

THE INFLUENCE OF BRACKISH-WATER INTRUSION ON MACROINVERTEBRATE
ASSOCIATIONS OF THE LOWER TCHFUNCTE RIVER, LOUISIANA

A Thesis
Submitted to the Graduate Faculty of the
Louisiana State University in
New Orleans
in partial fulfillment of the
requirements for the degree of
Master of Science

in

The Department of Biological Sciences

by

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B.S., University of New Orleans, 1973
August, 1975

ACKNOWLEDGEMENTS

This work was supported in part by a Federal grant under PL 88-379, The Water Resources Research Act of 1964, which was made to the Louisiana Water Resources Research Institute by the Office of Water Resources Research of the U.S. Department of the Interior (Project A-038-LA).

Sincere gratitude is extended to Dr. Michael A. Poirrier, my major professor, for his time and patience in guiding this study to completion. Thanks is due Dr. Dolores S. Dundee and Dr. Aelita J. Pinter for their critical evaluation of this manuscript.

I also thank Dr. Mary Grace Curry of VTN, Mr. Richard Heard of the Gulf Coast Research Laboratory; and Mr. Ed Stern of the Louisiana State University at Baton Rouge for their time and assistance in the identification of certain specimens. Thanks is also extended to Mike Rayle for his helpful assistance on field trips and to Mrs. Connie Rebaudo for her patience in the typing of this manuscript.

Finally, I thank my husband, Lu, for his patience and understanding throughout this study.

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ABSTRACT

An ecological survey was conducted of the lower Tchefuncte River, Louisiana, from June through November, 1974. The Tchefuncte River drains into Lake Pontchartrain, a large oligo-haline estuary. Brackish water from Lake Pontchartrain enters the river channel when flow is minimal. Maximum extent of brackish-water intrusion was determined to be approximately nine miles from the mouth of the river during October.

Eighty-six macroinvertebrate taxa were collected in the study area. Seventeen taxa were marine, and 69 were predominately fresh water. Their distribution in relation to salinity and other physico-chemical parameters is discussed. Balanus improvisus, Victorella pavida, Rithropanopeus harrisi, Gammarus sp., Melita nitida, and an unidentified polyclad flatworm existed at the mouth of the river in limnetic conditions and colonized up-river habitats during maximum brackish-water intrusion when salinity reached approximately 0.79 ppt in these areas. I have proposed these organisms as short term indicators of the extent of brackish-water intrusion. Rangia cuneata, Congerina leucophaeta, and Cordylophora caspia existed under limnetic conditions only in the tidal area of the river. Since these organisms seem dependent upon brackish water for their continued existence in the river, I have proposed them as long term indicators of the extent of brackish-water intrusion.

Physico-chemical parameters measured included: salinity, specific conductance, chlorides, turbidity, color, settleable matter, pH, phenolphthalein alkalinity, total alkalinity, free carbon dioxide, dissolved oxygen, total hardness, sulfate, ammonium nitrogen, nitrate nitrogen, orthophosphate, and total iron. These parameters are discussed in relation to seasonal trends and in relation to similar ones in comparable habitats.

INTRODUCTION

The Tchefuncte River is located in southeastern Louisiana. Beginning southwest of Sunnyhill, Louisiana, it follows the parish line between Tangipahoa and Washington parishes and between Tangipahoa and St. Tammany parishes, discharging into Lake Pontchartrain, south of Madisonville, Louisiana. The lower portion of the river lies on the Pleistocene prairie terrace, except for the two miles below Madisonville, where it courses on sediments of Mississippi River origin (Saucier, 1963). It has a dendritic drainage pattern, and its total drainage area is 450.35 square miles (Sloss, 1971).

Drainage from acidic pinelands in the upper extent of the stream, as well as drainage from fresh-water swamps and fresh-brackish marshes in the lower reaches, is maximal in the winter and minimal in the fall. Oligohaline water from Lake Pontchartrain enters the Tchefuncte River channel during the fall of the year because flow is minimal. The entrance of brackish water is maximal when winds are generally southerly. Since the periodic tidal range in Lake Pontchartrain is about .2 ft. (Saucier, 1963), the entrance of oligohaline water in the river channel is not significantly influenced by lunar tides. Wind generated tides combined with the fact that the river channel is deeper than the lake significantly influence the entrance of lake water into the river.

This investigation was undertaken to establish which macroinvertebrate associations were present in the lower Tchefuncte River and to examine qualitatively the effect of brackish water on these macroinvertebrate associations. This study area included that portion of the river between its termination at Lake Pontchartrain and its intersection with U.S. Hwy. 190 near Goodbee, Louisiana.

This study was designed to provide basic physico-chemical and biological data for the lower Tchefuncte River. The ecology of the river is closely tied to that of Lake Pontchartrain. The salinity of the lake has increased since the completion of the Mississippi River Gulf Outlet in 1963, and there is a possibility of a long term salinity change in the lake if the Army Corps of Engineers Hurricane Barrier Plan is implemented. A knowledge of the change in faunal associations of the lower river with the intrusion of oligohaline water may be useful in future studies to detect such salinity changes in the lake. A knowledge of the fauna and physico-chemical parameters of the river will also be useful in determining possible detrimental effects of the development of the land surrounding the river and the increased use of the river for recreational purposes. Since few studies have been made on the physico-chemical parameters of southeastern Louisiana streams, these data will provide information on the water quality of north shore drainage into Lake Pontchartrain.

The analysis of macroinvertebrates in the lower extent of the river will contribute to the growing knowledge of the fauna of Louisiana. Although Louisiana is rich in the number and diversity of aquatic habitats, few studies have been made of its aquatic faunal associations. The faunal analysis with which this study was concerned will also allow speculation about the life history and origin of some species.

The Tchefuncte River is a unique habitat with unique faunal associations which permits observations of the distribution in relation to salinity of local fresh-water and estuarine organisms. Prior work by Poirrier et al. (1975) examines the use of certain epifaunal invertebrates as water quality indicator species in Lake Pontchartrain. Since many of these sessile organisms exist near the mouth of the Tchefuncte River, this study will contribute to the understanding of the natural ecology of these animals in a low salinity environment. A knowledge of the natural ecology of aquatic invertebrates is necessary for a better understanding of their pollution ecology (Hart and Fuller, 1974).

Past studies of the Tchefuncte River included a study by Cardwell, Forbes, and Gaydos (1967) on the feasibility of using north shore streams as a source of fresh water. This report contains physico-chemical data for the lower Tchefuncte River. Other water quality data from the Tchefuncte River can be found in miscellaneous publications of the United States Geological Survey.

Ryan (1968) studied the food habits of the spotted bass in the Tchefuncte River. Saucier (1963) discussed the geologic history of the Lake Pontchartrain basin and surrounding areas.

Past studies of Lake Pontchartrain include reports by Suttkus, Darnell and Darnell (1954) to the Louisiana Wild Life and Fisheries Commission. This report contains information on physico-chemical parameters of the lake as well as a preliminary checklist of many of the invertebrates in the lake. Studies by Tarver (1971), Tarver and Dugas (1973), and Dugas, Tarver and Nutwell (1974) provide data on the water quality and ecology of molluscs in the lake.

Bick, Hornuff and Lambremont (1953) studied the fauna of Bayou Lacombe, a stream located on the north shore of Lake Pontchartrain which is in some ways a habitat similar to the Tchefuncte River. Gegan (1963) studied the fauna of the same area after dredging. Bordelon (1973) provided further information on the physico-chemical parameters of Bayou Lacombe as well as information on the basic properties of coloring colloids in an acid stream. These studies of Bayou Lacombe provided information on the taxonomy of many organisms as well as physico-chemical data for comparison and contrast. Moore (1970) provided information on the physico-chemical parameters of temporary ponds in southeastern Louisiana. Nutrient parameters measured in these ponds are indicative of the nutrient input into the river during

periods of high rainfall and runoff.

Wurtz and Roback (1955) investigated the invertebrate fauna of several Gulf Coast rivers including the tidal areas. Diener (1962) studied the penetration of marine vertebrates and invertebrates in the tidal Colorado River. Studies examining faunal distribution in relation to salinity have been done in the southeastern states by Odom (1953), Gunter (1956), and Gunter (1961). Cali (1972) examined the fauna of oligohaline ponds in City Park, Louisiana. Gunter, Ballard, and Venkataramiah (1974) examined the salinity problems of estuarine organisms in a coastal environment.

MATERIALS AND METHODS

Study Area

Biological and physico-chemical stations were established to determine the maximum extent of brackish-water intrusion. Stations were also established on the basis of ease of access and availability of substrate. Stations are illustrated in Figure 1.

Station A was located at the mouth of the Tchefuncte River where the channel was approximately 300 feet wide and 25 feet deep. Silt, sand, and clay made up the bottom, and fresh-brackish marsh (Saucier, 1963) surrounded the river. Biological collections were made on both east and west shores. Physico-chemical parameters were measured on the west shore.

Station B was located 1.4 miles upstream from Station A. The channel was approximately 225 feet wide and over 25 feet deep, and bottom sediments were silt and clay. Fresh-brackish marsh lined the river. The major submerged aquatic vegetation consisted of Nuphar, Najas, Ceratophyllum, and Cladophora. Biological samples were obtained from the area of a sunken wooden barge on the east bank. Physico-chemical parameters were measured offshore.

Station C was located at Fairview Riverside State Park, 2.8 miles upstream from Station B. The channel was approximately 180 feet wide and over 25 feet deep; flow was sluggish. Bottom

sediments were silt and clay, and cypress swamp lined the river. Major aquatic vegetation consisted of Nuphar, Najas, and Cladophora. Biological collecting was done in the area of a sunken boat.

Station D was located 3.6 miles upstream from Station C near the confluence of Bayou Tete L'Ours and the Tchefuncte River. The channel was approximately 150 feet wide and over 25 feet deep, and flow was sluggish. Bottom sediments were silt and clay and cypress swamp lined both banks. Nuphar and Najas comprised the major aquatic vegetation. Biological samples were obtained in the area of a nearly collapsed pier on the south side of the river.

Station E was located 1.4 miles north of Station D. This station is similar to Station D in channel width, channel depth, flow rate, bottom sediments and shoreline and aquatic vegetation. Biological samples were obtained in an area rich in shoreline debris such as fallen trees and limbs.

Station F was located 3.6 miles upstream from Station E at La. Hwy. 21. Since this station was above the confluence of the Tchefuncte and Bogue Falaya Rivers, the channel was approximately 50 feet wide and 20 feet deep. Silt and sand comprised the bottom sediments. This was a more upland station with pine, mixed hardwoods and cypress growth. Shoreline areas were two to three feet above the low water mark. Biological samples were taken from submerged substrate.

Station G was located 5.9 miles above Station F at U.S. Hwy. 190. Here the channel was approximately 25 feet wide and four feet deep, and flow was rapid. The channel bottom consisted exclusively of sand. The river here was lined by pine and mixed hardwoods, and the banks of the stream were four to five feet above the low water mark. Biological samples were taken from submerged substrate.

Sampling Plan

Physico-chemical data were collected bimonthly during June, July and August at Stations A through E, monthly during July and August at Station F, and monthly in August for Station G for the following surface parameters: Secchi disc visibility, pH, total alkalinity, phenolphthalein alkalinity, free CO₂, nitrate-N, orthophosphate, and color. Surface and bottom measurements were made of temperature and dissolved oxygen. Surface and bottom samples were taken for specific conductance, salinity, and chloride. During September, October, and November, all stations were sampled monthly for the above parameters in addition to surface measurements of turbidity, settleable matter, sulfate, hardness, ammonium-N, and total iron. Measurements of these parameters were added to further elucidate differences among stations. Although I would have preferred to follow a bimonthly sampling plan at all stations throughout the study period, teaching responsibilities and inclement weather often limited sampling.

