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AN ECOLOGICAL RECONNAISSANCE OF A NATURALLY ACID STREAM IN SOUTHERN LOUISIANA

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INTRODUCTION

Between 1947 and 1952 the Zoology Department of Tulane University undertook numerous collecting trips to Bayou Lacombe to demonstrate to various classes the fauna of a small, sandy, acid stream. During 1951 more detailed studies were begun and six stations were established to determine zonation of the biota and the physical conditions of the environment.

In September, 1952, a visit to the stream at the village of St. Tammany showed that drastic changes had occurred. It had been deepened and straightened. The natural obstructions were removed and on the banks were mounds of sand fully 20 feet high. The "bayou" had been made into a drainage canal. It was clear that our study of a gently flowing, undisturbed stream must be terminated. Although we anticipated obtaining more extensive information, we believe that since this stream has now been so radically changed a description of natural conditions will be of value. Perhaps ecologists in the future may use these data as a starting point in a study of succession following artificial disturbance.

An investigation of the literature showed that but little is available on acid streams. Jewell (1922) studied the fauna of Big Muddy River in the coal fields of southern Illinois. Cowles and Schwitalla (1923) investigated the hydrogen ion concentration of a creek, its waterfall, swamp and ponds. Carpenter (1927) studied the faunistic ecology of streams in West Wales some of which were acid. Allee and Torvik (1927) reported on factors affecting animal distribution in a small stream in Panama. Shoup (1948) listed general ecological conditions of two acid streams in Virginia and Parsons (1952) considered practical aspects of acid mine pollution in Tennessee. The scant literature and the total lack of information relative to naturally acid streams in Louisiana have further prompted us to publish our information.

GENERAL CONDITIONS

The course and location of the stream is shown in figure 1 and table 1 summarizes the ecological conditions at the six stations. Bayou Lacombe is located entirely in St. Tammany Parish, Louisiana, and flows southwest from Talisheek through St. Tammany and Lacombe to Lake Pontchartrain. At about one and one quarter miles north of State Highway 114, a small fork from the east joins the main stream and at an equal distance south of this highway a larger fork from the west meets the main stream. Approximately one half mile south of Lacombe, Big Branch Bayou enters and one and a half miles farther south Little or Cypress Bayou enters. There are no other tributary streams of significant size.

South of Talisheek for approximately three and a half miles the stream has been classified as intermittent. However, for the entire distance between Talisheek and Highway 114 it is actually a more or less continuous black gum slough. A short distance below Florenville the banks become higher to about 10 feet and the stream

