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ABSTRACT

The main ditch of Flat Bayou Drainage in north central Jefferson County carries water southward into Plum Bayou which then shortly empties into the Arkansas River. Flat Bayou proper flows northward into Wabbaseka Bayou which in turn flows into the Arkansas River in northeastern Lincoln County. Two sites on the main ditch were sampled for physico-chemical parameters and benthic macroinvertebrates on 9 September, 7 October and 11 November 1978. No visible detrimental effects were attributed to physico-chemical characteristics. Thirty-one below-family taxa and 19 families were found in abundance from zero at one site and date to 3580 per m^2 at one site and date. *Corbicula* was by far the most numerous taxon whereas several taxa (e.g. *Placobdella, Piscicolaria, Lampsilis, Uniomerus, Campeloma, Berosus* and *Palpomyia*) were represented by a per m^2 density of 8.6 on one date at one site. Dominance indices were generally greater, and distribution values indicated stronger clumping at Site 1 whereas diversity values were generally greater at Site 2. These indicated the substrate at Site 2 was more suitable for community development.

INTRODUCTION

The main ditch of Flat Bayou is a small tributary of Plum Bayou, Jefferson County, Arkansas (Fig. 1). Both drainages originate in north central Jefferson County and flow generally southward to join about 0.8 km (0.5 mi) before Plum Bayou joins the Arkansas River about 4.9 km (3 mi) upstream from Lock and Dam No. 4. In this area much acreage is cultivated for commercial production of soybeans and cotton. Relatively thin strips of bottomland hardwoods line the bayou tributaries and drainage ditches making suitable but sparse cover for wildlife. A series of constructed ditches lateral to the main ditch helps drain the farmland (Fig. 2). Flat Bayou proper originates near the town of Altheimer and flows northward about 11.3 km (7 mi) to Wabbaseka Bayou. However, because of the proximity of the main ditch to the Flat Bayou, the former apparently handles most of the area's drainage. This study was funded by the Soil Conservation Service (SCS) and will be used to plan methods of reducing damage from floodwater, drainage and erosion.

MATERIALS AND METHODS

A. **Description of sites.** Site 1 was about 0.4 km (0.25 mi) above its confluence with Plum Bayou (T5S,R8W,S6). A levee between the sample site and Plum Bayou and flood gates help protect the nearby farmland. The substrate at Site 1 included numerous large rocks and concrete fragments near the end of a large culvert. Beyond 6 m (20 ft) from the culvert's end, rigid clay with prominent longitudinal ridges made up approximately 80% of the bottom. The remainder was soft "pebbly" clay (when seived the clay would roll up into pebble-like balls 3-10 mm diameter). Algae covered about 5% of the bottom. Site 2 was 2.4 km (1.5 mi) north of U.S. Highway 79 (T4S,R8W,S29) 0.4 km upstream from the entrance of lateral ditch no. 1. The substrate here contained much finely divided and very soft silt and organic matter. The organic matter was an evenly distributed mixture of sticks and leaves. Algae covered about 95% of the bottom.

B. **Physico-chemical measurements.** Weather data (percent cloud cover, precipitation and air temperature), physical characteristics of the water (temperature, flow, width, depth and turbidity) and chemical parameters (dissolved oxygen, pH, alkalinity, carbon dioxide, nitrate and phosphate) were recorded on 9 September, 7 October and 11 November 1978. Stream flow was measured with a General Oceanics Model 2031 impeller-type flowmeter. Chemical parameters were measured in the field with a HACH DR-EL "Engineer's Laboratory."

C. **Benthos.** Five benthic samples using a 6 x 6-inch (232 cm^2) standard Ekman grab were taken at each site on each date. Each sample was rinsed in a sieving bucket having a mesh size of approximately 0.5 mm, transferred to a wide-mouth glass jar and transported to the lab. The first series (9 Sep) was frozen until sorting and identification could be done, but this was unsuitable because a few oligochaetes were apparently lost. Samples in the other two series were preserved in 5% formalin immediately upon collection. After sorting, the specimens were put into 70% Ethanol. Identifications to genus, except Oligochaeta and Chironomidae, were made using keys in Edmondson (1959), Pennak (1953), Usinger (1956) and Merritt and Cummins (1978). Finally the specimens were counted, dried and weighed (EPA 1973). Not all the organisms in the family Chironomidae and the families of Oligochaeta were identified to genus because these groups present serious taxonomic problems; they were labelled "A", "B", etc.

