1976

The Freshwater Mussels (Unionidae) of the Lake Maurepas - Pontchartrain -Borgne Drainage System, Louisiana and Mississippi.

Edward Marc Stern
Louisiana State University and Agricultural & Mechanical College

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THE FRESHWATER MUSSELS (UNIONIDAE) OF
THE LAKE MAUREPAS-PONTCHARTRAIN-
BORGNE DRAINAGE SYSTEM, LOUISIANA
AND MISSISSIPPI.

The Louisiana State University and
Agricultural and Mechanical College
Ph.D., 1976
Zoology

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THE FRESHWATER MUSSELS (UNIONIDAE) OF THE LAKE MAUREPAS-
PONTCHARTRAIN-BORGNE DRAINAGE SYSTEM,
LOUISIANA AND MISSISSIPPI

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Zoology and Physiology

by

Edward Marc Stern
B.A., University of Texas at El Paso, 1969
M.S., University of Texas at El Paso, 1971
May, 1976
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Finally I want to thank my wife, Margaret, for her encouragement and patience.
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ABSTRACT

While there are some studies available concerning the freshwater mussel fauna (Unionidae) of northern Louisiana, none exists for the Lake Maurepas-Pontchartrain-Borgne drainage system of southeastern Louisiana and southwestern Mississippi. The drainage system may be characterized as an area of rolling timbered hills with moderate to fast flowing streams and rivers of low turbidity. The area to the west is a flattened, poorly drained floodplain with oxbows, bayous and few rapidly flowing tributary waters. This contrast in ecological environments is reflected in both the physico-chemical parameters of the water and in the faunal composition.

A total of 36 species and subspecies of unionid mussels was collected in the Lake Maurepas-Pontchartrain-Borgne drainage system. Temperature, pH and dissolved oxygen levels do not appear to be limiting, although some values differ considerably from those presented in the literature. With a few exceptions, a wide range of tolerance to different bottom types is exhibited. Of particular interest is the correlation between shell shape and environment. This is best illustrated among members of the *Fusconaia flava* complex where both shell height and shell obesity increase moving from the headwaters toward the mouth.
A comparison between the faunal assemblage of the Lake Maurepas-Pontchartrain-Borgne drainage system with those of adjacent drainages suggests greater affinities to the east in the Alabama-Coosa River system. The analysis of present distributions and past geological events suggests that the introduction of the present fauna did not occur via the Mississippi River system. Supportive geological evidence is found in a postulated Pliocene Tennessee River that flowed from northeastern to southwestern Mississippi where it entered the Mississippi Embayment. Alternatively, immigration may have been accomplished through former stream confluence between the headwaters of the Pearl and Tombigbee River systems.
INTRODUCTION

Scope

The objectives of this study are: (1) investigate the ecology of the freshwater mussels (Unionidae) inhabiting the Lake Maurepas-Pontchartrain-Borgne drainage system, (2) to provide descriptions, figures and distributional maps of all species found within the study area, (3) to postulate on the origin and affinities of the present fauna and (4) to present a practical key for the identification of the unionid mussels in the study area. Finally this study is intended to serve as an introduction to a larger work that will consider the freshwater mussel fauna of the State of Louisiana.

Previous Work

Many regional and worldwide faunal surveys for freshwater mussels (Superfamily Unionacea) have been compiled. Although the naiades (= unionids) of Louisiana do receive incidental coverage in some of the regional surveys, upon closer examination detailed studies are noticeably lacking. The principal references to the voluminous naiad literature are listed by Valentine and Stansbery (1971), which includes a 63 page World Bibliography by Simpson (1900) covering the period prior to 1900, and are therefore not repeated here. To these are added the recent publications by Clarke (1973) and Burch (1973, 1975), which warrant special notice because of their scope.
Of the earlier faunal lists available for Louisiana drainages, those by L. S. Frierson, a Louisiana conchologist, are some of the most useful. Between 1898 and 1928 Frierson described 47 new species of freshwater mussels, most of which were from the southern United States (Johnson, 1972b). Unfortunately, many of those publications pertinent to Louisiana (Frierson 1897, 1899, 1902, 1911, 1927) dealt almost entirely with the northwestern parishes and are now old and incomplete. More recent studies that have dealt specifically with Louisiana unionids, either directly or indirectly, include those by Crawford (1972), Vidrine (1974), and a bibliography of the zoology of Louisiana by Bick (1954).