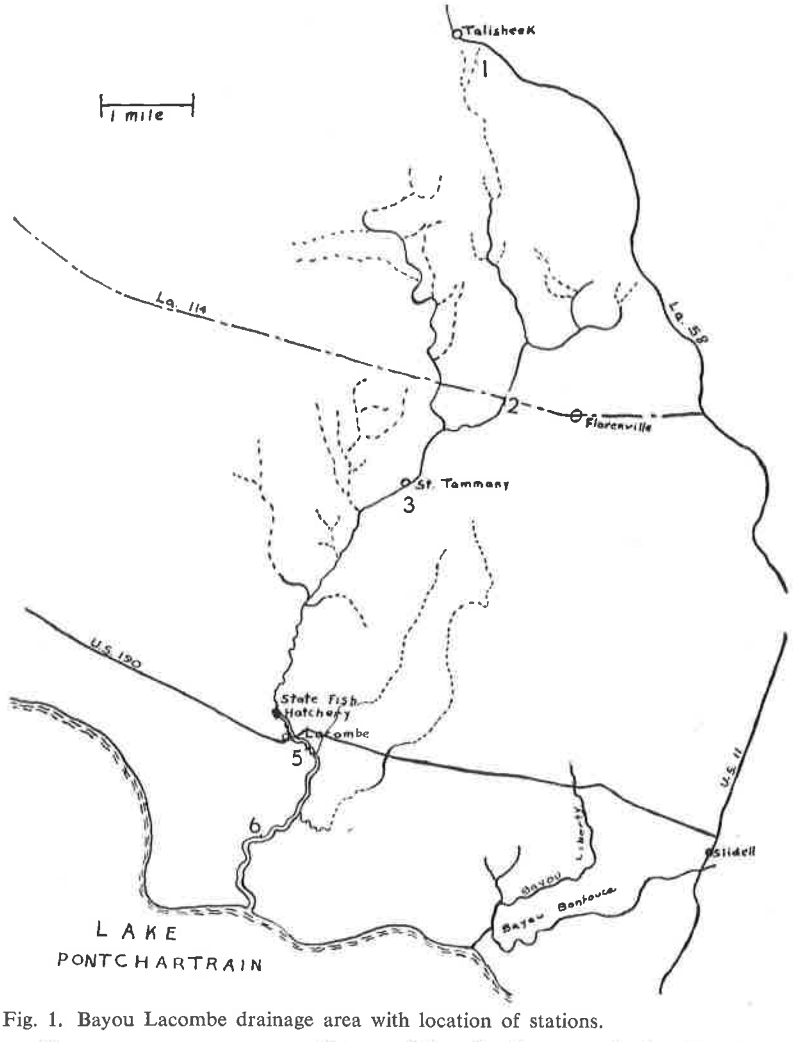

Fig. 1. Bayou Lacombe drainage area with location of stations.

continues as a narrow, rather swiftly flowing creek to about two miles north of the State Fish Hatchery. Here the stream widens, the banks become much lower and the flow much slower to produce typical "bayou" conditions. South of the Hatchery the stream is

TABLE 1. *Ecological conditions at the six stations*

Station	Location	Appearance	Width	Depth	Banks	Bottom	Flow	Color	Vegetation: Aquatic	Vegetation: Bordering
I	Talisheek	Slough	3-15′	1-6″	1′	Mud, debris, cow dung	Static	Light amber	Nyssa Acer Iris Myriophyllum	Pine Ilex Oak
II	Florenville, 1.5 miles west	Small flowing creek	8′	1-4′	4-6′	Mud	.8 feet/second	Dark amber	Myriophyllum	Pine
III	St. Tammany	Small flowing creek	12′	1-4′	10′	Sand	1.3 feet/second	Dark amber	Sphagnum	Pine
IV	Lacombe, 4 miles north	Small flowing creek	12′	1-4′	10′	Sand	1.3 feet/second	Dark amber	None evident	Pine Beech Magnolia
V	Lacombe	Slowly flowing "bayou"	75′	24′	1-2′	Mud	Very slow	Light amber	Zizaniopsis	Live oak Cypress
VI	Lake Pontchartrain, 1.3 miles north	Slowly flowing brackish "bayou"	100′	15′	1′	Mud	Very slow	Light amber	Zizaniopsis Water hyacinth	Cypress Zizaniopsis

navigable and south of Lacombe the width is 75 feet or more and depths vary from 11 to 24 feet. Thus, upstream of Highway 114 conditions are essentially lentic. Downstream nearly to the Fish Hatchery, lotic conditions prevail and southward the stream is again essentially lentic.

Almost the entire length is in longleaf pine flats (Viosca, 1933). Nearly all of the drainage area has been cut or burned. Reforestation has resulted in interrupted stands of loblolly and longleaf pines, but sizeable intervening areas remain grassy. Where the banks are highest, south of Florenville and almost to the State Fish Hatchery, there are a few large beech and magnolia trees scattered among the pines at the margin of the stream. South of Lacombe the immediate banks are primarily live oak until swamp and marsh conditions are reached