Biological sampling was done monthly at Stations A, B, C, D and E during the period from June through October. Station F was sampled monthly July through October, and Station G was sampled monthly August through October.

Physico-chemical Field Methods

Water samples for pH, total alkalinity, and free CO₂ were taken at a depth of one to two feet, and water samples for the Winkler oxygen determination were taken surface and bottom employing a three liter PVC Van Doren water sampler. Water samples for laboratory procedures were collected similarly, stored in polypropylene bottles, and frozen immediately upon return to the laboratory. All water samples were obtained in accordance with methods given in Welch (1948).

Dissolved oxygen and temperature were measured using a YSI Model 51A oxygen meter which was calibrated according to methods given by Yellow Springs Instrument Co. (1968). The Winkler method as given in Standard Methods (American Public Health Association, 1971) was used to check results obtained with the YSI meter. On days when the YSI meter was not functional, dissolved oxygen measurements were obtained using the Winkler method, and temperature measurements were obtained using a mercury thermometer calibrated in degrees Celsius. Results from the Winkler method were found to be within the limits of precision of the YSI meter.

A Rascher and Betzold Model R-84 Colormetric kit was used to measure pH. The pH kit measurements of river water were periodically checked against a Beckman expandomatic laboratory pH meter. Phenolphthalein and total alkalinity were determined according to Standard Methods (APHA, 1971). Mixed bromcresol green-methyl red indicator was used for total alkalinity. Water transparency was measured using a Secchi disc.

Physico-Chemical Laboratory Methods

All water samples were analyzed within 48 hours of collection. Samples were allowed to come to room temperature from the frozen state.

Hach reagents, Hach methods (Hach Chemical Co., 1971) and a Hach AC-DR Colorimeter, Model DR-A 2452 were used to measure the following: orthophosphate (Stanna Ver method), nitrate-N, total iron (1, 10 Penathroline method), sulfate and ammonium-N. Methods for preparation of standard orthophosphate and nitrate solutions were taken from Standard Methods (APHA, 1971). Hach methods were chosen because of availability. Although these methods were good indicators of relative trends, exact concentrations of nutrients such as orthophosphate would have been difficult to determine because a number of substances are known to interfere with these tests in northern waters. No experimental work has been done with the accuracy of these measurement techniques in Louisiana waters.

Turbidity was measured with a Hellige turbidimeter. Settleable matter was measured using Imhoff cones and methods given in Standard Methods (APHA, 1971). Samples analyzed for true color were first centrifuged in accordance with procedures given in Standard Methods (APHA, 1971), and then a Taylor Color Comparator was used. Specific conductance was measured with a YSI Model 31 conductivity bridge and cells with cell constants of 0.1 and 1.0, respectively. Chloride was measured by the mercuric nitrate method as given in Standard Methods (APHA, 1971) employing diphenylcarbazone-bromothymol blue as an indicator. Salinity was determined from chloride data (Harvey, 1957).

Biological Sampling Methods

All biological samples were qualitative. Most collections were made near shoreline areas because of the abundance of substrate. Substrate such as tree branches and other submerged and semi-submerged objects were examined macroscopically in the field and transported back to the laboratory for a more detailed microscopic examination. A fine-meshed dipnet was used near shoreline vegetation. Benthic animals were collected using a 9 x 9 Ekman dredge.

An attempt was made to quantify biological data by securing artificial substrate to already existing substrate. Three ten centimeter square asbestos epifaunal panels and three one inch

seine-mesh bags filled with rocks were fastened along a piece of wood 1' 7/8" x 3' 3/4" x 4". Two boards with substrate were placed at each station in early August and retrieved in late November.

INTERPRETATION OF CHEMICAL AND PHYSICAL DATA

Results of field and laboratory water analyses may be found listed by station and date in Tables 2 through 13. A discussion of ranges and mean station values is given below.

Water Temperature

Surface water temperature ranged from 14°C to 30.5°C. Mean surface temperatures ranged from 20°C to 27°C. The lowest mean temperature was found at Station G, located at La. Hwy. 21, possibly because of the abundance of shade. Highest mean temperature was found at Station E. Mean temperatures were higher below the confluence of the Tchefuncte and Bogue Falaya Rivers because areas where measurements were taken were not shaded and because of the increased silt load and decreased rate of flow. Bottom temperatures were measured when the YSI meter was functional at a depth of approximately 12 feet. These temperatures were slightly lower than surface water temperatures possibly due to the absorption of heat by the silt and organic material near the surface and the sluggish flow. Bottom temperatures were more than one degree centigrade lower than surface temperatures at Stations B, C, D, and E during June and at Stations D and E during August, indicating stratification. Diurnal variations as well as pronounced seasonal variation may be seen in the data.

Secchi Disk Visibility

Secchi disk visibility ranged between 0.5 feet and 4.5 feet.

Mean visibilities ranged between 1.0 feet and 2.4 feet. Stations F and G, located above the confluence of the Tchefuncte and Bogue Falaya Rivers, had high mean visibilities as did Stations A and B which were influenced most by Lake Pontchartrain water. Highest visibilities were found during August and October at most stations due to low rainfall and runoff as well as water from Lake Pontchartrain entering the channel. Lowest visibilities occurred during July and November, the months of maximum rainfall.

Turbidity

Turbidity was measured at all stations during September, October and November. Values ranged from 9 ppm SiO₂ to 28 ppm SiO₂. Mean values ranged from 12 ppm SiO₂ to 19 ppm SiO₂. Highest values occurred at most stations during November when runoff was maximal. A significant increase in turbidity values occurred during November at Stations A, B, and C possibly from land drainage for a real estate development upstream from Station C.

Settleable Matter

Measurements for settleable matter were made only during September, October, and November at all stations. Values ranged from 0.0 ml/l to 0.4 ml/l. Station means ranged from less than 0.1 ml/l to 0.2 ml/l. Higher values were recorded during November at most stations than were recorded during September and October.

pH, Total Alkalinity, and Free Carbon Dioxide

The range of pH values was from 6.4 to 7.2. Mean values ranged from 6.8 to 7.0. Station A had the highest mean pH value because this station was under the constant influence of slightly more alkaline Lake Pontchartrain water. Stations B, C, D, and E showed an increase in pH during the month of October when maximum salt water intrusion was found. A drop in pH was noticed at all stations during November when rainfall and therefore runoff were maximum.

Total alkalinity ranged between 5 ppm CaCO_3 and 25 ppm CaCO_3 . Mean total alkalinities ranged from 10.4 ppm CaCO_3 to 19.1 ppm CaCO_3 . The highest mean total alkalinity occurred at Station A. Stations under the influence of brackish water during October showed an increase in total alkalinity. This increase was related to the increase in pH and the intrusion of Lake Pontchartrain water which is higher in total dissolved solids than Tchefuncte River water. A decrease in total alkalinity occurred during November.

Free carbon dioxide ranged from 2 ppm to 11 ppm. Mean free carbon dioxide concentrations ranged from 4.0 ppm to 5.6 ppm. Free carbon dioxide could be expected at the pH range of the river.

Conductance, Chloride and Salinity

Specific conductance, chloride, and salinity will be discussed together because they are interrelated. Specific conductance and

chloride values were obtained using laboratory techniques on surface and bottom water samples. Salinity values were computed from chloride data when chloride concentrations were above 25 ppm.

Surface chloride values ranged from 1.5 ppm to 623.4 ppm and station means varied from 3.4 ppm to 248.2 ppm. The lowest surface salinity calculated was 0.02 ppt and the highest 1.10 ppt. Surface chlorides and salinities were low at all stations during the months of June and July. An increase in both parameters occurred at Station A during August. A smaller increase occurred during August at Station B. During the month of September a significant increase in surface salinity and chlorides was found at Stations A and B. This was possibly due to an influx of salt water into Lake Pontchartrain caused by hurricane winds off the coast of southeastern Louisiana during early September. During the month of October, significant increases were seen in salinity and related parameters at Stations A, B, C, D, and E. These stations during October showed a decreasing salinity gradient with the highest salinity occurring at Station A and the lowest at Station E. Stations F and G at this time showed no change in salinity and related parameters. The intrusion of saline water was therefore maximum in October due to low rainfall and predominately southerly winds.

Specific conductance of surface samples ranged from 46 umhos/cm to 2200 umhos/cm. This parameter showed exactly the same trends

as discussed above for surface chloride and salinity.

In a study by Cardwell et al. (1967), surface conductivities of as high as 800 umhos/cm were recorded south of Covington during November. All values obtained during October of 1963 were above 100 umhos/cm. The locality from which these data were taken corresponds to Station F in this study. Stern and Atwell (1968) in a limnological study of Lake Pontchartrain recorded a surface salinity of 2.4 ppt on June 6, 1968, near Fairview Riverside State Park. The intrusion of brackish water during this study period was therefore not as extensive as during previous years from which data are available. This may have been the result of the 1973 opening of the Bonnet Carre Spillway which freshened the lake significantly (Poirrier et al., 1975). It is possible that lake salinities had not returned to normal. More probably, however, the low salinities experienced during the study period were the result of unusually high rainfall, 70.53 in., recorded at Covington (U.S. Dept. of Commerce, 1974), during 1974. Records from the U.S. Department of Commerce indicate that during the study period of Cardwell et al., 1963-1964, (1967), 50 in. of rainfall was recorded; and during 1968, the year during which Stern and Atwell studied the lake, only 40 inches of rainfall was recorded.

Bottom chlorides in this study were not measured at Station G because of its shallow depth. Values for the other six stations

varied from 3.1 ppm to 669.4 ppm and station means ranged from 4.1 ppm to 320.1 ppm. The lowest calculated bottom salinity was 0.02 ppt and the highest was 1.20 ppt. Specific conductance for bottom samples at Stations A through F varied from 50 umhos/cm to 2100 umhos/cm, and station means varied from 59 umhos/cm to 1050 umhos/cm. As with surface measurements of these parameters, increases occurred at Stations A and B during August; at Stations A, B, and C during September; and at Stations A, B, C, D, and E during October. In general, bottom measurements of conductivity, salinity and chloride were higher than surface measurements of these parameters. Salinity inversions occurred only at Stations B and E during July; at Station D during June and July; and at Station F during July and August. These inversions occurred only during the period in which these stations were not influenced by brackish water from Lake Pontchartrain.

Sulfate and Total Hardness

Sulfate concentrations varied from 5 ppm to 100 ppm. Station means ranged from 14.3 ppm to 75.0 ppm. Monthly variations in sulfate concentration were related to variations in salinity. A generally decreasing gradient of mean sulfate concentrations, corresponding to a decreasing gradient of mean specific conductance and chloride values, was observed from Station A to Station G.

Total hardness ranged from less than 1.36 ppm CaCO₃ at Station G, the least saline station to 17.7 ppm CaCO₃ at Station A, the most saline station. Mean values ranged from less than 1.36 ppm CaCO₃ to 11.3 ppm CaCO₃. Again, there was a generally decreasing gradient of mean hardness values from Station A to Station G.

Sulfate and total hardness values in this study were lower than those reported by Stern *et al.* (1968) due to the lower salinity. Upstream values were comparable to those published by the U.S. Geological Survey (1968) for samples collected during December, 1967.

Dissolved Oxygen

Surface dissolved oxygen values ranged from 2.0 ppm to 13.4 ppm. Station means varied from 6.1 ppm at Station F to 9.0 ppm at Station G. Bottom dissolved oxygen values, measured at all stations except Station G, ranged from 0.9 ppm to 12.8 ppm. Mean bottom oxygen concentrations ranged from 4.7 ppm at Station E to 7.3 ppm at Station A.