Physiography of the Drainage System

The Lake Maurepas–Pontchartrain–Borgne drainage system (to be abbreviated hereafter as Lake M-P-B drainage system) is located east of the Mississippi River. It encompasses much of southeastern Louisiana (an area known locally as the Florida parishes because it was once considered as Florida territory) and southwestern Mississippi (Map 1). Lakes Maurepas and Pontchartrain are shallow (average depth of 4-5 meters), relatively flatbottomed, fresh to brackish water bodies indirectly connected to the Gulf of Mexico. The lakes are connected by two channels. The drainages, proceeding from west to east, and their major rivers are: Lake Maurepas drainage—Comite, Amite, Tickfaw, and Natalbany rivers—and Lake Pontchartrain drainage—Tangipahoa and Tchefuncte rivers. During low water stages, tidal variations in the lakes may directly influence the lower reaches of
### MAP 1. Study Area

- **Collecting sites**
  - LB Lake Borgne
  - BR Baton Rouge, La.
  - NO New Orleans, La.
  - JK Jackson, Miss.

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these rivers resulting in some salt water intrusion northward (Saucier, 1963). The eastern end of Lake Pontchartrain is connected to Lake Borgne by several passes, which in turn is connected to the Gulf of Mexico. The Bogue Chitto, Strong, and Pearl rivers are the major rivers of the Lake Borgne drainage.

In the southwestern corner of the State of Mississippi is the highest land of the lower Mississippi Valley where summit areas are more than 500 feet above sea level although the tide water in Lake Pontchartrain lies but 60 miles away. The average gradient, in excess of 8 feet/mile, has no counterpart elsewhere in Louisiana (Russell, 1940). Most of the Lake M-P-B drainage system may be characterized as an area of rolling timbered hills with moderate to fast flowing streams and rivers of low turbidity (Douglas, 1974). However, there is a narrow zone, from Interstate Highway 12 (I 12) south to the northern shores of Lakes Maurepas, Pontchartrain, and Borgne (Map 1), where stream gradients decrease markedly and elevations vary from only several inches to 2 feet above the Gulf (Saucier, 1963). In this swamp and marsh zone, the rivers are more bayoulike with sluggish water, numerous tributaries, and subject to frequent changes in their direction of flow and volume. The distribution of unionids within the Lake M-P-B drainage system reflects this difference in ecological environments. By contrast, that portion of Louisiana to the west of the Mississippi River is characterized by floodplains that dip gradually gulfward. Russell (1940) found an average gradient of only 1.5 feet/mile in central Louisiana. Thus Louisiana west of the
Mississippi River is a flattened, poorly drained floodplain with many oxbows, bayous, and swamps, and few rapidly flowing tributary waters.

**Methods**

Extensive field work was carried out during the summers of 1973 and 1974. Some preliminary collections were made prior to this time. Collections were made at each reasonable point of access ranging from the headwaters to the mouth. In shallow water, specimens were collected by hand-picking while downstream in deeper water a boat and Ekman grab were also occasionally used, although with little success. The live material collected was either preserved in 70% ethyl alcohol for later examination of the soft anatomy or the animals were placed in boiling water to relax the adductor muscles and permit removal of the soft tissue. Dead shells were also collected and utilized when feasible.

Nearly 175 localities were examined in the study area (Map 1). Field data recorded for each of the 144 collections included: (1) location, (2) date, (3) nature and size of the body of water and (4) physical and chemical data. The physical and chemical parameters measured during this study or taken from other sources (Louisiana Stream Control Commission) are presented in Tables 1 and 2. Complete locality data are on file in my collection.
ECOLOGY OF FRESHWATER MUSSELS

The basic details concerning the natural history of unionoids, i.e. growth and development, life cycle, mussel symbionts, and food and feeding can be found in several papers, including those by Lefevre and Curtis (1912), Coker et al. (1921), Baker (1928), and Fuller (1974). In the discussion that follows, the comments are pertinent to most of the mussels considered in this study. Specific comments regarding a particular species are included in the SYSTEMATICS section. The water quality data presented are meant to indicate only the broad ranges throughout which the species are found living. Much more work needs to be completed to delineate fully the niche for each species.

TEMPERATURE. A number of physical and chemical factors influence the diversity and quantity of mussels present in a particular environment, one of which is temperature. Minimum and maximum bottom water temperatures recorded during this study, at sites where mussels were found, ranged from 5°C to 32°C (Table 1). The maximum temperature recorded was 41°C in Bogue Lusa Creek below a wood products mill (Table 1, Loc. 7). No living mussels were found. Above this site, the maximum temperature measured was 29°C and I collected live Lampsilis straminea. Little information is available concerning the direct effects of temperature upon freshwater mussels, although temperature may indirectly affect mussels through changes in food composition and reproductive activity. Salbenblatt and Edgar (1964)
TABLE 1. Chemical and physical data for several localities within the Lake Maurepas-Pontchartrain-Borgne drainage system. For each parameter, the number of monthly observations (in parentheses), the mean and ± one standard error of the mean are above and the extremes are below. An asterisk (*) designates those localities at which live mussels were collected. Data for all but locality 2 are from the Louisiana Stream Control Commission.