TABLE 2. *Chemical conditions prior to the disturbance*

Stations and Dates	Temp. oC.	Oxygen		pH	Free CO_2 P.P.M.	HCO_3 P.P.M.
		P.P.M.	% Saturation			
Station 1:						
Feb.-21-51	22.0	1.6	17	5.9	18.0	16.0
Mar.-3-51	26.0	1.2	14	5.8	22.5	24.0
Mar.-28-51	20.5	0.9	8	5.5	23.0	14.0
Station 2:						
Feb.-9-51	12.5	3.0	27	5.3	9.5	15.0
Feb.-21-51	19.0	1.3	13	4.9	37.5	21.0
Mar.-28-51	18.7	1.2	11	5.3	18.0	12.0
Station 3:						
Feb.-9-51	11.5	3.3	30	5.0	21.5	17.0
Feb.-14-51	17.5	2.3	23	4.0	25.0	7.7
Station 4:						
Feb.-14-51	18.0	2.6	26	4.4	23.0	22.0
Mar.-3-51	21.5	1.3	13	5.8	14.5	7.0
Mar.-28-51	18.0	1.6	15	5.3	15.0	11.0
Station 5:						
Feb.-9-51	10.1	3.6	31	5.6	16.5	23.0
Feb.-14-51	20.1	1.9	20	6.2	16.0	21.0
Mar.-28-51	18.0	1.6	16	5.8	16.0	7.0
Station 6:						
Feb.-14-51	16.0	2.8	27	6.4	16.5	11.5
Mar.-3-51	24.0	1.9	21	6.8	9.5	32.0

near Lake Pontchartrain. Penfound (1944) described the soils of the general area as "primarily yellow to red acid sandy soils." However, to us, the soils in and just adjacent to the stream appeared to be a light grey, sandy clay.

There are no industrial installations along the entire length. Human dwellings are very sparse from the source to about one mile north of the Fish Hatchery and there is very little evidence of human activity along this portion. Further downstream, residences are more numerous, the stream is crossed by a much travelled highway, is utilized for fishing and picnicking and human disturbance is more obvious.

The total length of the main stream is 36 miles. The straight line distance from the source near Talisheek to Lake Pontchartrain is 19.5

miles. The total area drained is approximately 90 square miles. The fall is irregular and is approximately 1.8 feet per mile from six miles south of Talisheek to Highway 114; 4.3 feet per mile from the Highway to St. Tammany; 3.1 feet per mile from St. Tammany to the Fish Hatchery; and only .7 feet per mile from the Hatchery to the Lake.

On March 10, 1952, channel excavating and clearing began and the project was completed on November 12, 1952. The work commenced at Highway 114 and extended downstream 10.01 miles to a point about one mile upstream of the Fish Hatchery. A total of 507,300 cubic yards were excavated from the main stream and placed in large interrupted mounds on either bank. All fallen logs and obstructions were removed. Figure 2 shows the contrast at station 3 before and after the disturbance.

PHYSICAL-CHEMICAL FEATURES

The most striking physical character of the water was color which, except for station 1, was always noted as dark or light amber. Color was not measured quantitatively as a routine practice. However, on March 7, 1953, a sample from station 3 gave a color value of 160

TABLE 3. *Chemical conditions (Jan. 8, 1953) after the disturbance*

Stations	Temp. oC.	Oxygen P.P.M.	Oxygen % Saturation	pH	Free CO_2 P.P.M.	HCO_3 P.P.M.
Station 2	18.0	5.0	52	5.4	15.0	8.0
Station 3	19.0	7.5	52	5.0	18.0	6.0
Station 5	15.0	6.0	60	5.8	13.0	8.0

as determined with a U. S. Geological Survey outfit. Rate of surface flow was measured roughly by float methods. At stations 2, 3, and 4 before the disturbance it was .8, 1.3, 1.3 feet per second respectively. After the disturbance the rate was practically unchanged and was .9, 1.2, and 1.2 feet per second at these stations. Results of chemical analyses of the unaltered stream are given in table 2. All samples were from the surface. Methods follow Standard Methods (1938) and Welch (1948). pH was determined in the field with LaMotte color standards and in most cases check readings were also taken with a Helige comparator. Dissolved oxygen was determined by the Rideal-Stewart modification of the Winkler method. Although we have only a limited number of determinations from any one station and even though only one season is represented we are impressed by the variability of nearly all data at any one station on different dates.