Abundances of individual taxa were compared between the two sites using the Wilcoxon two-sample test of rank values. Single values for community dominance were calculated according to the formula, $c = \Sigma(\frac{ni}{N})^2$ where ni is the numerical importance value for each taxon in turn, and N is the total of individual ni's (Odum 1971). Diversity ($\bar{d}$) values were calculated by the formula, $\bar{d} = -\Sigma(\frac{ni}{N})\log(\frac{ni}{N})$, where ni and N are the same as in the previous calculation (Odum 1971). Distribution of individuals with respect to one another was judged by observing the variance, $v = \frac{\Sigma(X-\bar{X})^2}{N-1}$ of the subsamples (Odum 1971). There is room for error because a few subsamples, but these should not be ignored.

RESULTS AND DISCUSSION

A. **Physico-chemical.** Physico-chemical measurements were usually well within the range of expectation and caused no visible detrimental effects on the benthos within the study period (Table 1). Stream flow was not measurable on 7 Oct and 11 Nov, dissolved oxygen was somewhat low at Site 1 on 9 Sep, and phosphate was

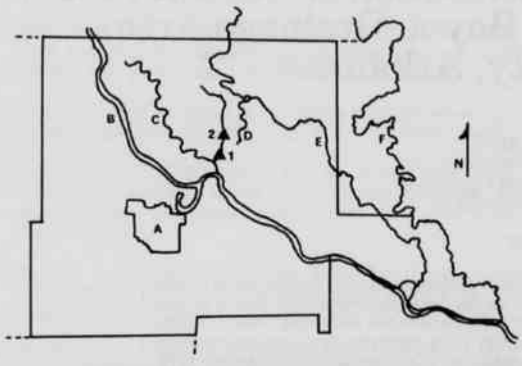

Figure 1. Jefferson County, Arkansas showing sample Sites 1 and 2. A = Pine Bluff; B = Arkansas River; C = Plum Bayou; D = Flat Bayou; E = Wabbaseka Bayou; F = Bayou Meto.

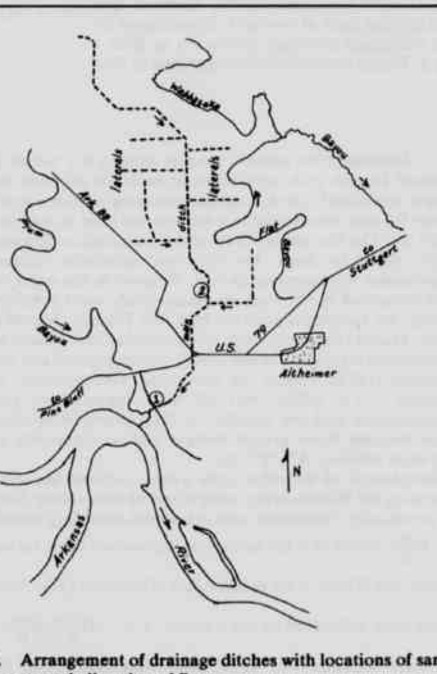

Figure 2. Arrangement of drainage ditches with locations of sample sites. Arrows mark direction of flow.

Table 1. Physico-chemical Characteristics of Water, Sites 1 and 2.

	9 Sep		7 Oct		11 Nov	
	site 1	site 2	site 1	site 2	site 1	site 2
Time (hrs)	1030-1300	1400-1520	1030-1245	1415-1600	1020-1220	1315-1530
Cloud cover (%)	80	100	0	0	100	5
Precipitation	none*	none	none	none	none	none
Air temp. (°C)	33	33	19	23	25	24
Water temp. (°C)	26	28	19	20	15	19.5
Flow (m/s)	0.1	0.16	n.m.	n.m.	n.m.	n.m.
Width (m)	8.69	7.85	9.36	7.00	6.60	7.60
Depth-max (cm)	80.7	68.5	83.6	56.5	73.0	67.0
-mean	35.6	35.8	34.0	29.1	34.0	39.1
Turbidity (FTU)	20	16	36	16	18	20
D. O. (mg/l)	5.6	9.2	11.2	11.7	10.3	10.7
pH	7.6	7.58	8.2	8.2	8.0	8.0
Alkalinity (mg/l)	110	120	60	100	80	110
CO_2 (mg/l)	8	7	16	8	12	12
$PO_4^{=}$ (mg/l)	0.74	0.74	0.59	1.72	0.60	0.75
NO_3^- (mg/l)	1.40	0.80	1.50	1.00	1.70	1.50