<table>
<thead>
<tr>
<th>Locality No.</th>
<th>Water Temperature °C</th>
<th>pH</th>
<th>Dissolved Oxygen mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>*1. Amite River at La. Hwy 64</td>
<td>(100) 20.14 ±0.63</td>
<td>(110) 5.90 ±0.05</td>
<td>(57) 8.60 ±0.23</td>
</tr>
<tr>
<td>*2. Bayou Manchac at U.S. Hwy 61</td>
<td>(18) 19.86 ±1.54</td>
<td>(18) 7.06 ±0.06</td>
<td>(18) 2.63 ±0.43</td>
</tr>
<tr>
<td>*3. Tangipahoa River at U.S. Hwy 190</td>
<td>(180) 19.49 ±0.44</td>
<td>(180) 6.03 ±0.04</td>
<td>(129) 8.31 ±0.13</td>
</tr>
<tr>
<td>*4. Tchefuncte River at U.S. Hwy 190</td>
<td>(185) 18.57 ±0.40</td>
<td>(185) 5.96 ±0.04</td>
<td>(129) 8.38 ±0.14</td>
</tr>
<tr>
<td>*5. Bogue Chitto River at La. Hwy 10</td>
<td>(185) 19.78 ±0.46</td>
<td>(185) 5.89 ±0.04</td>
<td>(129) 8.38 ±0.14</td>
</tr>
<tr>
<td>*6. Bogue Lusa Creek above paper mill</td>
<td>(182) 18.87 ±0.43</td>
<td>(182) 6.02 ±0.05</td>
<td>(129) 8.24 ±0.14</td>
</tr>
<tr>
<td>7. Bogue Lusa Creek below paper mill</td>
<td>(184) 23.03 ±0.51</td>
<td>(184) 6.52 ±0.08</td>
<td>(130) 3.56 ±0.28</td>
</tr>
<tr>
<td>8. Pearl River at La. Hwy 10</td>
<td>(184) 20.26 ±0.51</td>
<td>(184) 5.97 ±0.05</td>
<td>(129) 7.79 ±0.16</td>
</tr>
</tbody>
</table>
found that temperature tolerances vary among species, for while *Anodonta grandis* and *Lampsilis radiata* survived at 29°C, this temperature was lethal for *Anodontoides ferussacianus*. Although of importance, temperature seldom eliminates species living within their normal geographic ranges in natural waters (Harman, 1974).

pH. Pennak (1953) stated that the Anodontinae are rarely found in water of low pH, but the prevailing acidic conditions do not seem to inhibit the distribution of the 5 species of Anodontinae in the Lake M-P-B drainage system. Mean pH values at collection sites ranged from 5.89 to 7.06 (Table 1). Morrison (1932) also found mussels living throughout a broad pH range of from 5.6 to 8.3. Although the natural abrasive effect of sediment in the water accounts for some wear, acidic conditions are primarily responsible for the badly eroded umbos of most naiades collected in the Lake M-P-B drainage system. Consequently, with the exception of the genera *Uniomerus* and *Carunculina*, beak sculpture is of limited value in the identification of local species. The infrequent, unusually low pH values measured (Table 1) are apparently not lethal. Prolonged periods of low pH levels (4.4 to 6.1) have been shown to produce, in *Lampsilis radiata*, a response similar to aestivation (Matteson, 1955).

**DISSOLVED OXYGEN.** Like pH, the effects of low dissolved oxygen levels on freshwater mussels may be overstated in the literature. Ellis (1931) noted that mussels would not survive at oxygen levels below 5 mg/l, and Grantham (1969) found no living mussels where dissolved oxygen dropped as low as 3 mg/l. By contrast, during my study, live *Carunculina parva*, *Anodonta imbecilis*, and *Glebula*
rotundata were collected from Bayou Manchac in water with a mean dissolved oxygen content of only 2.6 mg/l along the bottom at a depth of 1 meter (Table 1, Loc. 2). Dietz (1974) demonstrated that Ligumia subrostrata is a facultative anaerobe and can survive for extended periods of time (greater than 15 days) in N₂ gassed water without suffering an oxygen debt. This ability is of obvious ecological significance in this pond-inhabiting species. Louisiana drainages west of the Mississippi River are typically sluggish, turbid, and rich in organics, resulting in low dissolved oxygen levels for much of the year. Such habitats, however, often contain an abundant and diversified fauna. The two bayou species, Plectomerus dombeyanus and Glebula rotundata, show particular tolerance to low oxygen levels.