The water may be briefly characterized chemically as acid, poorly buffered and low in oxygen. All pH readings were below 7.0. They varied from a low of 4.0 at station 3 to a high of 6.8 at station 6.

Free carbon dioxide was always present and ranged from 9.5 to 37.5 parts per million. Carbonates were entirely absent and bicarbonates varied from 7 to 32 parts per million. This poorly buffered system would seem to account for the considerable variation in pH at any one station. Oxygen was very low at all stations and varied from 8 percent saturation (.9 parts per million) at station 1 to 31 percent (3.6 parts per million) at station 5. This scant supply of oxygen may be partially accounted for by the scarcity of chlorophyll bearing plants and the large amount of organic decomposition at all stations. The low oxygen at station 1 was expected because of the slough like nature of the habitat and the large amount of dung in the water. But the low readings at stations 3 and 4 were surprising because here, in contrast with the other stations, the bottom was sandy and the flow more rapid. Chemical analyses after the disturbance was only from stations 2, 3, and 5. Results are given in table 3. Tables 2 and 3 together furnish a comparison of chemical conditions before and after the change. The most striking difference is in oxygen. Percent saturation was higher at all stations after the disturbance, not only at stations 2 and 3, the immediately altered sites but also at station 5 which is well downstream from the disturbance.

Ellis (1937) gave a pH range of 6.7 to 8.6 and a normal oxygen minimum of 5 parts per million for a good fish fauna in streams. Our pH readings varied from 4.0 to 6.8 and oxygen from .9 to 3.6 parts per million. Ellis *et al.* (1946) state that in general dissolved oxygen at levels of 3 parts per million or lower should be regarded as hazardous to lethal under average stream conditions. They further state that whereas low oxygen alone or low pH alone may not be definitely unfavorable to fish life, an increase in acidity and a synchronous reduction in dissolved oxygen will be seriously damaging or even lethal. Bayou Lacombe did not produce a good fish fauna as defined by Ellis, but certainly a large variety (19 species) and often a large number of fish were present.

Fauna

Our analysis of animal life was limited to macroscopic forms. Sampling was solely by hand picking and dip netting from the bank and by wading to depths less than four feet. No quantitative techniques were utilized. Table 4 lists the animals collected at the six stations. The amount and intensity of collecting during the detail study period was roughly equivalent at all stations. However, other records from any of our six stations were utilized: the records from earlier class trips, data on Hemiptera from Ellis (1952), data on crawfish from Penn (1950), and records of fish furnished through the kindness of Dr. R. D. Suttkus. Since these additional data were mostly from station 3, a strict comparison of this station with the others is not warranted. We acknowledge with sincere thanks the determinations which were made by the following: Dr. Herbert H. Ross (Trichoptera), Dr. Lewis Berner (Ephemerida), Mr. Arden R. Gaufin (Plecoptera).

The animal life was essentially lentic at stations 1, 5, and 6; lotic at

3 and 4; and intermediate at 2. Only the Hemipteran family Corixidae was present at all stations. *Palaemonetes* and *Gambusia affinis* occurred at every station except station 1. Amphipods and the crawfish, *Cambarellus shufeldtii* were abundant at station 1. Station 2 yielded the greatest variety of fish and a significant number of odonate species which commonly occur in lentic situations: *Tetragoneuria cynosura,*

Fig. 2. Station 3 before and after alteration.

Erythemis simplicicollis, Coryphaeschna ingens, Nasiaeschna pentacantha.