All surface measurements with the exception of the August measurement at Station F, were 70% saturation or above. The 25% saturation value obtained at Station F during August was measured using both the Winkler method and the YSI meter. There is no reasonable explanation apparent for such fluctuation in surface

dissolved oxygen concentration. Low species diversity at Station F may be a result of such fluctuations in oxygen concentration.

Bottom values were generally lower than surface concentrations and significantly lower at Stations B, C, D and E during June and at Stations D and E during August when surface and bottom temperatures indicated stratification.

Diurnal fluctuations in oxygen concentrations were very small, indicating a lack of oxygen input into the system from photosynthesis. Seasonal fluctuation due to decreased water temperature was apparent.

Ammonium Nitrogen

Ammonium nitrogen concentrations were measured only during September, October, and November. Values ranged from 0.1 ppm to 1.2 ppm. Station means were almost uniform with a range of 0.6 ppm to 0.8 ppm. The values obtained were consistent with values obtained by Moore (1970) in his studies of temporary ponds in St. Tammany Parish, Louisiana. Measurements showed a uniform and significant increase in November indicating that runoff was higher during this month than during the rest of the study period. Besides natural drainage, municipal sewage must be considered as a possible source of ammonium nitrogen.

Nitrate Nitrogen

Nitrate nitrogen values ranged from 0.3 ppm to 3.5 ppm.

Station means varied from 1.2 ppm to 1.5 ppm. Although these values were higher than those obtained by Stern et al. (1968), they were well within the range found in data from studies by the U.S. Geological Survey (1968) of the Tchefuncte River. Highest concentrations of nitrate nitrogen were found at all stations in November. These concentrations may have been influenced by extensive runoff.

Orthophosphate

Total dissolved and suspended orthophosphate concentrations ranged from 0.2 ppm to 1.5 ppm. Mean concentrations ranged from 0.6 ppm to 0.8 ppm. As with nitrate nitrogen, values obtained in this study were higher than those reported by Stern et al. (1968), but were comparable to data of the U.S. Geological Survey (1968). Highest concentrations of orthophosphate were found at all stations during November.

Total Iron

Total iron was measured during September, October and November. Iron concentrations ranged from 0.1 ppm to 0.8 ppm. Mean concentrations varied from 0.3 ppm to 0.4 ppm. At all stations, iron values gradually increased over the months that this variable was measured with the maximum values occurring during November.

Color

Color was measured in platinum cobalt units. Values ranged from 20 units to 140 units. Station means varied from 70.0 units to 92.8 units. Lowest values at Stations A, B, C, D, and E were recorded during October when salinity was maximum. Highest values were recorded at all stations during November.

DISTRIBUTION AND ECOLOGY OF MACROINVERTEBRATES OF THE LOWER TCHFUNCTE RIVER

In this section, the distribution and ecology of the macroinvertebrates of the river is discussed. The organisms are discussed individually in phylogenetic order, and a list of these organisms is presented in Table 1.

Since this study was concerned only with macroinvertebrates, groups such as the lower platyhelminths, nematodes, ostracods, and copepods were not included. A total of 86 macroinvertebrate taxa, representing eight major phyla, was collected from the study area. Of these 86 taxa, 17 are marine, and are commonly found in Lake Pontchartrain. The other 69 taxa are predominately fresh water.

All organisms collected, with the exception of the oligochaetes, were identified to the lowest taxon possible. A more comprehensive study of the brackish water oligochaetes is currently in progress. Many organisms encountered in this study, especially the insects, could not be identified to the species level because further taxonomic studies of these organisms are needed in the southeastern United States. The paucity of specimens of many species encountered in this study often hindered definitive specific determinations.

PHYLUM PORIFERA
FAMILY SPONGILLIDAE

Anheteromyemia ryderi

Identification source: Poirrier (1969).

One colony of this sponge was found during October at Station G. It is known to occur in Louisiana in fast flowing streams during the fall and winter months (Harrison, 1974), and it has been reported from the Tchefuncte River at U.S. Hwy. 190 by Poirrier (1969).

Eunapius fragilis

Identification source: Poirrier (1969).

Colonies of Eunapius fragilis were found at Stations A from July through September and at Stations B, C, D, E, and F from July through October. Colonies with gemmules were not collected until August. This sponge is known to tolerate high levels of siltation (Harrison, 1974), and thus its existence on the upper surfaces of submerged substrate in the Tchefuncte River can be explained. Many of the megascleres of E. fragilis showed an enlarged or swollen area in the middle of the spicule. E. fragilis has been reported from the Tchefuncte River by Poirrier (1969).

Spongilla wagneri

Specimens identified by Dr. Michael A. Poirrier, University of New Orleans, Louisiana.

Although this brackish-water species is common throughout Lake Pontchartrain, and it has been reported from the mouth of the Tchefuncte River by Poirrier (1969), no live colonies were found during the study period. Dermal spicules of S. wagneri were found when slides of other sponges at this location were prepared. Since this species is restricted to brackish water and is active from May through October (Poirrier, 1969), possibly salinities at Station A were too low during this period to allow growth of this sponge.

Spongilla lacustris

Identification source: Poirrier (1969).

Colonies of this sponge were found at Station G during August and September. It has been reported from this locality by Poirrier (1969).

Trochospongilla horrida

Identification source: Pennak (1953).

Colonies of this sponge were collected at Station A from June through September and at Stations B, C, D, E, and F from June through October. Colonies with gemmules were not observed until July. This sponge is known to tolerate slightly brackish water (Poirrier, 1969) and thus its existence in the tidal area can be explained. It has been reported from the Tchefuncte River by Poirrier (1969).

Trochospongilla leidyi

Identification source: Pennak (1953).

Colonies of this sponge were found at Stations A, B, C, D, and E throughout the study period. According to Poirrier (1969), this sponge is often found in waters high in conductivity due to sodium chloride, and it is often found in very turbid waters. Therefore, its existence in the tidal area of the Tchefuncte River can be explained. This sponge has been reported from the Tchefuncte River by Poirrier (1969).

PHYLUM COELENTERATA
CLASS HYDROZOA

Cordylophora caspia

Identification source: Pennak (1953).

Cordylophora caspia was found at Stations A, B, C, D, and E consistently throughout the study period. At Station A, it was found growing over colonies of Plumatella repens. At stations further upstream, it was found in close association with fresh-water sponges and ectoprocts. Poirrier and Denoux (1973) reported that when Cordylophora occurs in streams north of the lake, it occurs only in tidally influenced areas. Because of its occurrence in areas of these streams influenced by brackish water at least once a year, this organism would seem to serve as a good long term indicator of the extent of brackish-water intrusion in

the Tchefuncte River.

Hydra sp.

Identification source: Pennak (1953).

Only a few specimens of Hydra were collected at Stations D and G. The organisms were found attached to submerged wooden substrate as well as to aquatic vegetation. At Station D, Hydra was found only during June and July when the water was fresh. Hydra occurred at Station G throughout the study period.

PHYLUM PLATYHELMENTHES
CLASS TURBELLARIA
ORDER TRICLADIDA

Dugesia tigrina

Identification source: Pennak (1953).

Dugesia tigrina was collected at Station A only during the months of June and July. At Stations B, C, D, E and F, it occurred throughout the study period, although only 2 specimens were found at Station B during October when salinity was maximum. Dugesia was most often collected on both upper and lower surfaces of submerged wooden substrate. Numbers of individuals of this species increased noticeably during September at all stations. Throughout the study period, the number of individuals present at any one station was inexplicably highest at Station F.

Several other species of triclad flatworms were collected, but identification was not possible.

ORDER POLYCLADIDA

Identification source: Pennak (1953).

The only polyclad turbellarian found during this study was small, less than 3 mm total length, and thus definitive identification could not be made. However, this animal occurred only at Stations A and B. It was first collected at Station A during September when surface salinity was 1.10 ppt. It remained at Station A through October and was found in association with ectoprocts, barnacles, sponges, and Cordylophora caspia. This animal was first collected at Station B during October when surface salinity reached 0.79 ppt there. Since this organisms showed movement upstream with the intrusion of brackish water, it would seem to be a good indicator of brackish water intrusion on a yearly basis.

PHYLUM ROTIFERA

Floscularia sp.

Identification source: Pennak (1953).

Colonies of this sessile, fresh-water rotifer occurred at Stations B, C, D, and E from June through September. No colonies were found in October when brackish-water intrusion was maximum. It was found at Station F throughout the study period. This animal was most often collected on the undersides of submerged wood.

PHYLUM ECTOPROCTA
CLASS GYMNOAEMATA

Pottsiella erecta

Identification source: Pennak (1953).

This ectoproct was found at Station A from June through September and at Stations B, C, D, E and F throughout the study period. This organism was often found associated with Trochospongilla leidyi. Colonies could also be found on the underside of submerged wood associated with other ectoprocts. Many of the individuals in colonies collected exhibited a morphological variation as described by Everitt (1972). In these individual zooecia, a brown rod runs from each angle of the pentagonal orifice parallel to the long axis of the zooecia for a few millimeters.

Victorella pavid

Identification source: Gosner (1971).

This ectoproct was collected at Station A during September and October and at Station B during October. Only unbranched colonies were collected. Everitt (1972) reported unbranched colonies of Victorella pavid occurring in waters with salinities as low as 0.5 ppt. Since 0.5 ppt seems to be the lower limit of tolerance of this organism, and since it appeared upstream with the intrusion of brackish water, it would seem to be a good indicator of brackish-water intrusion on a yearly basis.

CLASS PHYLACTOLAEMATA

Fredericella sultana

Identification source: Pennak (1953).

This fresh-water ectoproct was found at Stations B, C, D, and E throughout the study period. This ectoproct is known to tolerate conductivities as high as 660 umhos/cm (Everitt, 1972). In the Tchefuncte River it was found to tolerate conductivities as high as 1700 umhos/cm at least for short periods of time. The organisms was found on a variety of submerged substrates such as wood, brick, metal, rope and Ceratophyllum.

Pectinatella magnifica

Identification source: Pennak (1953).

This ectoproct was found at Station B from July through September and at Stations C, D, and E from July through October. Very young encrusting colonies were first observed in July. Colonies with statoblasts were not collected until August. During August and September, very large colonies were observed especially on wooden substrate, often to the exclusion of other ectoprocts and sponges. Whether the gelatinous mass produced by this organism overgrows any sessile invertebrates already established on the substrate or whether the organism actually secretes a substance toxic to other invertebrates was not investigated.

Although this organism is reported to die when water temperatures reach 15°C (Reid, 1961), young, encrusting colonies were found during October when mid-day temperature was recorded at 16°C.

Plumatella repens

Identification source: Pennak (1953).

This fresh-water ectoproct is known to tolerate salinities up to 3 ppt (Everitt, 1972). It was found at Stations A, B, C, D, and E throughout the study period encrusting the undersides of a variety of substrates such as dead tree trunks, limbs, metal and bricks. At Station A it was associated with Cordylophora caspia, Victorella pavida, and Balanus improvisus. At other stations, it was associated with Cordylophora caspia, Fredericella sultana, Pottsiella erecta, and fresh-water sponges.

PHYLUM ANNELIDA
CLASS POLYCHAETA
FAMILY NEREIDAE

Nereis pelagica

Identification source: Hartman (1951).

This polychaete is a common member of the epifaunal community of Lake Pontchartrain (Poirrier et al., 1975). Only one specimen was collected in this study. It was encountered during October at Station A when salinity was maximum.

CLASS OLIGOCHAETA
ORDER PLEISOPORA
FAMILY TUBIFICIDAE

Branchiura sp. (probably sowerbyi)

Identification source: Pennak (1953).

