity and relative numbers of fishes increased progressively from Station B-1 to Station B-5. Station M-1 was second only to Station B-5 in number of species and total number of specimens collected. In direct contrast to Big Creek, Lost Creek decreased in quality and quantity of fishes from Station L-1 to Station L-2. Station L-2 had lowest number of species and total specimens procured of any station in the watershed (Table 2).

Although several species, such as **N. umbratilis, F. olivaceous,** and **L. cyanellus** were collected on most occasions at all stations, other species were limited in their distribution. **Ictalurus natalis** (LeSueur), **Aphredoderus sayanus** (Gilliams), and **Etheostoma gracile** (Girard) were limited to Station M-1. **Dorsoma cepedianum** (LeSueur) was collected at Station L-1 only and on only one occasion. Two species, **Gambusia affinis** (Baird and Girdard) and **Semotilus atromaculatus** (Mitchill) were limited to headwaters or areas which presented a highly variable habitat. **Notropis venustus** (Girard) and **Pimphales vigilax** (Baird and Girard) were limited to down stream stations B-4 and B-5; however, on one occasion three specimens of **N. venustus** were collected at Station M-1. **Notemigonus crysoleucas** (Mitchill) and **Cyprinus carpio** (Linnaeus) were limited, primarily, to stations B-5, L-1 and L-2 with the former being collected also at stations M-1 and B-3. **Micropterus salmoides** (Lacepede) was collected only at stations B-3 and B-5, and **Ictalurus punctatus** (Rafinesque) was limited to stations B-2, B-4 and B-5.

Of the remaining species, **Erimyzon oblongus** (Mitchill), **Notropis chrysocephalus** (Rafinesque), **Ictalurus melas** (Rafinesque), **Lepomis macrochirus** (Rafinesque, **Lepomis megalotis** (Rafinesque), and **Pomoxis annularis** (Rafinesque) all showed a preference to Big Creek with the exception of **I. melas** which was collected in greater numbers in Lost Creek.

DISCUSSION

Big Creek Watershed. Seventeen species of fishes were collected from Big Creek (Table 2). Investigations of five similar streams in Missouri, Kansas, and Oklahoma have reported species diversity to range from 17-50, mean 31 (Hanson and Campbell, 1963; Wade and Craven, 1965; Harrel **et al.**, 1967; Cross and Braasch, 1969).

That Big Creek supported a relatively limited diversity of fish species may be attributed to several factors. Among the most important are relatively low alkalinity, siltation from land cultivation, and periodic dredging of the channel proper.

TABLE 2. Number and species of fishes collected and frequency of collection in four visits, Big Creek Watershed, Craighead and Greene counties, Arkansas, March - June, 1970. Figures in parentheses indicate percent of total fish contributed by a species at each station.

TAXA	STATIONS							
	B-1	B-2	B-3	B-4	B-5	L-1	L-2	M-1
Dorosoma cepedianum	0	0	0	0	0	2-1 (0.9)	0	0
Cyprinus carpio	0	0	0	0	1-1 (0.17)	1-1 (0.4)	3-2 (3.5)	0
Notemigonus crysoleucas	0	0	3-2 (1.3)	0	2-2 (0.3)	15-4 (6.7)	5-3 (5.9)	14-2 (3.4)
Notropis chrysocephalus	1-1 (0.8)	6-2 (3.7)	1-1 (0.4)	12-2 (3.1)	1-1 (0.17)	0	0	0
Notropis umbratilis	33-4 (27.8)	45-4 (27.6)	84-4 (35.4)	100-4 (26.0)	20-4 (35.0)	59-3 (27.2)	6-1 (7.0)	160-4 (38.8)
Notropis venustus	0	0	0	146-4 (38.0)	219-4 (37.6)	0	0	3-1 (0.7)
Pimephales vigilax	0	0	0	49-4 (12.7)	9-3 (1.55)	0	0	0
Semotilus atromaculatus	34-4 (28.6)	6-2 (3.7)	0	0	0	0	0	7-2 (1.7)
Erimyzon oblongus	17-3 (14.3)	8-2 (4.9)	2-2 (0.8)	5-2 (1.3)	1-1 (0.2)	1-1 (0.4)	0	11-3 (2.7)
Ictalurus melas	12-3 (10.3)	0	1-1 (0.4)	2-2 (0.5)	3-2 (0.5)	21-4 (9.3)	39-3 (45.8)	3-2 (0.7)
Ictalurus puctatus	0	1-1 (0.6)	0	4-3 (1.0)	16-2 (27.0)	0	0	0
Ictalurus natalis	0	0	0	0	0	0	0	3-2 (0.7)
Fundulus olivaceous	17-3 (14.3)	69-4 (42.3)	77-4 (32.5)	43-4 (11.2)	94-4 (16.2)	50-4 (22.2)	5-2 (5.9)	119-4 (28.8)
Gambusia affinis	1-1 (0.8)	0	0	0	0	5-3 (2.2)	5-3 (5.9)	4-2 (0.97)
Aphredoderus sayanus	0	0	0	0	0	0	0	7-3 (1.7)
Lepomis cyanellus	4-2 (3.4)	14-3 (8.6)	27-3 (11.4)	10-1 (2.6)	11-4 (1.9)	65-4 (28.9)	22-4 (25.9)	51-3 (12.1)
Lepomis macrochirus	0	1-1 (0.6)	15.4 (6.3)	6-4 (1.5)	10-3 (1.7)	5-1 (2.2)	0	19-4 (4-6)
Lepomis megalotis	0	9-3 (5.0)	5-4 (2.1)	6-3 (1.5)	6-2 (1.0)	0	0	4-3 (1.0)
Micropterus salmoides	0	0	4-3 (1.7)	0	3-2 (0.5)	0	0	0