*Began sprinkling rain about 1230, lasted about 20 minutes.

quite high at Site 2 on 7 Oct. I was not able to determine if the large concentration of phosphate was correlated with the application of fertilizer.

B **Benthos.** Thirty-one species representing 19 families of invertebrates were present (Table 2). Some taxonomic review of Pelecypoda is currently in progress but incomplete at the time of manuscript preparation (Mr. Mark Gordon, *pers. comm.*). Table 3 gives a summary of numbers and weights per m^2, whereas Figure 3 shows changes with time in numbers of the five most abundant groups.

Oligochaeta and Hirudinea were more abundant at Site 2, while Mollusca were generally more abundant at Site 1. Diptera increased with time at Site 1 and decreased with time at Site 2. Naididae "B" was the most abundant oligochaete, *Helobdella* the most abundant leech, *Corbicula* the most abundant pelecypod, *Amnicola* the most abundant gastropod and chironomid "A" the most abundant dipteran. Several groups could be considered incidental, having occurred only once (Tubificidae, *Placobdella*, *Piscicolaria*, *Lampsilis*, *Campeloma*, *Berosus* and *Palpomyia*). Branchiobdellidae, Naididae "C" and *Uniomerus* were found in two samples on the same date, whereas *Ligumia* and chironomid "B" were found twice on different dates, and chironomid "D" was found twice at different sites.

The total benthic abundance was greater at Site 1 on all dates because of the large numbers of *Corbicula*, but abundance of individual taxa was generally greater at Site 2. On 7 Oct the difference in abundance was significant at $\alpha = 0.025$ but not significant at $\alpha = 0.10$ on 9 Sep and 11 Nov.

Dominance values range from zero to one, the larger indicating a greater degree of dominance in the community (Table 4). The dominant taxa appeared to be Naididae "B", *Corbicula*, *Amnicola* and Chironmidae "A". By number, Site 1 exhibited greater dominance on 9 Sep and 11 Nov, but by weight Site 1 showed greater dominance on all dates. Dominance is generally stronger in communities subject to harsh climates, poor habitat or in subclimax stages of ecological succession (Odum 1971).

Table 4 also gives diversity values. Lower values indicate lower diversity and generally greater dominance. Obviously these are relative and used only for comparison of two or more communities. Of 16 paired diversity values, 14 were larger at Site 2 indicating the environment was more suitable for community development. At Site 1 gastropods were more diverse than pelecypods and insects more then mollusks. At Site 2 pelecypods were more diverse than gastropods, while mollusks were more diverse than insects. Change in diversity with time was variable, Site 1 exhibiting a general increase for all benthos, while Site 2 showed a decrease. Oligochaete diversity decreased at Site 1, while mollusk diversity decreased at both sites. Insect diversity at Site 2 showed a sharp rise on 7 Oct but dropped again to near the initial value on 11 Nov. There seems to be no clear distinction between the two sites regarding changes in diversity.

A variance of one indicates random distribution, but if greater than one it tends to be clumped. Table 4 shows that most of the groups are strongly clumped. Of the 13 paired values the variance was larger at Site 1 nine times, indicating the benthic substrate was more highly variable causing clumped distributions (this varied substrate was also directly observed). Pelecypods were the most highly clumped at Site 1 whereas oligochaetes were at Site 2. Dipterans were least clumped at both sites. Change in clumping with time was highly variable, both sites showing a general increase for all benthos, but within there was considerable variation. Pelecypods at Site 1 exhibited reversal ending with greater clumping and at Site 2 showed a uniform increase. Gastropods at Site 1 exhibited reversal ending with less clumping but at Site 2 showed a uniform increase. Diptera increased at Site 1 and decreased at Site 2. This seems to indicate the substrate at Site 2 was more uniform and consistent with time (seasonal change).