Stations 3 and 4 produced the species characteristic of a small sandy creek. Table 4 gives a complete list of Ephemerida, Plecoptera, Odonata and Trichoptera which seem to constitute the most characteristic groups at these stations. The more striking forms were *Progom-*

phus burrowing in the sand; *Corydalis, Stenonema, Hydropsyche,* and *Chimarra* on or hidden in fallen logs or lesser twigs. In regard to the Trichoptera, Dr. Ross in a personal communication stated the record of *Chimarra* is apparently the first for the genus in Louisiana and that *Phylocentropus placidus* is a new record not only for Louisiana but for the entire central South. The animal life of stations 5 and 6 contrast strikingly with that of 3 and 4. Based primarily on Odonata, station 5 presented an array of lentic species: *Tetragoneuria cynosura, Pachidiplax longipennis, Erythemis simplicicollis, Coryphaeschna ingens, Nasiaeschna pentacantha, Anax junius.*

Although salinities were not measured, it is clear that the lower reaches are at times influenced by the slightly brackish waters of Lake Pontchartrain. The blue crab (*Callinectes sapidus*), and the rock barnacle (*Balanus* sp.) were found at station 6 which is only 1.3 miles upstream of the Lake. The platform mussel (*Congeria leucopheata*) a form usually associated with brackish water was recorded from stations 5 and 6.

In her study of an acid (pH 5.8-7.1) stream Jewell (1922) stated that *Palaemonetes* and Unionidae were characteristic. We collected *Palaemonetes* in abundance at every station except station 1. But no records whatsoever of Unionidae were obtained. In fact, the only molluscs which we record are a single small collection of Sphaeridae at station 3, *Physa* in abundance at station 5, and *Congeria leucopheata* abundant at stations 5 and 6.

Jewell also stated that it would be of great interest to know whether branchiate snails and may fly nymphs are universally absent from acid waters. We did not collect any branchiate snails. But, rather than being absent, may flies were numerous both as to individuals and as to varieties. *Stenonema* was abundant at station 3 and the following additional ephemerid genera were recorded at this station: *Baetis, Blasturus, Callibaetis, Paraleptophlebia.* Berner (1950) found that nymphs of *Stenonema smithae* are not at all or very little affected by pH and recorded them from a pH range of 4.0 to 7.8. He gave a pH range of 4.0 to 10.0 for *Callibaetis floridanus* and stated that *Baetis australis* has been collected only from acid streams.

All stations were visited twice (March 7 and 14, 1953) after the disturbance. Stations 1, 5, and 6 were unaltered and the expected forms were present. Stations 2, 3, and 4 were radically altered and with the removal of all possible cover they were practically devoid of macroscopic life. Only gyrinid beetles, two small crawfish and *Chenobritus coronarius* and *Fundulus olivaceus* were collected at the altered sites.

It is interesting to add that station 3 is the type locality of the crawfish *Orconectes hobbsi* (Penn, 1950). Habitat conditions at the type locality have now been so drastically altered that its continued existence here is questionable. No collections of *O. hobbsi* have been taken from the type locality or anywhere in Bayou Lacombe since the disturbance.