TABLE 2. (continued)

TAXA	STATIONS							
	B2	B-2	B-3	B-4	B-5	L-1	L-2	M-1
Pomoxis annularis	0	4-3 (2.4)	17-2 (7.2)	2-2 (0.5)	2-2 (0.3)	1-1 (0.4)	0	0
Etheostoma gracile	0	0	0	0	0	0	0	10-2 (2.4)
Total Specimens	119	163	237	385	582	225	85	413
Total Taxa	8	10	11	12	15	11	7	14

Alkalinity values were moderately low in Big Creek, indicating its relatively low buffering capacity. In general, the more alkaline waters are more productive (Ruttner, 1966). Of greater significance is the intensive land use characteristic of the Big Creek watershed. Subsequent siltation and shallowing of pools are self-evident and deleterious in their effect (Reid, 1961).

Accentuating the situation is the periodic channeling of Big Creek in the interest of floor control. This practice has effectively destroyed distinct pool-riffle biocies and reduced the number of acceptable spawning areas. This is in part reflected in the relatively low number of fishes collected and of those, many being characteristic of the pond-marsh biocies (Kendeigh, 1961).

Jackson (1966) collected 9 species at Station B-5, Abernathy and Osoinach (1969) collected 12 species, and in the present study, 15 species were collected. Jackson collected **Gambusia affinis, Notropis galacturus,** and **Etheostoma gracile** from this station, and Abernathy and Osoinach reported **G. affinis, Ictalurus natalis,** and **Semotilus atromaculatus,** none of which were taken in this study. The increase in number of species collected at Station B-5 from 1966-70 is probably due primarily to sampling effort.

Mud Creek provided a relatively greater diversity of habitat than did Big Creek. Despite its short length (7.5 vs. 23 miles for Big Creek), and although only one station was sampled, 14 species of fishes were collected. Amongst these were **Aphredoderus sayanus, Ictalurus natalis,** and **Etheostoma gracile,** species taken at no other station. Also, the second highest number of total fishes was taken from this station. Although there was little difference in the physicochemical characteristics, Mud Creek, as opposed to Big Creek, had no stream channeling and was flanked primarily by pastured land.

Lost Creek, in spite of its greater length (10 miles) and collections at two stations, supported only 11 and 7 species of fishes at stations L-1 and L-2, respectively. The smallest number of total fishes taken in this study was at station L-2. Lost Creek, like Big Creek, is periodically channeled. Probably most important, however, is the fact that Lost Creek receives effluent from residential dwellings, a secondary treatment sewage plant (Station L-2), and a meat rendering plant. Formerly, a meat packing plant also released an untreated effluent at Station L-1.

Jackson (1966) collected 6 species of fishes at Station L-1 and 2 species at L-2. He collected **Semotilus atromaculatus** at Station L-1, but it was not taken at that station in this study.

Since no fish were collected in four attempts below the sewage plant, it is probable that the fish population of Lost Creek is isolated.

Effects of inflow from Lost Creek on the fish population of Big Creek is incompletely known since a temporary holding dam was built on Lost Creek by the Arkansas Highway Department. The waters were used daily to wet the newly constructed roadbed and embankments of the Jonesboro bypass.