POTASSIUM. Although unionids evolved in the Mississippi Basin (Walker, 1917), few mussels are found in the Rocky Mountain states and in a zone from western North Dakota to Texas. Imlay (1973), using freshwater mussels for bioassay toxicity tests, found that the lowest lethal level of potassium was between 4 and 7 parts per million. He thus attributed the paucity of species in those areas to high potassium concentrations derived from saline rock. Potassium is also a waste product from petroleum brine, paper mills, and industry in general, and Imlay (1973) was able to predict successfully the distribution of freshwater mussels in selected streams given the potassium concentration. The high potassium concentrations measured below the paper mill (Table 2, Loc. 7) probably contribute significantly to the absence of unionids from that portion of the creek.
TABLE 2. Chemical and physical data for several localities within the Lake Maurepas-Pontchartrain-Borgne drainage system. Data as in the legend for Table 1.

<table>
<thead>
<tr>
<th>Locality No.</th>
<th>Dissolved Potassium mg/l</th>
<th>Total Residue mg/l</th>
<th>Turbidity Jackson Turbidity Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>*1. Amite River at La. Hwy 64</td>
<td>(83) 2.64 ±0.17</td>
<td>(18) 112.67 ±24.43</td>
<td>(111) 50.21 ±4.20</td>
</tr>
<tr>
<td></td>
<td>1.0-7.0</td>
<td>30.0-424.0</td>
<td>20.0-340.0</td>
</tr>
<tr>
<td>*2. Bayou Manchac at U.S. Hwy 61</td>
<td>(5) 107.60 ±6.74</td>
<td>(92.0-128.0)</td>
<td></td>
</tr>
<tr>
<td>*3. Tangipahoa River at U.S. Hwy 190</td>
<td>(81) 2.49 ±0.17</td>
<td>(91) 96.20 ±7.76</td>
<td>(180) 30.98 ±1.61</td>
</tr>
<tr>
<td></td>
<td>1.0-8.0</td>
<td>6.0-488.0</td>
<td>2.0-250.0</td>
</tr>
<tr>
<td>*4. Tchefuncte River at U.S. Hwy 190</td>
<td>(84) 2.07 ±0.16</td>
<td>(90) 79.23 ±7.75</td>
<td>(184) 27.18 ±0.72</td>
</tr>
<tr>
<td></td>
<td>1.0-7.0</td>
<td>12.0-616.0</td>
<td>5.0-100.0</td>
</tr>
<tr>
<td>*5. Bogue Chitto River at La. Hwy 10</td>
<td>(85) 2.28 ±0.17</td>
<td>(87) 84.78 ±7.76</td>
<td>(185) 29.64 ±1.16</td>
</tr>
<tr>
<td></td>
<td>1.0-7.0</td>
<td>10.0-572.0</td>
<td>3.0-120.0</td>
</tr>
<tr>
<td>*6. Bogue Lusa Creek above paper mill</td>
<td>(83) 1.94 ±0.16</td>
<td>(89) 82.15 ±8.59</td>
<td>(180) 26.67 ±0.78</td>
</tr>
<tr>
<td></td>
<td>1.0-7.0</td>
<td>5.0-550.0</td>
<td>3.0-110.0</td>
</tr>
<tr>
<td>7. Bogue Lusa Creek below paper mill</td>
<td>(83) 4.83 ±0.38</td>
<td>(90) 223.29 ±25.26</td>
<td>(182) 71.43 ±5.68</td>
</tr>
<tr>
<td></td>
<td>1.0-22.0</td>
<td>14.0-1250.0</td>
<td>2.0-550.0</td>
</tr>
<tr>
<td>8. Pearl River at La. Hwy 10</td>
<td>(85) 2.99 ±0.18</td>
<td>(91) 119.06 ±6.73</td>
<td>(182) 39.09 ±2.16</td>
</tr>
<tr>
<td></td>
<td>1.0-10.0</td>
<td>14.0-308.0</td>
<td>4.0-240.0</td>
</tr>
</tbody>
</table>
TOTAL RESIDUE. Tests for total residue do not determine specific chemical substances but may be used as a rough approximation of the total mineral and organic content of the water. Five-hundred mg/l is considered the tolerable maximum for drinking water (American Public Health Association, 1971). Between 1870 and 1900, 49 different species and subspecies of mussels were present in the Illinois River and its bottomland lakes (Starrett, 1971). In a more recent survey conducted from 1966 to 1969 in the same area, Starrett (1971) collected only 24 species and subspecies of living mussels, 5 of which were represented by only a single specimen. Using a considerable amount of historical biological and chemical data for the Illinois River, he was able to correlate domestic and industrial pollution with the extirpation of 25 species of mussels. Total residue values for several localities in the Lake M-P-B drainage system are presented in Table 2. Of particular interest are the high mean and extreme recorded for Bogue Lusa Creek below the paper mill (Table 2, Loc. 7).