Several specimens of this organism were found at Station C during August. They were found inside of a rotting board buried deep in the bottom reducing mud. Tafaro (1967) has reported the occurrence of this species in Louisiana from Pointe Coupee Parish.

Tubifex sp.

Identification source: Pennak (1953).

One specimen of this oligochaete was dredged from the reducing mud at Station C during July.

FAMILY AEOLOSOMATIDAE

Aeolosoma beddardi

Identification source: Pennak (1953).

This oligochaete was identified from live specimens collected at Stations C and D during July. These animals were found in association with Trochospongilla leidyi.

Although many more oligochaetes were found at all stations, identification was not attempted. However, oligochaetes were

the only animals which colonized the asbestos epifaunal panels in spite of the silt and organic matter which adhered to the rough surface of the panels.

CLASS HIRUDINEA

Helobdella lineata

Specimens identified by Dr. Mary G. Curry, VTN, Louisiana.

This species has been reported from Louisiana by Sawyer (1967) from East Baton Rouge Parish. Two specimens of this leech were collected on the Tchefuncte River, one at Station B and the other at Station C during July.

Mooreobdella microstoma

Identification source: Sawyer (1972). Identification checked by Dr. Mary G. Curry, VTN, Louisiana.

Mooreobdella microstoma has been reported from East Baton Rouge Parish, Louisiana, by Sawyer (1967). This leech was collected at Station C from June through August at Stations D and E from June through September and at Station F from June through October. Fewer individuals of this species were found at Stations C, D, and E than were found at Station F. This is one of the few species which was found in great abundance at Station F.

Placobdella papillifera

Identification source: Sawyer (1972). Identification checked by Dr. Mary G. Curry, VTN, Louisiana.

Several specimens of this leech were collected sporadically at Stations C, D, and E from June through September. Individuals with young attached to the ventral surface of the parent were observed to occur during the summer months. Specimens of this leech were collected on wooden substrate and not on known hosts.

Placobdella parasitica

Identification source: Sawyer (1972). Identification checked by Dr. Mary G. Curry, VTN, Louisiana.

Several specimens of the turtle leech were encountered occasionally at Stations C, D, and E throughout the study period. This leech has been reported from Louisiana by Sawyer (1967) although he stated that this leech is uncommon in the South. Specimens found on the Tchefuncte River were observed free living on submerged substrate and not attached to host individuals.

Placobdella sp.

Specimens identified by Dr. Marcy G. Curry, VTN, Louisiana.

Only two specimens of this leech were found during the study period. This leech is an undescribed species of Placobdella which is now in the process of being described by Sawyer (Curry, personal communication).

PHYLUM MOLLUSCA
CLASS GASTROPODA
ORDER PULMONATA

Gyraulus sp.

Identification source: Pennak (1953).

This tiny gastropod was found at Stations B, C, D, and E from June through September. Gyraulus could be found on submerged vegetation as well as on a variety of substrates such as wood. This organism increased in numbers through September. In October, only a few individuals were encountered at Stations D and E possibly because of the influx of brackish water at this time or possibly as a response to water temperature or increased predation.

Helisoma sp.

Identification source: Clench (1959).

Only a few specimens of this fresh-water snail were found during the study period at Stations B, C, D, and E. Since they were not collected regularly, no statement can be made about their tolerance to brackish water.

Physa sp.

Identification source: Pennak (1953).

Physa sp. was regularly collected at Stations B, C, D, and E throughout the study period. It could be collected in great numbers by sweeping a dipnet near the roots of shoreline vegetation.

Viviparus sp.

Identification source: Clench (1959).

Although several specimens of this fresh-water snail were collected at Stations B, C, D, E, F, and G, Station F supported far more individuals than other stations. These organisms were abundant from June through September on the pilings of the bridge at La. Hwy. 21. Most of the Viviparus sp. collected from the Tchefuncte were juvenile.

CLASS PELECYPODA
SUBCLASS LAMELLIBRANCHIA

Carunculina parva

Villosa lienosa

Specimens identified by Mr. Ed Stern, Zoology Department,
Louisiana State University, Baton Rouge, Louisiana.

One live specimen of Carunculina parva was collected from Station F. Only the shell of Villosa lienosa was collected at Station F. Since these are fresh-water mussels, possibly their range extends upstream and not downstream.

Eupera cubensis

Identification source: Burch (1972).

This clam was abundant at Stations D and E throughout the study period. It was encountered in shallow areas near the

shoreline attached to submerged vegetation such as mosses and liverworts. Eupera cubensis became much more abundant at these two stations during the months of September and October.

Sphaerium sp.

Identification source: Burch (1972)

Only three living specimens of this clam were collected in the study area. One specimen was collected at Station B, one at Station D, and one at Station E. All were collected during October, and one gravid female was found at this time. Several species of this genus have been reported from Louisiana by Heard (1963), but definitive identification to the species level could not be made with the limited number of specimens available.

Mytilopsis (Congeria) leucophaeta

Identification source: Pennak (1953).

This clam was collected at Stations A, B, C, D, and E throughout the study period. Abundance of individuals of this species increased with increasing distance from the mouth of the river. This clam when collected in Lake Pontchartrain is often found in areas protected from major predators such as the crevices in concrete pilings. At Stations A and B Congeria was found in such protected areas. The abundance of Congeria at Stations D and E in unprotected areas indicates a possible lack of major predators. The shell thickness of this organism decreased with

increasing distance from the mouth, just as total hardness decreased with increasing distance from the mouth. Although mollusc shells are known to be thinner in soft water (Macan, 1961), none of the other pelecypods collected in this area exhibited this phenomenon. Either the calcium requirement of this species is higher than that of other species or this species is not adapted to using calcium in the form in which it is available in the Tchefuncte River.

The distribution of this brackish-water organism appears to be limited to the tidal area of the Tchefuncte River. One shell attached to firm substrate was collected at Station F. This indicates that the species in the recent past extended its range at least as far up as Station F. Possibly extensive rainfall and fresh-water input into the lake from the Bonnet Carre Spillway in the past few years have limited the extent of the tidal area and thus the distribution of this species. Therefore, this organism would be a good indicator of the long term extent of brackish-water intrusion.

Rangia cuneata

Identification source: Abbott (1954).

Rangia cuneata was found at Stations A, B, C, D, and E throughout the study period. Although Tenore, Horton, and Duke (1968) reported that clay-silt sediments were an undesirable

substrate for Rangia cuneata, this clam was very common in the bottom sediments in the tidal area of the Tchefuncte River. This brackish-water organism is known to withstand at least seven months in salinity below 0.3 ppt (Gunter et al., 1975). It must then, in the Tchefuncte River, depend upon periods of brackish-water intrusion for its continued existence. Therefore, its distribution is now limited to the tidal area of the river. It would seem possible, however, that this organism as well as Congerina leucophaeta could be in the process of invading fresh water.

Although the reproduction of Rangia cuneata in the Tchefuncte River was not investigated, Fairbanks (1963) reported that Rangia in Louisiana spawns during spring and from late summer through November with the spring spawn being more intense. Since brackish-water is found in the Tchefuncte River during fall, it would seem possible that Rangia could spawn in this habitat during the fall. If salinities were sufficient for larvae to survive, 2-10 ppt, according to Hopkins, Anderson, and Horvath (1973), a successful spawn could be effected. Larval transport from intruding Lake Pontchartrain water would also be a source of young Rangia in the tidal areas of the river.

Because of its distribution pattern and apparent dependence upon oligohaline water for its existence, Rangia, could be used as an indicator of long term changes in the extent of brackish-water intrusion.

PHYLUM ARTHROPODA
CLASS CRUSTACEA
SUBCLASS CIRRIPIEDIA

Balanus improvisus

Identification source: Gosner (1971).

Balanus was found throughout the study period at Station A. During September and October, several small specimens were found at Station B. Since the larvae of this organism seem to colonize upriver habitats, this organism would serve as a good indicator of brackish-water intrusion on a short term basis.

SUBCLASS MALACOSTRACA
ORDER MYSIDACEA

Taphromysis louisiana

Identification source: Banner (1953).

This species was found to occur at Stations C, D, and E. Specimens were collected from these localities only during October using a dipnet near shoreline areas. Although this species was undoubtedly present throughout the study period, individuals could have been overlooked because of their size and transparency.

ORDER ISOPODA

Asellus obtusus

Identification source: Williams (1972).

Identification checked by Mr. Richard Heard, Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

A few specimens of this isopod were collected at Stations B, C, D, and E from June through September and at Station F during August and September. During October, individuals of this species were more abundant at these stations, possibly indicating a fall breeding season.

Cassidinidea sp.

Identification source: Schultz (1969).

Cassidinidea sp. was found only at Station A throughout the study period. It commonly occurred on substrate no lower than two feet below the water level. Cassidinidea sp. extends its range out into the lake, but no movement upstream of this brackish-water isopod was observed.

No species designation was given to this animal because Schultz (1969) indicated that more studies of southern specimens are needed before the taxonomic problems of this genus will be solved.

Cyathura polita

Identification source: Schultz (1969). Identification checked by Mr. Richard Heard, Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

The occurrence of this brackish-water isopod was restricted to Stations A and B. Several specimens of this benthic animal were dredged from each station. Since C. polita lives its entire life cycle within a few meters (Burbanck et al., 1964), the species is essentially stationary. Therefore, there is probably a small but established population of these isopods at least as far up the river as Station B.

C. polita is known to exist only within the salinity range of 0.5 to 32 ppt. Although salinities in the water column dropped below this, salinities in the microenvironment in which C. polita lives are probably much more stable and higher.

Lirceus louisianae

Identification source: Williams (1972).

Identification checked by Mr. Richard Heard, Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

Specimens of this isopod were found at Stations B and C throughout the study period. Individuals were most numerous during October indicating the possibility of breeding early in the fall.

Munna sp.

Identification source: Schultz (1969).

Only one specimen of this tiny isopod was found. It was collected at Station A during October when salinity was maximum. Munna was a constituent of the epifaunal community in the lake before the 1973 opening of the Bonnet Carre Spillway (Poirrier, personal communication). Studies made after the 1973 spillway opening (Poirrier et al., 1975), indicated that the distribution of this isopod had been affected, possibly due to the limnetic conditions in the lake. Therefore, it is possible that this isopod was existing near its minimum salinity tolerance at the mouth of the river.

Sphaeroma terebrans

Identification source: Schultz (1969).

This wood-boring isopod was encountered at Stations A and B throughout the study period. Although species numbers were higher at Station A than at Station B, there was an established population at Station B which probably existed near the minimum salinity tolerance of the species. Since fixed substrate as far up the river as Station C showed evidence of the presence of Sphaeroma at some time, the average salinity of this area might possibly have been higher as indicated by Cardwell et al. (1967) in past years.

ORDER AMPHIPODA

Corophium lacustre

Identification source: Shoemaker (1947).

Identification checked by Mr. Richard Heard.

This tube-dwelling amphipod is a member of the epifaunal community in the lake. Its occurrence on the Tchefuncte River was limited to Station A, but a large population was established there. Since ovigerous females were found throughout the study period, it was assumed that the population is reproducing in this locality.

Gammarus sp.

Identification sources: Holsinger (1972); Bousfield (1969; 1973).

This amphipod was found at Stations A, B, C, D, and E throughout the study period. It was equally abundant at all stations and could be found on any submerged objects as well as in aquatic vegetation. Prior work by Poirrier et al. (1975) does not indicate that this amphipod extends its range into the lake.

However, Suttkus and Darnell (1954) indicated the presence of a Gammarus sp. in a preliminary checklist of the invertebrates of Lake Pontchartrain. Whether or not this is the same species of amphipod as found on the Tchefuncte River is unknown.