ICHTHYOFAUNA. **Species of Wide Distribution. Notropis umbratilis, Fundulus olivaceous,** and **Lepomis cyanellus** were the most abundant species collected in the Big Creek watershed, contributing 31%, 21%, and 11% respectively, of the total specimens procured. They are primarily pool species inhabiting small warm - water streams with variable current and relatively high turbidity (Trautman, 1957; Larimore, 1961; Cross and Braasch, 1967). **F. olivaceous** is primarily a topwater species, **N. umbratilis** congregates in mid-water, and **L. cyanellus** forages over all depths; thus competition is limited due to depth effect (Sheldon, 1968). Tolerance of turbidity coupled with limited competition suggests possible reasons for their abundance.

Erimyzon oblongus was collected at every station except L-2. This wide distribution was probably due to migratory habits of this species during spring breeding season. They prefer the sand + gravel bottom pools in the headwaters of small streams to spawn. After spawning, they migrate to larger streams to overwinter (Cross, 1967).

Only one other species, **Ictalurus melas**, was widely distributed in the watershed; however, they were collected in greater numbers at stations L-1 and L-2. Deacon (1961) considered the black bullhead to be a highly vagile species and able to withstand high turbidity. They apparently are tolerant of organic pollution, also, as demonstrated in this study and that of an Oklahoma stream (Wade and Craven, 1965).

HEADWATER SPECIES. **Semotilus atromaculatus** was collected only at stations B-1 and B-2. This species prefers the headwaters of small, warm-water streams (Trautman, 1957; Hanson and Campbell, 1963; Metcalf, 1966; Branson, 1967; Cross, 1967; Sheldon, 1968), but will migrate to larger pools in late summer.

Gambusia affinis, the mosquito fish, is a particularly hardy fish which is adaptable to most stream environments and feeds on a variety of plankton, as well as some relatively large aquatic insect species (Mulla and Isaak, 1961). Cross (1967) and Trautman (1957) found this species to frequent the headwater pools in intermittent streams, which is evidenced in the collection of specimens from B-1 and M-1.

DOWNSTREAMS SPECIES. The appearance of **Notropis venustus** and **Pimphales vigilax** at stations B-4 and B-5 is perhaps the result of the confluence of Mud Creek and Big Creek at Station B-4. Kuehne (1962), using Horton's (1945) classification of streams, reported that the merging of one stream with another constitutes a progression in stream order. A more varied habitat results in the support of greater numbers of species. Odom et al. (1969) postulated that an increase in species diversity was due to a more complex, thus stable, per capita hierarchy of function in a community. Each rare species is required by a definite number of more common species for its survival and support.

Most centrarchids in this watershed, **Pomoxis annularis**, **Lepomis macrochirus**, and **Micropterus salmoides**, prefer the pond-lake environment (Kendeigh, 1961). It is probable that the present population of these fishes, as well as **Ictalurus punctatus**, are the result of overflowing ponds in the watershed.

Another centrarchid collected downstream, **Lepomis megalotis**, is mostly indigenous to streams, preferring their clear water pools (Trautman, 1957;) Metcalf, 1966). This suggests a reason for the fewer specimens of **L. megalotis** collected at times of relatively high turbidity.

Notropis chrysocephalus is a warm-water fish that prefers clear water over sand + gravel-bottom pools in low-gradient streams and migrates to headwaters for breeding (Trautman, 1957). Of the 21 specimens collected, 18 were taken in March. This suggests a temporary migration from below station B-5.

SPECIES OF SPARSE DISTRIBUTION. Station M-1 was unique in that it supported three species of fishes, **Aphredoderus sayanus**, **Etheostoma gracile**, and **Ictalurus natalis**, not found at any other station in the watershed. The characteristics of the pool from which specimens of **A. sayanus** were collected fit perfectly the description given by Trautman (1957). He stated, "The Pirate-perch inhabited pools of streams where the bottom consisted of soft, dark muck which contained much decomposing organic material. Such a bottom usually had many twigs, leaves, roots and downtimber lying upon it." Hellier (1967) reported collecting **A. sayanus** from similar habitats in a Florida stream and discussed their ability to avoid being seined. This ability coupled with habitat preference make them a rarely collected species in the Big Creek watershed.