While this drainage system is man-made and probably would not resemble a natural southeastern Arkansas bayou in every respect, there are similar characteristics because several years have elapsed since the most recent maintenance effort. Year round sampling would probably yield additional taxa and possibly seasonally variable diversity and dominance. Also, different sampling techniques would probably have yielded additional taxa, but SCS specifications called

Table 2. Taxonomic list of Benthic Macroinvertebrates, Flat Bayou Drainage area, 1978

- Platyhelminthes
  - Turbellaria
    - Tricladida
      - Planariidae
        - Phagocata
- Annelida
  - Oligochaeta
    - Prosopora
      - Branchiobdellidae
    - Plesiopora
      - Naididae "A"
      - Naididae "B"
      - Naididae "C"
      - Tubificidae
  - Hirudinea
    - Pharyngobdellida
      - Erpobdellidae
        - Dina
    - Rhynchobdellida
      - Glossiphoniidae
        - Helobdella
        - Placobdella
      - Piscicolidae
        - Piscicolaria
- Mollusca
  - Pelecypoda
    - Heterodonta
      - Corbiculidae
        - Corbicula
      - Sphaeriidae
        - Musculium
        - Sphaerium
    - Schizodonta
      - Unionidae
        - Crenodonta
        - Lampsilis
        - Ligumia
        - Uniomerus
  - Gastropoda
    - Ctenobranchiata
      - Bulimidae
        - Amnicola
      - Viviparidae
        - Campeloma
    - Pulmonata
      - Physidae
        - Physa
      - Planorbidae
        - Heliosoma
- Arthropoda
  - Insecta
    - Ephemeroptera
      - Caenidae
        - Caenis
    - Coleoptera
      - Hydrophyllidae
        - Berosus (larva)
    - Diptera
      - Ceratopogonidae
        - Palpomyia
      - Chironomidae "A"
      - Chironomidae "B"
      - Chironomidae "C"
      - Chironomidae "D"
      - Chironomidae "E"
      - Culicidae
        - Chaoborus

for Ekman sampling only. On 28 July 1978 I visited Site 1, captured *Pantala flavescens* and *Erythemis simplicicollis* and observed *Plathemis lydia*, *Libellula luctuosa* and *Pachydiplax longipennis*. At Site 2 I caught *E. simplicicollis*, *L. luctuosa* and *P. longipennis*. All of these were adult dragonflies (Odonata). Caither and Harp (1975) reported two species of Isopoda, numerous mayflies including the genera *Hexagenia* and *Stenonema* and several species each in the orders Odonata, Hemiptera, Trichoptera and Diptera in Big Creek, a typical delta stream. Many of these would probably be found in Flat Bayou area upon further investigation.

SUMMARY

Both sites on the main ditch of Flat Bayou appear to be marginally suited for healthy aquatic populations but possess a surprising variety of benthic invertebrates — 31 species representing 19 families. Most of the invertebrates were herbivore or detritovores. Substrate at Site 1 was less uniform and suitable as indicated by clumping and diversity values. It was mostly rigid clay whereas at Site 2 it was finely divided silt with much semidecomposed vegetation embedded. Values for physico-chemical parameters were somewhat variable but apparently not detrimental during the study period. Diversity was greater at Site 2, whereas abundance and clumping were greater at Site 1. Changes in diversity and clumping with time were variable with no trends readily seen or correlated with seasonal change. Site 2 appeared to be slightly more suitable for community development.

Table 3. Summary of Numbers (per m²) and Weights (g/m²) of Benthos, Flat Bayou Drainage area, 1978