The morphology of this amphipod is intermediate between Gammarus fasciatus and Gammarus tigrinus. This amphipod shares

key characters with both species. Gammarus tigrinus is restricted to estuaries while Gammarus fasciatus occurs in large rivers and even ranges into the tidal zone with salinities of 1-3 ppt (Bousfield, 1973). According to Holsinger (1972), in the coastal areas from South Carolina to Louisiana, G. fasciatus is probably replaced by two to three closely related undescribed species which have characters in common with G. fasciatus and G. tigrinus.

Gammarus sp.

Identification source: Bousfield (1969; 1973).

This amphipod was collected in mats of Cladophora at Station A from July through October and at Station B during October. The closest described species to this amphipod is Gammarus mucronatus. However, this amphipod has been recognized from the Mississippi Sound by Farrell (1970) as a new species.

Since this brackish-water organism showed movement upstream with the intrusion of salt water, it would serve as an indicator organism of brackish water intrusion on a yearly basis.

Hyalella azteca

Identification source: Bousfield (1973).

This fresh-water amphipod was collected at Station B from June through September and at Stations C, D, E, and F throughout the study period. Although Hyalella azteca has been reported to occur in tidal fresh water (Bousfield, 1973), this amphipod was

absent only from Station B during October indicating that perhaps salinity, some salinity-related factor, or even competition from Gammarus sp. which may be better adapted to brackish water was involved.

Melita nitida

Identification source: Bousfield (1973).

Identification checked by Mr. Richard Heard, Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

Melita nitida was collected in small numbers at Station A during September and October and at Station B during October. This brackish-water organism is a member of the epifaunal community of the lake, and it has been incorrectly reported by Poirrier et al. (1975) as Gammarus sp. Since it showed migration into the mouth of the river when salinity was maximum and ranged upriver to Station B with the intrusion of Lake Pontchartrain water, it would indicate salt-water intrusion in the Tchefuncte River on a short term basis.

Orchestia platensis

Identification source: Bousfield (1973).

Identification checked by Mr. Richard Heard, Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

This amphipod, commonly called a beach-hopper, was collected on the sandy beach at Station A. It did not range upstream to

Station B at any time possibly due to lowered salinity or the lack of sandy beaches upstream.

ORDER DECAPODA

Callinectes sapidus

Identification source: Gosner (1971).

Specimens of this species were encountered periodically throughout the study period at Station A.

Palaemonetes kadiakensis

Palaemonetes paludosus

Palaemonetes pugio

Identification source: Pennak (1953).

All three species of grass shrimp were collected during October. At this time, P. paludosus and P. pugio were found to co-occur at Station A, and P. paludosus and P. kadiakensis were found to co-occur at Station B. P. kadiakensis was found at Stations B, C, D, E, F, and G, being abundant at all stations except Station E. The distribution of these species corresponds to the salinity gradient along the river during this time.

Rithropanopeus harrisi

Identification source: Gosner (1971).

This mud crab, commonly found in Lake Pontchartrain, was

abundant at Station A throughout the study period. It was most often dredged from bottom reducing mud. Rithropanopeus harrisii was found at Station B during October. For this reason, this organism could be used as an indicator of salt water intrusion on a short term basis.

CLASS ARACHNOIDEA
ORDER HYDRACARINA

Identification source: Pennak (1953).

Although several different species of water mites were found at all stations throughout the study period, further identification was not attempted because of limited information available on water mites in the southeastern United States.

CLASS INSECTA

(All specimens were identified as larvae or nymphs unless otherwise noted).

ORDER EPHEMETOPTERA
FAMILY HEPTAGENIIDAE

Stenonema sp.

Identification source: Usinger (1971).

This organism was extremely abundant at Station B from June through August and at Stations C, D, E, F, and G throughout the study period. They were found clinging to submerged wooden substrate. There were several species of the genus Stenonema found,

but further identification was not attempted. Four different species of this genus have been reported from Bayou Lacombe by Bick, Hornuff, and Lambremont (1953).

Heptagenia sp.

Identification sources: Pennak (1953); Usinger (1971).

This stonefly nymph was found in small numbers at Station G during the summer. Specimens were found clinging to submerged, partially buried wooden substrate when the substrate was removed from the water.

FAMILY BAETIDAE

Neocleon sp.

Baetis sp.

Isonychia sp.

Paraleptophlebia sp.

Identification sources: Pennak (1953); Usinger (1971); Edmunds (1959).

All four of these free ranging mayflies were encountered only at Station G during August and September. Only a few of each of these organisms were encountered. Since their range does not extend downstream as far as Station F, it is probable that these species are better adapted to the fast flowing clear water at Station G. Both Baetis and Paraleptophlebia have been reported by Bick et al. (1953) and Geagan (1963) from Bayou Lacombe.

Baetisca sp.

Identification sources: Edmunds (1959); Pennak (1953); Usinger (1971).

Two specimens of this organism were found, one at Station B during June and one at Station G during August. This organism was not encountered at other stations.

Callibaetis sp.

Identification sources: Pennak (1953); Usinger (1971); Edmunds (1959).

This lotic water nymph has been reported from Bayou Lacombe by Bick et al. (1953) and Gegan (1963). It was encountered only at Station G during August and September.

ORDER ODONATA
SUBORDER ANISOPTERA

Didymops sp.

Macromia sp.

Nasiaechna pentacantha

Somatochlora sp.

Identification sources: Pennak (1953); Usinger (1971).

Didymops sp., Macromia sp., and Nasiaechna pentacantha were collected at Station F during August. Somatochlora sp. was collected at Station G during August and September. Nymphs of Didymops transversa, Macromia georgina, Macromia taeniolata, and Somatochlora linearis have been reported from streams in St. Tammany Parish, Louisiana, by Bick (1957). Nasiaeschna pentacantha

was reported as nymphs from St. Tammany Parish, Louisiana, in lentic environments by Bick (1957). Didymops transversa, Nasiaeschma pentacantha, Macromia sp., and Somatochlora linearis have been reported from Bayou Lacombe by Bick et al. (1953).

SUBORDER ZYGOPTERA

Lestes sp.

Ischnura sp.

Identification sources: Pennak (1953); Usinger (1971).

Lestes sp. was collected at Station B during July. Ischnura sp. was collected at Station B during June and August; at Station C during July; at Station D during July and August and at Station E during September. Adult Lestes disjunctus australis and Lestes vigilax were reported by Bick (1957) from St. Tammany Parish. Bick (1957) reported several species of Ischnura from St. Tammany Parish. Cali (1972) reported the genus from a brackish water pond system in Orleans parish.

ORDER PLECOPTERA

Acroneuria sp.

Perlesta sp.

Identification sources: Pennak (1953); Usinger (1971).

Collections were made of each of these genera of stonefly nymphs at Station G during August and September. Although there

seemed to be two species of Acroneuria, positive identification to the species level was impossible. Acroneuria abnormis, Acroneuria arenosa, and Perlesta placida have been reported from Bayou Lacombe by Bick et al. (1953).

ORDER HEMIPTERA

Belostoma sp.

Ranatra sp.

Identification source: Usinger (1971).

These swimming bugs were encountered at all stations sporadically throughout the study period. Only adult specimens were found.

ORDER MEGALOPTERA

Corydalis cornutus

Identification source: Pennak (1953).

The larva of this dobson fly was common at Station G throughout the study period. It was found clinging to submerged wooden substrate. This organism is very common in streams and is restricted to fast flowing water. This explains the absence of the organism from downstream stations.

Sialis sp.

Identification source: Pennak (1953).

Two specimens of this dobson fly larva were found at

Station E during October. They were found clinging to a submerged brick. Its distribution along the Tchefuncte River is probably more widespread than this study indicates.

ORDER TRICHOPTERA

Hydropsyche sp.

Macronemum sp.

Orthotrichia sp.

Polycentropus sp.

Identification source: Ross (1959).

Both Hydropsyche and Macronemum larvae were limited to the fast flowing current at Station G in this study. Only one specimen of each was taken during August. The larva of Orthotrichia was found at Station E during July and only one specimen and its case were found attached to wooden substrate. Larvae of Polycentropus were collected sporadically throughout the study area. It did occur at Station A during September when surface salinity was 1.10 ppt.

ORDER COLEOPTERA FAMILY HALIPLIDAE

Pelodytes sp.

Identification source: Usinger (1971).

Specimens of this adult beetle were found throughout the study period at Station F.

FAMILY GYRINIDAE

Gyrinus sp.

Identification source: Usinger (1971).

This adult beetle was found to occur on the surface of the water in large numbers throughout the study period at Station G near shoreline areas.

FAMILY ELMIDAE

Ancyronyx variegataMacronychus glabratus

Identification source: Brown (1972).

Both species of adult beetles were collected throughout the study period at Stations F and G. Adults were found clinging to submerged wooden substrate.

Stenelmis sp.

Identification source: Brown (1972).

Stenelmis sp. adults were limited in its distribution to Station G, and it was found throughout the study period. Although positive identification to the species level was not possible, this organism does belong to the humerosa-sinuata group.

FAMILY DRYOPIDAE

Helichus sp.

Identification source: Brown (1972).

Adult beetles were collected at Station G throughout the study period clinging to submerged tree branches. This organism is possibly Helichus basalis, but positive identification could not be made.

FAMILY PSEPHENIDAE

Ectopria sp.

Identification source: Brown (1972).

The tiny larva of this beetle was found at Station G during October. Only one specimen was collected from a submerged tree limb.

ORDER DIPTERA
FAMILY CHIRONOMIDAE

Identification source: Usinger (1971).

Several species of chironomid larvae were collected in the study area, but identification was impossible. Chironomid larvae occurred at all stations throughout the study period. These organisms were most often dredged from black reducing mud or found in rotting tree limbs. These larvae were also found in

association with fresh-water sponges. Station F supported a larger population of chironomid larvae than any other station within the study area.

FAMILY SIMULIIDAE

Identification source: Usinger (1971).

Only one specimen was found at Station G. Identification beyond the level of family was impossible.

ORDER NEUROPTERA

Climacia areolaris

Identification source: Poirrier and Arceneaux (1972).

Larvae of this species were found in association with Trochospongilla leidyi, upon which they are parasitic, at Stations A, B, C, D, and E sporadically throughout the study period.

DISCUSSION AND CONCLUSIONS

The fauna of the lower Tchefuncte River is an unusual combination of fresh and brackish-water organisms. Of the 86 taxa of macroinvertebrates collected, 17 were marine, and 69 were fresh water.

Station A, located at the mouth of the river, supported a predominately estuarine fauna in spite of the limnetic conditions which persisted there during three of the five months of sampling. These fluctuating conditions could be responsible for species diversity being lower here than at any other site studied. During the latter two months of the study, higher salinity forms from Lake Pontchartrain such as an unidentified polyclad flatworm, Victorella pavid, Nereis pelagica, Gammarus sp. and Melita nitida were collected. Salinity measurements taken at this time indicated that salinity reached one ppt, the highest value recorded during these two months.

Several fresh-water species were found at Station A throughout the study period. However, these forms such as Trochospongilla leidy, Cordylophora caspia, Plumatella repens, and Pottsiella erecta are known to tolerate slightly brackish water (Everitt, 1972; Poirrier, 1969; Poirrier and Denoux, 1973). None of these species was encountered living above reported maximum salinity tolerances.

Several members of the epifaunal community of the lake as reported by Poirrier et al. (1975) were absent from Station A. This is probably due to their inability to tolerate the lower salinity at this station. These included Spongilla wagneri, Bimeria franciscana, Membranipora sp., Polydora sp., an unidentified serpulid polychaete, Neanthes succinea, and Brachidontes recurvus.