E. gracile, unlike most darters, occupies lowland pools having muddy bottoms, rather than streams where currents sweep the channel free of silt (Cross, 1967). Wallen (1958) reported this species from several tributaries of the Verdigris River in Oklahoma occupying habitats similar to the Mud Creek station.

The yellow bullhead, **I. natalis**, inhabits quiet, mud-bottom pools in small streams (Metcalf, 1966). Cross (1967) reported this species to avoid interspecific competition and high gradient streams. The nearest competitor, **I. melas**, was collected at station M-1 in a 1:1 ratio with **I. natalis**. This condition could be detrimental to **I. natalis** in future years. Trautman (1957) observed a decrease in numbers of yellow bullhead when the more vagile black bullhead moved into its range.

Dorsoma cepedianum, **Gambusia affinis**, **Cyprinus carpio**, **Notemigonus crysoleucas**, and **Ictalurus melas** were fishes collected in greatest numbers at stations L-1 and L-2. All are indicative of streams with plentiful organic debris (Trautman, 1957; Wade and Crave, 1965; Cross, 1967.)

D. cepedianum was collected on only one occasion and this being at station L-1 when a dense plankton bloom was present. They apparently migrated from a large pool directly behind the packing plant to feed upon the abundant plankton. **D. cepedianum** consumes microorganisms (both plant and animal) that are strained indiscriminately from water as it passes over the gills (Cross, 1967).

Wade and Craven (1965) reported **G. affinis** to have a distinct tolerance of sewage. This was apparent in the present study as one specimen was captured at the periphery of the sewage plant outfall. They also reported **N. crysoleucas** and **C. carpio** to frequent stream habitats of low gradient and plentiful organic waste. Confluence of Lost Creek with Big Creek near station B-5 would possibly account for their presence at this location. **N. crysoleucas** was collected at one other station, B-3, where their presence could perhaps be explained by the abundant food supply. On the two dates **N. crysoleucas** were procured **Zygnema** spp. was prevalent. Only two other stations, B-2 and L-1, supported a noticable bloom of algae during the course of this study.

I. melas is highly tolerant of many types of industrial and domestic loplutants in smal, warm-water streams (Trautman, 1957). It frequently become over-populated in small streams with a consequent dwarfing in size (Cross, 1967).

The physicochemical data do not reflect it, but physical observations such as odor, plankton blooms, **Tubifex** populations along pool shorelines and the species composition of the ichthyofauna of Lost Creek, attest to the profound effect of organic pollutants upon this section of the Big Creek watershed.

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Rapid Electroosmosis Measurements

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ABSTRACT

A cell has been designed and built that allows for rapid measurement of volume moved in a definite time by electroosmosis. The cell is simple to use and is not very elaborate. Using a water jacket, the cell temperature can be controlled to ± 0.1° C. Measurements are presented for acetonitrile, dimethylformamide, and nitrobenzene at 25° C for applied voltages of 25, 50, 75, and 100 volts.

I. INTRODUCTION

Interest in electroosmotic measurements and especially a cell for rapid measurements arose from attempts to use this phenomenon in electrical circuits. It was believed that electroosmosis could be used for the opening and closing of a switch in an electrochemical relay.

Electroosmosis is a definite phenomena of a system and therefore would have a high reliability. Since each liquid, colloid, or mixture of liquids have different electroosmotic properties, a variety of times would be available for a relay by just changing the chemical component. The operating temperature would cause some limitations on the choice of systems, but many organic liquids could be used over the standard operating range (-65 to +165° F). However, electroosmosis has a temperature dependence and this would have to be studied for most systems to see what its magnitude is.

Since it would be desirable to look at many systems that have not ben studied in great detail, it would be desirable to have a cell in which rapid measurements could be made. A cell for this purpose has been designed and built. Measurements are presented for acetonitrile, dimethylformamide, and nitrobenzene.

II. THEORY OF ELECTROOSMOSIS

Electroosmosis is the phenomena of a fluid moving with respect to a solid wall when a potential has been applied across the fluid. Ruess first observed this phenomena in 1808 which makes electroosmosis one of the first electrochemical effects to be observed. Extensive experimental studies were carried out later by Wiedemann[1] and Quincke.[2] Quincke[3] in his studies first suggested that a streaming potential should exist between the wall and the fluid. The streaming potential is the reverse of electroosmosis. Electroosmosis is expressed in terms of velocity of flow or in volume moving per unit time. For our purposes volume will be used.

The theory of electroosmosis has been treated extensively by Helmholtz,[4] Lamb,[5] Smoluchowski,[6] and Per-