	9 September				7 October				11 November			
	site 1		site 2		site 1		site 2		site 1		site 2	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Phagocata											25.8	.043
Branchiobdellidae					94.7	1.64						
Naididae "A"					585	.516			318	.387	25.8	.043
Naididae "B"					120	.086	1730	14.8	379	.086	1713	9.47
Naididae "C"											68.8	.086
Tubificidae					8.6	.040						
Dina	8.6	.172	43	.172								
Helobdella			17.2	.170			68.9	.258	25.8	.129	112	.258
Placobdella									8.6	.086		
Piscicolaria							8.6	.172				
Corbicula	3365	144	344	313	2814	213	318	334	3580	411	258	284
Musculium	8.6	.430	94.7	3.18	43	2.32	112	15.2	17.2	.516	318	15.0
Sphaerium			25.8	1.12			17.2	8.18				
Crenodonta	17.2	5.16	25.8	32.9	17.2	.688	8.6	4.65				
Lampsilis							8.6	16.8				
Ligumia							8.6	97.0			17.2	18.6
Uniomerus							25.8	29.3				
Amnicola	577	7.49	120	3.18	749	26.0	318	6.63	404	14.0	482	9.12
Physa	17.2	.430	43	.689	68.8	1.46	43	1.20	25.8	.258	215	4.73
Heliosoma	8.6	.043	34.4	1.29	25.8	.086	17.2	2.75			8.6	.040
Campeloma											8.6	.258
Caenis	17.2	.040									8.6	.040
Berosus									8.6	.040		
Palpomyia									8.6	.040		
Chironomidae "A"			284	.215	120	.129	60.2	.043	336	.301	94.7	.086
Chironomidae "B"							34.4	.040	8.6	.040		
Chironomidae "C"							43	.043	8.6	.040	25.8	.043
Chironomidae "D"									8.6	.040	8.6	.040
Chironomidae "E"			103	.129			25.8	.040	25.8	.043		
Chaoborus	17.2	.040					8.6	.040			8.6	.040
TOTALS	4036	158	1136	356	4647	246	2857	530	5164	427	3400	342

Table 4. Diversity indices, Variances and Dominance values, Flat Bayou Drainage area, 1978.

	Diversity Indices		Variances		Dominance Values	
	site 1	site 2	site 1	site 2	site 1	site 2
Oligochaeta						
9 Sep	---	---	---	---		
7 Oct	.355	---	320	1340		
11 Nov	.299	.133	462	955		
Pelecypoda						
9 Sep	.022	.380	5417	5.76		
7 Oct	.050	.478	4706	44		
11 Nov	.013	.299	9312	61		
Gastropoda						
9 Sep	.089	.408	112	14		
7 Oct	.181	.232	317	77		
11 Nov	.099	.318	62	190		
All Mollusca						
9 Sep	.216	.649				
7 Oct	.312	.669				
11 Nov	.170	.631				
Chironomidae			Diptera			
9 Sep	---	.252	---	30		
7 Oct	---	.581	1.44	14		
11 Nov	.242	.317	23	3.61		
All Insecta						
9 Sep	.301	.252				
7 Oct	---	.638				
11 Nov	.321	.398				
All benthos						
9 Sep	.244	.852	6773	38	.715	.186
7 Oct	.562	.653	9312	1170	.411	.395
11 Nov	.502	.678	15252	1648	.500	.295

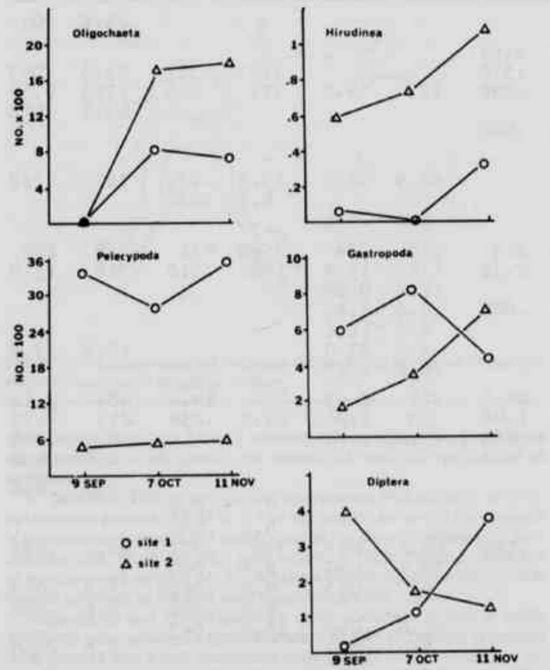

Figure 3. Changes in number (x $100/m^2$) with time of benthos groups, Flat Bayou Drainage area, 1978.

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