Station B, located below Madisonville, supported a predominately fresh-water fauna with only four brackish-water organisms, Cyathura polita, Sphaeroma terebrans, Congerina leucophaeta, and Rangia cuneata occurring consistently throughout the study period. During October, however, when intrusion of brackish water was maximum, several other brackish-water organisms were found to penetrate upriver at least as far as Station B. These organisms were an unidentified polyclad flatworm, Victorella pavidia, Gammarus sp., Melita nitida, Balanus improvisus and Rithropanopeus harrisii. Since these organisms occurred at Station B only during October, I have proposed them as indicators of salt-water intrusion on a short term basis.

During October, when salinity was maximum, several fresh-water species were absent from Station B. These included Dugesia tigrina, Floscularia sp., Pectinatella magnifica, Hyallela azteca, and Stenonema sp.

Stations C, D, and E, located above Madisonville and below the confluence of the Tchefuncte and Bogue Falaya Rivers supported an entirely fresh-water fauna with the exception of two truly estuarine forms, Congeria leucophaeta and Rangia cuneata. These two organisms as well as Cordylophora caspia could serve as indicators of brackish-water intrusion on a long term basis since they seem to depend upon brackish-water intrusion for their continued existence upriver. Cordylophora caspia, a colonial hydroid, is found throughout the world. It commonly occurs in slightly brackish waters and rarely occurs in true fresh waters (Poirrier and Denoux, 1973). Cordylophora caspia has been reported as occurring in tidal areas of streams north of the lake (Poirrier and Denoux, 1973).

Stations above the confluence of the Tchefuncte and Bogue Falaya Rivers, Stations F and G supported an entirely fresh-water fauna. Station F supported a low species diversity possibly because the area showed fluctuation in oxygen concentration. The absence of filter-feeders at this station and the presence of Trochospongilla horrida and Trochospongilla leidyi, both very resistant to excess turbidity, indicated the possibility of detrimental siltation at this station. Station G supported a large insect fauna, and had the highest species diversity of any station studied.

Both short and long term indicator organisms could be useful in determining overall changes in the salinity of Lake Pontchartrain. An increase in the salinity of Lake Pontchartrain would, assuming normal or below normal rainfall, cause higher salinities in the tidal area of the river than experienced in this study and possibly extend the tidal area. Higher salinities in the tidal area could allow penetration farther upriver of short term indicator organisms and possibly movement upriver of other estuarine species. Extension of the tidal area for a period of several years could result in the establishment of long term indicator species upstream. Conversely, an overall decrease in the salinity of Lake Pontchartrain which could result if the U.S. Army Corps of Engineers Hurricane Barrier Plan were implemented, would probably limit the extent of upriver penetration of short term indicator species. If the tidal area were reduced by an overall decrease in lake salinity, the distribution of long term indicator organisms would probably be similarly affected.

This study of the fauna of the Tchefuncte River has added to the growing knowledge of the poorly investigated aquatic invertebrate fauna of Louisiana. Many of the fresh and brackish-water invertebrates found in the Tchefuncte River may constitute new state distributional records. Since few studies have been made of the fauna of Louisiana waters, identification to the species level of many organisms was difficult and often impossible.

Physico-chemical parameters measured during this study indicated that the Tchefuncte River is a circumneutral stream without large fluctuation in pH values. Buffering capacity of this stream was found to be low, and surface oxygen concentrations were found to be 70 per cent saturation or above. Plant nutrient concentrations were generally high possibly due to a significant amount of runoff from the surrounding swamp and input from sewerage treatment ponds. Monthly differences in nutrient concentrations can be related to the amount of rainfall received during different months. Turbidity was consistently low (below 25 ppm) throughout the study period, and color values were never found to exceed 120 platinum-cobalt units. Measurements of the aforementioned physico-chemical parameters were comparable to results obtained by the U.S. Geological Survey. These results may be found in miscellaneous reports of the U.S. Geological Survey.

Diluted oligohaline water from Lake Pontchartrain penetrated approximately nine miles upstream during the fall of 1974. In a previous study by Cardwell et al., (1967), salt water was found as far upstream as 13 miles. The low salinities encountered during this study were probably the result of above average rainfall, 70.53 inches, recorded at Covington during 1974 (U.S. Dept. of Commerce, 1974).

Bayou Lacombe is similar to the Tchefuncte River in that it, too, empties into Lake Pontchartrain from the north shore. Bayou

Lacombe, however, is a much smaller stream with a drainage area of only 96.18 sq. mi. as compared to the Tchefuncte River which drains 451.35 sq. mi. (Sloss, 1971). In addition to differences in surface drainage area, the two streams drain different Pleistocene terraces and therefore different soil types. Physico-chemical results reported by Bick et al. (1953), Geagan (1963), and Bordelon (1972) indicated that Bayou Lacombe is a more acid habitat than the Tchefuncte River with much greater fluctuations in pH values. These studies also indicated that Bayou Lacombe is a more highly colored habitat than the Tchefuncte River. In all other physico-chemical parameters reported, results were comparable to those obtained on the Tchefuncte River. The fauna of Bayou Lacombe as reported by Bick et al. (1953) and Geagan (1963) is similar to that of the Tchefuncte River. Although brackish-water intrusion can be seen in the physico-chemical data, its influence on the fauna of Bayou Lacombe has not been studied in detail.

The Tchefuncte River above its confluence with the Bogue Falaya River has been designated as a scenic river and is protected by the Louisiana Natural and Scenic Rivers Act (Davidson, 1971). The river is used extensively for recreational purposes such as boating, fishing, swimming, and water skiing during the summer months. The effects of extensive use on the river is unknown. This could be determined by future studies which would

compare future conditions with base-line data presented in this study to determine if changes had occurred. Development of the land areas surrounding the river will further the problem of municipal pollution which may soon pose a threat to the river. Additional studies may also elucidate changes brought about by the 1963 opening of the Mississippi River-Gulf Outlet.

Further studies are needed of the ecology of each of the organisms found here, especially of those species which I have proposed as indicator organisms. These organisms may prove to be useful indicators of the extent of brackish-water intrusion in habitats similar to the Tchefuncte River. Studies of the life histories of such organisms as Congeria leucophaeta and Rangia cuneata in the Tchefuncte River are needed to determine how the upriver sites are colonized and whether these low salinity populations reproduce. Because the Tchefuncte River is a mini-estuary with a salinity gradient, it could provide a natural laboratory for the investigation of differing ion ratios upon the distribution of many aquatic organisms.

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Figure 1. Map of the lower Tchefuncte River

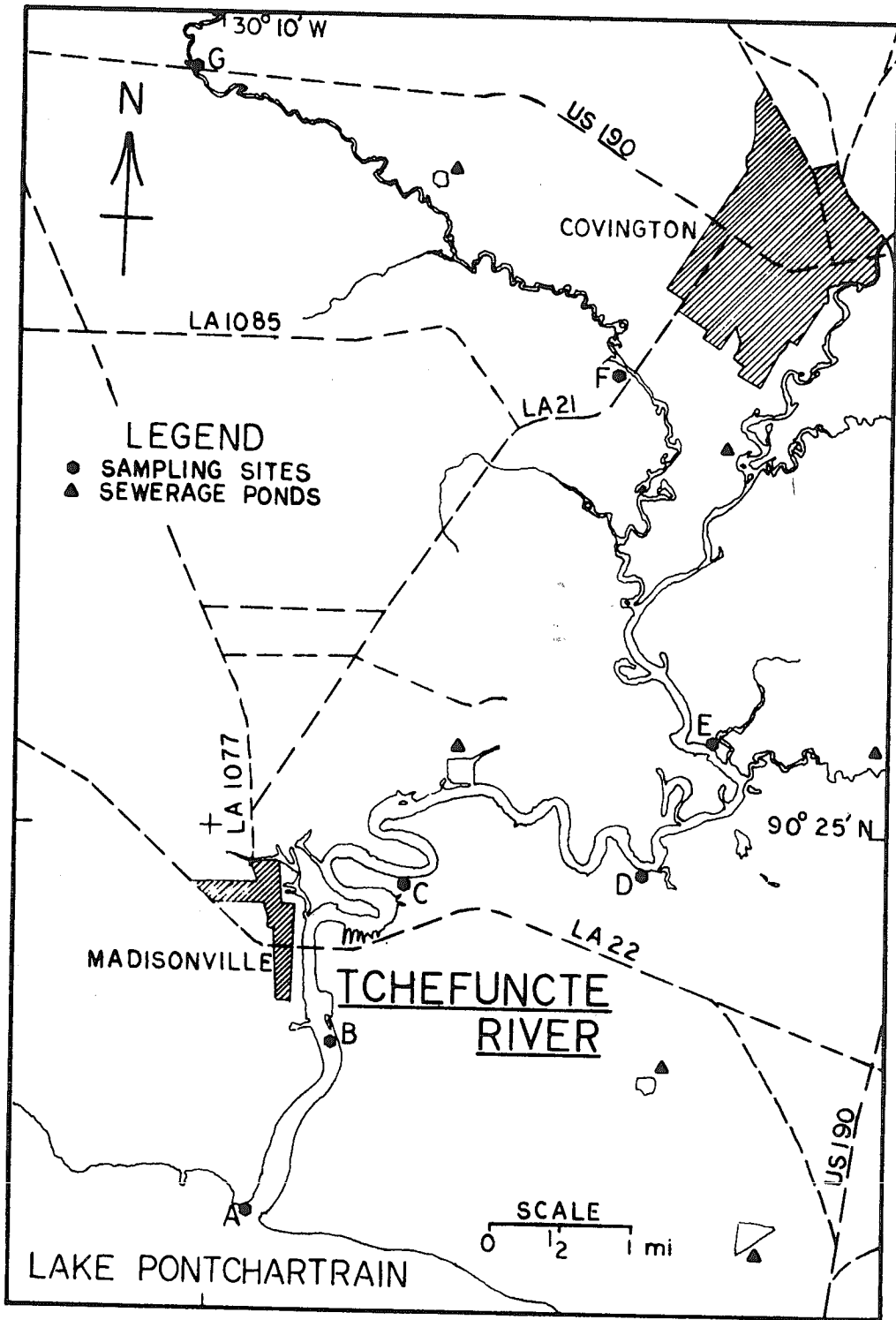


TABLE 1

MACROINVERTEBRATES COLLECTED FROM THE TCHEFUNCTE RIVER
JUNE 1974, THROUGH OCTOBER, 1974

PHYLUM PORIFERA

FAMILY SPONGILLIDAE

Anheteromyenia ryderi
Eunapius fragilis
Spongilla lacustris
Spongilla wagneri
Trochospongilla horrida
Trochospongilla Teidyi

PHYLUM COELENTERATA

CLASS HYDROZOA

Cordylophora caspia
Hydra sp.

PHYLUM PLATYHELMENTHES

CLASS TURBELLARIA

ORDER TRICLADIDA

Dugesia tigrina

ORDER POLYCLADIDA

PHYLUM ROTIFERA

Floscularia sp.

PHYLUM ECTOPROCTA

CLASS GYMNOAEMATA

Pottsiella erecta
Victorella pavida

CLASS PHYLACTOLAEMATA

Fredericella sultana
Pectinatella magnifica
Plumatella repens

PHYLUM ANNELIDA

CLASS POLYCHAETA

FAMILY NEREIDAE

Nereis pelagica

CLASS OLIGOCHAETA

ORDER PLESIOPORA

FAMILY TUBIFICIDAE

Branchiura sp.
Tubifex sp.

TABLE 1 (Continued)

FAMILY AEOLOSOMATIDAE
Aeolosoma beddardi

CLASS HIRUDINEA

Helobdella lineata
Mooreobdella microstoma
Placobdella papillifera
Placobdella parasitica
Placobdella sp.