TABLE 4. *Animals collected at the six stations*

Animals Collected	*Stations* 1	2	3	4	5	6
Mollusca:						
Sphaeridae			X			
Physa sp.					X	
Congeria leucopheata					X	X
Crustacea:						
Palaemonetes sp.		X	X	X	X	X
Amphipoda	X	X			X	X
Isopoda	X	X			X	X
Cambarellus shufeltdii	X	X			X	X
Procambarus vioscai			X			
Procambarus blandingii acutus		X	X			
Orconectes hobbsi			X	X		
Procambarus clarkii					X	
Orconectes clypeatus		X				X
Callinectes sapidus						X
Balanus sp.						X
Ephemerida:						
Stenonema sp. (pulchellum group)			X			
Stenonema sp. (interpunctatum group)			X			
Stenonema sp. (smithae?)			X			
Stenonema sp.			X	X		
Baetis australis?			X			
Blasturus sp.			X			
Callibaetis sp.			X			
Paraleptophlebia sp.			X			
Plecoptera:						
Perlesta placida		X	X			
Acroneuria abnormis			X			
Acroneuria arenosa			X			
Odonata:						
Didymops transversa			X			
Hagenius brevistylus				X		
Progomphus obscurus			X	X		
Boyeria vinosa			X	X		
Macromia sp.			X	X		
Dromogomphus spinosus		X	X	X		
Tetragoneuria spinosus		X		X	X	
Somatochlora linearis		X				
Erythemis simplicicollis		X			X	
Coryphaeschna ingens		X			X	
Nasiaeschna pentacantha		X			X	
Anax junius					X	
Pachidiplax longipennis					X	
Hemiptera:						
Corixidae	X	X	X	X	X	X
Ranatra buenoi		X	X			
Notonecta irrorata			X			
Pelocoris femoratus			X			
Microvelia atratata			X			
Gerris argenticolis			X			
Rheumobates hungerfordi			X			
Belostoma testaceum			X			
Belostoma lutarium			X	X		
Ranatra australis				X		
Ranatra nigra		X			X	X
Megaloptera:						
Corydalis cornuta			X	X		

Animals Collected	*Stations* 1	2	3	4	5	6
Trichoptera:						
Hydropsyche sp.			X			
Hydropsyche sp. (near aerata)			X			
Chimarra sp.			X			
Phylocentropus placidus			X			
Coleoptera:						
Dytiscidae	X	X		X		
Hydrophilidae	X					
Gyrinidae		X	X	X		
Haliplidae	X	X		X	X	
Fish:						
Elassoma zonatum	X	X	X	X		
Chenobritus coronarius		X		X		
Fundulus notti notti		X				
Notropis roseus roseus			X			
Notropis notatus			X			
Lepomis megalotis megalotis		X	X			
Labidesthes sicculus		X	X			
Erimyzon suetta		X				
Etheostoma barrati		X				
Lepomis punctatus		X				
Notemogonus crysoleucas		X				
Aphrododerus sayanus gibbosus		X		X		
Fundulus olivaceus		X	X	X		
Schilbeodes mollis				X		
Gambusia affinis affinis		X	X	X	X	X
Fundulus chrysotus		X	X	X		X
Trinectes maculatus					X	
Mollienesia latipinna					X	
Heterandria formosa					X	X

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A MATHEMATICS CONTEST FOR HIGH SCHOOLS

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The Mathematics Department of Austin Peay State College has conducted for the past two years a contest in mathematics for high school students. The results so far have been of such a nature, in the opinions of the members of the department, as to justify the continuance of the competition, and plans are underway for the third contest to be held in April, 1953.

Collaborating in the planning and preparation for the contest is the Galois Club, the student mathematics organization on the campus. These students have charge of administering the tests, and entertaining contestants. The grading of the tests is a duty of a committee from the club under the supervision of a faculty member. The grading in previous meets was done by the visiting high school teachers and college students, but because of the large numbers of contestants and the relatively few teachers, it has been decided that college students, members of the Galois Club, should check, grade, and record results. The students also have a part in the construction of the tests.

Regulations governing somewhat similar contests were studied when the Galois Club contest was organized. The New York City contest conducted by the Mathematical Association, the Indiana state contest sponsored by Purdue University, and the William Putman competition in California were taken as examples of unobjectionable, well regulated contests.

It was decided that the outcome most desired from the contest was the arousing of interest in the study of mathematics in the high schools of the area reached by the Austin Peay State College. Convincing evidence of the success of the venture came last year (the scond contest) when fifty high school students presented themselves for the examination. Fortunately, fifty copies of the examination had been prepared, but so large an attendance had not been expected.

The examination given has been of a comprehensive nature, covering the algebra and geometry taught in the high schools, and lasting less than two hours. Future contests will be conducted in two sections: one for those who have had no high school geometry, and a separate section for those who have had geometry in high school. We found that many high school students had had no opportunity to study geometry and trigonometry, since these subjects were not offered in