PHYLUM MOLLUSCA

CLASS GASTROPODA

SUBCLASS PULMONATA

Gyraulus sp.
Helisoma sp.
Physa sp.
Viviparus sp.

CLASS PELECYPODA

SUBCLASS LAMELLIBRANCHIA

Carunculina parva
Eupera cubensis
Mytilopsis (Congeria) leucophaeta
Rangia cuneata
Sphaerium sp.
Villosa Tienosa

PHYLUM ARTHROPODA

CLASS CRUSTACEA

SUBCLASS CIRRIPIEDIA

Balanus improvisus

SUBCLASS MALACOSTRACA

ORDER MYSIDACEA

Taphromysis louisianae

ORDER ISOPODA

Asellus obtusus
Cassidinidea sp.
Cyathura polita
Lirceus louisianae
Munna sp.
Sphaeroma terebrans

TABLE 1 (Continued)

ORDER AMPHIPODA

Corophium lacustre
Gammarus sp.
Gammarus sp.
Hyalella azteca
Melita nitida
Orchestia platensis

ORDER DECAPODA

Callinectes sapidus
Palaemonetes kadiakensis
Palaemonetes paludosus
Palaemonetes pugio
Rithropanopeus harrisii

CLASS ARACHNOIDEA

ORDER HYDRACARINA

CLASS INSECTA

ORDER EPHEMETOPTERA

FAMILY HEPTAGENIIDAE

Stenonema sp.
Heptagenia sp.

FAMILY BAETIDAE

Baetis sp.
Baetisca sp.
Callibaetes sp.
Isonychia sp.
Neocleon sp.
Paraleptophlebia sp.

ORDER ODONATA

SUBORDER ANISOPTERA

Didymops sp.
Macromia sp.
Nasiaeschna pentacantha
Somatochlora sp.

SUBORDER ZYGOPTERA

Lestes sp.
Ischnura sp.

ORDER PLECOPTERA

Acroneuria sp.
Perlenta sp.

TABLE 1 (Continued)

ORDER HEMIPTERA
Belostoma sp.
Ranatra sp.

ORDER MEGALOPTERA
Corydalis cornutus
Sialis sp.

ORDER TRICHOPTERA
Hydropsyche sp.
Macronemum sp.
Orthotrichia sp.
Polycentropus sp.

ORDER COLEOPTERA
FAMILY HALIPLIDAE
Pelodytes sp.

FAMILY GYRINIDAE
Gyrinus sp.

FAMILY ELMIDAE
Ancyronyx variegata
Macronychus glabratus
Stenelmis sp.

FAMILY DRYOPIDAE
Helichus sp.

FAMILY PSEPHENIDAE
Ectopria sp.

ORDER DIPTERA
FAMILY CHIRONOMIDAE
FAMILY SIMULIIDAE

ORDER NEUROPTERA
Climacia areolaris

TABLE 2
SURFACE WATER ANALYSES FOR STATION A

Date:	6/15	6/29	7/13	7/27
Time:	1130	1225	1300	1400
Air Temperature (°C)	30	29	34	29
Water Temperature (°C)	*28.6/27.0	27.0/27.0	30.5/29.7	28
Secchi Disk Visibility (ft)	2.0	1.5	1.0	0.5
Turbidity (ppm SiO ₂)	-	-	12	-
Settleable Matter (ml/l)	-	-	-	-
Color (platinum-cobalt units)	65	80	80	80
pH	7.2	7.2	7.2	6.6
Phenolphthalein alkalinity (ppm CaCO ₃)	0	0	0	0
Total Alkalinity (ppm CaCO ₃)	25	21	15	15
Free Carbon Dioxide (ppm)	5	5	5	11

*Indicates surface/bottom readings

TABLE 2 (Continued)

Date:	8/25	9/21	10/12	11/23
Time:	1000	1400	1045	1450
Air Temperature (°C)	29	32	26	19
Water Temperature (°C)	28.5/28.0	29	22	17.0/15.5
Secchi Disk Visibility (ft)	4.0	4.5	4.0	0.5
Turbidity (ppm SiO ₂)	-	11	12	19
Settleable Matter (ml/l)	-	0.0	0.1	0.1
Color (platinum-cobalt units)	80	60	20	100
pH	7.0	7.2	7.2	6.6
Phenolphthalein alkalinity (ppm CaCO ₃)	0	0	0	0
Total Alkalinity (ppm CaCO ₃)	18	25	22	12
Free Carbon Dioxide (ppm)	5	3	3	4

TABLE 3
 SURFACE WATER ANALYSES FOR STATION A (Continued)

	6/15	6/29	7/13	7/27
Date:	6/15	6/29	7/13	7/27
Time:	1130	1225	1300	1400
Conductance (umhos/cm)	500/550	470/490	390/400	270/240
Salinity (ppt)	0.24/0.28	0.23/0.24	0.18/0.19	0.10/0.09
Chloride (ppm)	135.4/152.8	130.2/134.6	101.6/104.2	54.7/50.5
Sulfate (ppm)	-	-	-	-
Total Hardness (ppm CaCO ₃)	-	-	-	-
Dissolved Oxygen (ppm)	8.0/8.8	8.2/7.0	6.0/4.4	-
Ammonium Nitrogen (ppm)	-	-	-	-
Nitrate Nitrogen (ppm)	1.3	1.2	1.0	1.5
Orthophosphate (ppm)	0.6	0.5	0.9	0.5
Total Iron (ppm)	-	-	-	-

TABLE 3 (Continued)

Date:	8/25	9/21	10/12	11/23
Time:	1000	1400	1045	1450
Conductance (umhos/cm)	980/1020	2000/2000	2100/2200	270/1600
Salinity (ppt)	0.49/0.48	1.10/1.20	1.10/1.20	0.09/0.95
Chloride (ppm)	272.5/271.4	614.8/651.3	623.4/669.4	52.6/526.3
Sulfate (ppm)	-	90	100	35
Total Hardness (ppm CaCO ₃)	-	13.6	17.7	2.7
Dissolved Oxygen (ppm)	5.8/6.0	7.5/6.5	7.2/7.0	11.2/11.4
Ammonium Nitrogen (ppm)	-	0.3	0.6	1.2
Nitrate Nitrogen (ppm)	1.0	1.2	1.0	3.0
Orthophosphate (ppm)	0.3	0.4	0.3	1.3
Total Iron (ppm)	-	0.1	0.2	0.8

TABLE 4

SURFACE WATER ANALYSES FOR STATION B

Date:	6/15	6/29	7/13	7/27
Time:	1030	1025	1130	1145
Air Temperature (°C)	29	29	32	28
Water Temperature (°C)	28.6/27.0	28.0/27.0	28.8/28.0	27
Secchi Disk Visibility (ft)	2.0	1.5	0.5	0.5
Turbidity (ppm SiO ₂)	-	-	17	-
Settleable Matter (ml/l)	-	-	-	-
Color (platinum-cobalt units)	80	100	100	60
pH	6.6	6.6	6.6	6.6
Phenolphthalein alkalinity (ppm CaCO ₃)	0	0	0	0
Total Alkalinity (ppm CaCO ₃)	18	20	17	10
Free Carbon Dioxide (ppm)	4	6	5	8

TABLE 4 (Continued)

	8/25	9/21	10/12	11/23
Date:	8/25	9/21	10/12	11/23
Time:	0800	1445	1010	1515
Air Temperature (°C)	26	31	26	18
Water Temperature (°C)	28.0/27.0	30	22	17.0/16.0
Secchi Disk Visibility (ft)	2.0	1.5	3.0	0.5
Turbidity (ppm SiO ₂)	-	13	11	24
Settleable Matter (ml/l)	-	0.1	0.1	0.3
Color (platinum-cobalt units)	60	80	40	120
pH	6.6	7.0	7.2	6.6
Phenolphthalein alkalinity (ppm CaCO ₃)	0	0	0	0
Total Alkalinity (ppm CaCO ₃)	12	18	15	10
Free Carbon Dioxide (ppm)	8	5	3	6

TABLE 5
 SURFACE WATER ANALYSES FOR STATION B (Continued)

	6/15	6/29	7/13	7/27
Date:				
Time:				
Conductance (umhos/cm)	170/190	260/280	126/130	112/92
Salinity (ppt)	0.07/0.08	0.09/0.10	-/0.05	-
Chloride (ppm)	37.4/46.8	52.4/55.6	23.4/25.0	13.0/10.9
Sulfate (ppm)	-	-	-	-
Total Hardness (ppm CaCO ₃)	-	-	-	-
Dissolved Oxygen (ppm)	6.5/4.7	5.6/4.2	7.8/5.9	-
Ammonium Nitrogen (ppm)	-	-	-	-
Nitrate Nitrogen (ppm)	1.2	1.5	1.2	1.3
Orthophosphate (ppm)	0.7	0.6	1.0	0.3
Total Iron (ppm)	-	-	-	-

TABLE 5 (Continued)

Date:	8/25	9/21	10/12	11/23
Time:	0800	1445	1010	1515
Conductance (umhos/cm)	360/660	940/1400	1700/1800	134/105
Salinity (ppt)	0.17/0.32	0.47/0.83	0.79/0.97	-
Chloride (ppm)	93.8/177.1	260.5/458.5	439.4/669.4	15.3/20.4
Sulfate (ppm)	-	55	80	35
Total Hardness (ppm CaCO ₃)	-	6.8	13.6	1.4
Dissolved Oxygen (ppm)	7.0/8.2	7.1/4.0	7.3/6.5	12.2/10.5
Ammonium Nitrogen (ppm)	-	0.3	0.5	1.4
Nitrate Nitrogen (ppm)	1.3	1.0	1.0	3.5
Orthophosphate (ppm)	0.4	0.6	0.4	1.5
Total Iron (ppm)	-	0.2	0.1	0.8

TABLE 6

SURFACE WATER ANALYSES FOR STATION C

Date:	6/15	6/29	7/13	7/27
Time:	1300	0925	1000	0945
Air Temperature (°C)	32	30	32	28
Water Temperature (°C)	30.2/29.8	25.0/24.0	29.2/26.8	27
Secchi Disk Visibility (ft)	1.3	1.5	0.5	0.5
Turbidity (ppm SiO ₂)	-	-	12	-
Settleable Matter (ml/l)	-	-	-	-
Color (platinum-cobalt units)	100	100	100	60
pH	6.8	6.6	6.8	6.6
Phenolphthalein alkalinity (ppm CaCO ₃)	0	0	0	0
Total Alkalinity (ppm CaCO ₃)	12	15	11	8
Free Carbon Dioxide (ppm)	4	9	5	10

TABLE 6 (Continued)

Date:	8/16	9/21	10/12	11/23
Time:	1205	1300	1200	1400
Air Temperature (°C)	33	32	28	20
Water Temperature (°C)	30.0/30.0	29	24	18.0/17.0
Secchi Disk Visibility (ft)	0.8	1.5	2.5	.5
Turbidity (ppm SiO ₂)	-	16	12	21
Settleable Matter (ml/l)	-	0.1	0.1	0.1
Color (platinum-cobalt units)	60	100	50	120
pH	7.0	6.6	7.2	6.8
Phenolphthalein alkalinity (ppm CaCO ₃)	0	0	0	0
Total Alkalinity (ppm CaCO ₃)	13	15	18	8
Free Carbon Dioxide (ppm)	4	9	5	5

TABLE 7
 SURFACE WATER ANALYSES FOR STATION C (Continued)

Date:	6/15	6/29	7/13	7/27
Time:	1300	0925	1000	0945
Conductance (umhos/cm)	88/124	69/75	86/70	94/102
Salinity (ppt)	-	-	-	-
Chloride (ppm)	15.6/17.2	8.8/9.4	10.4/7.8	10.9/12.6
Sulfate (ppm)	-	-	-	-
Total Hardness (ppm CaCO ₃)	-	-	-	-
Dissolved Oxygen (ppm)	6.8/6.4	7.8/4.5	5.3/5.5	-
Ammonium Nitrogen (ppm)	-	-	-	-
Nitrate Nitrogen (ppm)	1.5	1.6	1.0	1.2
Orthophosphate (ppm)	0.8	0.7	0.8	0.3
Total Iron (ppm)	-	-	-	-

TABLE 7 (Continued)

Date:	8/16	9/21	10/12	11/23
Time:	1205	1300	1200	1400
Conductance (umhos/cm)	73/82	136/150	130/670	70/72
Salinity (ppt)	-	-/0.5	0.3/0.7	-
Chloride (ppm)	3.1/4.1	20.8/26.1	168.6/408.8	6.6/7.2
Sulfate (ppm)	-	25	35	29
Total Hardness (ppm CaCO ₃)	-	1.4	5.4	1.4
Dissolved Oxygen (ppm)	13.4/12.8	5.3/3.7	6.5/4.7	8.2/10.2
Ammonium Nitrogen (ppm)	-	0.6	0.5	1.3
Nitrate Nitrogen (ppm)	0.5	1.1	1.2	3.0
Orthophosphate (ppm)	0.2	1.0	0.4	1.3
Total Iron (ppm)	-	0.3	0.2	0.8

TABLE 8

SURFACE WATER ANALYSES FOR STATION D

Date:	6/15	6/29	7/20	8/16
Time:	1530	1430	0915	1400
Air Temperature (°C)	32	30	29	34
Water Temperature (°C)	29.5/27.5	29.0/26.5	28.0/27.0	32.0/30.0
Secchi Disk Visibility (ft)	0.5	0.8	0.8	0.8
Turbidity (ppm SiO ₂)	-	-	-	-
Settleable Matter (ml/l)	-	-	-	-
Color (platinum-cobalt units)	100	110	80	80
pH	6.6	7.0	6.6	6.8
Phenolphthalein alkalinity (ppm CaCO ₃)	0	0	0	0
Total Alkalinity (ppm CaCO ₃)	12	14	14	15
Free Carbon Dioxide (ppm)	4	6	10	5

TABLE 8 (Continued)

Date:	9/21	10/12	11/23
Time:	1050	1250	1200
Air Temperature (°C)	30	27	20
Water Temperature (°C)	28	22	17.0/16.0
Secchi Disk Visibility (ft)	1.5	2.0	1.0
Turbidity (ppm SiO ₂)	16	13	15
Settleable Matter (ml/l)	0.1	0.0	0.1
Color (platinum-cobalt units)	100	60	120
pH	6.6	7.0	6.6
Phenolphthalein alkalinity (ppm CaCO ₃)	0	0	0
Total Alkalinity (ppm CaCO ₃)	14	15	8
Free Carbon Dioxide (ppm)	5	5	5

TABLE 9
 SURFACE WATER ANALYSIS FOR STATION D (Continued)

Date:	6/15	6/29	7/20	8/16
Time:	1530	1430	0915	1400
Conductance (umhos/cm)	75/50	66/64	80/67	46/82
Salinity (ppt)	-	-	-	-
Chloride (ppm)	9.3/6.2	8.6/8.3	8.3/5.2	1.5/3.1
Sulfate (ppm)	-	-	-	-
Total Hardness (ppm CaCO ₃)	-	-	-	-
Dissolved Oxygen (ppm)	7.0/4.3	7.2/5.4	9.0/8.8	7.0/5.2
Ammonium Nitrogen (ppm)	-	-	-	-
Nitrate Nitrogen (ppm)	2.2	1.3	1.6	0.5
Orthophosphate (ppm)	1.2	0.5	0.8	1.0
Total Iron (ppm)	-	-	-	-

TABLE 9 (Continued)

Date:	9/21	10/12	11/23
Time:	1050	1250	1200
Conductance (umhos/cm)	88/88	270/1800	70/74
Salinity (ppt)	-	0.08/1.11	-
Chloride (ppm)	10.4/10.4	45.7/618.3	6.6/9.1
Sulfate (ppm)	20	12	15
Total Hardness (ppm CaCO ₃)	1.4	2.7	1.4
Dissolved Oxygen (ppm)	5.8/0.9	6.9/4.8	7.2/8.0
Ammonium Nitrogen (ppm)	0.5	0.5	1.1
Nitrate Nitrogen (ppm)	1.1	1.3	2.3
Orthophosphate (ppm)	1.3	0.4	1.7
Total Iron (ppm)	0.3	0.2	0.4

TABLE 10

SURFACE WATER ANALYSES FOR STATION E

Date:	6/15	6/29	7/20	8/16
Time:	1640	1600	1130	1530
Air Temperature (°C)	31	30	31	34
Water Temperature (°C)	29.0/28.5	28.3/25.0	28.9/27.2	31.0/27.0
Secchi Disk Visibility (ft)	0.5	1.0	0.8	1.0
Turbidity (ppm SiO ₂)	-	-	-	-
Settleable Matter (ml/l)	-	-	-	-
Color (platinum-cobalt units)	100	80	80	80
pH	6.6	7.0	6.8	6.8
Phenolphthalein alkalinity (ppm CaCO ₃)	0	0	0	0
Total Alkalinity (ppm CaCO ₃)	12	12	16	15
Free Carbon Dioxide (ppm)	3	4	5	5

TABLE 10 (Continued)

Date:	9/21	10/12	11/23
Time:	1145	1325	1245
Air Temperature (°C)	31	28	20
Water Temperature (°C)	29	24	18.0/15.0
Secchi Disk Visibility (ft)	1.5	3.0	1.0
Turbidity (ppm SiO ₂)	28	13	15
Settleable Matter (ml/l)	0.1	0.0	0.3
Color (platinum-cobalt units)	100	60	140
pH	6.8	7.0	6.6
Phenolphthalein alkalinity (ppm CaCO ₃)	0	0	0
Total Alkalinity (ppm CaCO ₃)	14	13	6
Free Carbon Dioxide (ppm)	5	5	4

TABLE 11

SURFACE WATER ANALYSES FOR STATION E (Continued)

Date:	6/15	6/29	7/20	8/16
Time:	1640	1600	1130	1530
Conductance (umhos/cm)	49/52	62/71	65/60	62/70
Salinity (ppt)	-	-	-	-
Chloride (ppm)	3.1/5.6	6.3/6.8	4.7/4.1	2.6/3.6
Sulfate (ppm)	-	-	-	-
Total Hardness (ppm CaCO ₃)	-	-	-	-
Dissolved Oxygen (ppm)	8.5/6.7	9.0/4.6	9.5/4.2	7.8/2.0
Ammonium Nitrogen (ppm)	-	-	-	-
Nitrate Nitrogen (ppm)	1.6	1.3	1.7	0.5
Orthophosphate (ppm)	1.0	0.6	1.1	0.5
Total Iron (ppm)	-	-	-	-

TABLE 11 (Continued)

Date:	9/21	10/12	11/23
Time:	1145	1325	1245
Conductance (umhos/cm)	62/72	150/670	78/53
Salinity (ppt)	-	-/0.35	-
Chloride (ppm)	4.7/5.21	15.3/199.2	9.1/4.5
Sulfate (ppm)	20	9	15
Total Hardness (ppm CaCO ₃)	1.4	2.7	1.4
Dissolved Oxygen (ppm)	7.4/1.5	7.4/5.3	8.0/8.8
Ammonium Nitrogen (ppm)	0.4	0.6	1.2
Nitrate Nitrogen (ppm)	1.1	1.3	2.5
Orthophosphate (ppm)	1.0	0.4	1.3
Total Iron (ppm)	0.4	0.2	0.5

TABLE 12

SURFACE WATER ANALYSIS FOR STATION F

	7/20	8/25	9/21	10/12	11/23
Date:	1515	1300	1705	1610	0930
Air Temperature (°C)	33	27	29	26	16
Water Temperature (°C)	28.0/27.0	26.5/26.0	27	24	14
Secchi Disk Visibility (ft)	1.0	2.5	1.5	3.0	1.0
Turbidity (ppm SiO ₂)	-	-	9	15	16
Settleable Matter (ml/l)	-	-	0.1	0.1	0.4
Color (platinum-cobalt units)	60	50	60	60	140
pH	6.8	6.8	6.8	6.8	6.4
Phenolphthalein alkalinity (ppm CaCO ₃)	0	0	0	0	0
Total Alkalinity (ppm CaCO ₃)	14	11	13	9	5
Free Carbon Dioxide (ppm)	4	5	5	4	3

TABLE 12 (Continued)

	7/20	8/25	9/21	10/12	11/23
Date:	7/20	8/25	9/21	10/12	11/23
Time:	1515	1300	1705	1610	0930
Conductance (umhos/cm)	60/54	72/58	59/69	62/80	46/52
Salinity (ppt)	-	-	-	-	-
Chloride (ppm)	4.2/3.6	4.1/3.1	3.1/4.7	3.6/4.6	3.5/4.5
Sulfate (ppm)	-	-	23	5	25
Total Hardness (ppm CaCO ₃)	-	-	1.36	0	1.36
Dissolved Oxygen (ppm)	7.5/7.2	2.0/1.8	6.8/6.2	7.3/7.6	7.0/6.5
Ammonium Nitrogen (ppm)	-	-	0.1	0.2	1.4
Nitrate Nitrogen (ppm)	1.1	0.3	0.5	1.0	3.0
Orthophosphate (ppm)	0.5	0.4	0.7	0.2	1.3
Total Iron (ppm)	-	-	0.1	0.1	0.6

TABLE 13
SURFACE WATER ANALYSES FOR STATION G

	8/16	9/21	10/12	11/23
Date:				
Time:	1000	1620	1515	0830
Air Temperature (°C)	27	29	27	16
Water Temperature (°C)	23	24	19	14
Secchi Disk Visibility (ft)	2.5	3.0	3.0	1.0
Turbidity (ppm SiO ₂)	-	10	11	14
Settleable Matter (ml/l)	-	0.2	0.1	0.2
Color (platinum-cobalt units)	40	80	60	140
pH	7.0	7.0	7.0	6.6
Phenolphthalein alkalinity (ppm CaCO ₃)	0	0	0	0
Total Alkalinity (ppm CaCO ₃)	12	10	12	9
Free Carbon Dioxide (ppm)	5	4	2	5

TABLE 13 (Continued)

Date:	8/16	9/21	10/12	11/23
Time:	1000	1620	1515	0830
Conductance (umhos/cm)	62	57	92	50
Salinity (ppt)	-	-	-	-
Chloride (ppm)	2.6	3.1	4.6	3.1
Sulfate (ppm)	-	2.3	5	15
Total Hardness (ppm CaCO ₃)	-	1.4	1.4	1.4
Dissolved Oxygen (ppm)	10.5	7.4	8.6	9.5
Ammonium Nitrogen (ppm)	-	0.2	0.4	1.4
Nitrate Nitrogen (ppm)	0.4	0.3	0.3	2.7
Orthophosphate (ppm)	0.2	0.6	0.3	1.2
Total Iron (ppm)	-	0.1	0.2	0.6

VITA

Maureen Molony Mulino was born in New Orleans, Louisiana on May 7, 1951. She attended elementary school in New Orleans and graduated from Mercy Academy in 1969. In September, 1969 she entered the University of New Orleans (formerly Louisiana State University in New Orleans). On December 27, 1972 she married Lu Mulino. In May, 1973 she graduated from the University of New Orleans with the degree of Bachelor of Science in Biological Sciences. In September, she entered the Graduate School of the University of New Orleans and is presently a candidate for the degree of Master of Science in Biological Sciences.