TURBIDITY. High residue values are correlated with high turbidity readings (Table 2), and persistent turbidity (siltation) may be the most damaging physical factor to mussels (Ellis, 1936; Murray and Leonard, 1962; and Grantham, 1969). Ellis (1936) found that 1/4 to 1 inch of silt was lethal to most mussels and all died when completely covered. Of the species that Ellis (1936) studied, *Lampsilis teres* (= anodontoides) was the least tolerant to silting while *Quadrula quadrula* was the most resistant. In the Lake M-P-B drainage system, *L. anodontoides* is typically an inhabitant of sandy bottom, moderate to fast flowing streams and *Q. quadrula* becomes most
abundant in a mud and silt bottom in sluggish water. H. and A. van der Schalie (1950), investigating the mussels and mussel fishery of the Mississippi River above the mouth of the Missouri River, believed that below this point the river supported no appreciable mussel fauna because of the silt load carried into it from the extensive treeless plains drained by the Missouri River. Within the Lake M-P-B drainage system, where siltation has occurred in localized areas from gravel washing operations, no living mussel populations are present. Most of the streams and rivers in this drainage system exhibit a moderate to fast current and low turbidity (Table 2). As noted earlier, the waters draining the floodplain to the west of the Mississippi River are more sluggish and higher mean turbidity values, like that recorded for Bayou Manchac (Table 2, Loc. 2), are typical.

BOTTOM TYPE. The nature of the bottom plays an important role in the distribution of unionids. Members of the genera Anodonta and Leptodea are most often found in mud, but many species of naiades show a wide range of tolerance with optimum development and greatest abundance in a bottom composed of a mixture of gravel, sand, and mud (Parmalee, 1967). Unionids are rarely found in a shifting sand bottom but are replaced by the introduced asiatic clam Corbicula manilensis, which may be better adapted to this type of habitat.

Because no extensive faunal survey had been conducted in the Lake M-P-B drainage system prior to this study, it is difficult in some cases to correlate directly the absence of mussels with specific chemical and/or physical parameters. One exception is a study of the Unionidae of the Pearl and Sabine rivers in which Frierson (1911)
collected 24 species from the Pearl River at Jackson, Mississippi. Heard (1970) demonstrated that industrial effluents have led to the elimination of the entire fauna at this site. That was verified by my study.

**CORRELATION OF SHELL SHAPE AND ENVIRONMENT.** Many authors, including Ortmann (1920), Ball (1922), Grier and Mueller (1926), Brown et al. (1938), and van der Schalie (1941), have discussed the correlation between shell shape (width, height) and environment. Most of the conclusions have been summarized by Eagar (1948) and include the following generalizations: (1) those species inhabiting a soft mud bottom in lakes, pools, and sluggish water are often thin-shelled and obese; (2) among some river species, the downstream, large river form is obese and grades into a compressed form in the headwaters; and (3) changes in obesity are typically accompanied by changes in other shell dimensions. Of the unionids considered in my study, members of the *Fusconaia flava* complex from the Amite River best illustrate this phenomenon and a more complete discussion is found in the SYSTEMATICS section.

The nature of the bottom, water velocity, and turbidity, as factors related to the size of the stream or river, are partially responsible. Unfortunately no detailed studies that correlate limnological data with measurable differences in shell morphology are available. Thus only a superficial understanding of the correlation between shape and environment exists. Recognition of such tendencies is of taxonomic importance, however, when attempting to distinguish between ecophenotypes and separate species.
SYSTEMATICS

Introduction

The following section is an account of the freshwater mussel fauna (Unionidae) of the Lake M-P-B drainage system. A complete taxonomic treatment for each species (complete synonymy, type locality) seems unwarranted because this can be found in the monographs of Simpson (1914) and Haas (1969). For each species listed in this section, the following items are covered in the manner described.

CLASSIFICATION: No one scheme of classification of the subfamilies of Unionidae is universally accepted. While the earliest schemes relied heavily upon shell morphology, most schemes followed today are variations of the arrangement proposed by Ortmann (1910, 1911, 1912), which is largely based upon the nature of the marsupial demibranchs. Both Heard and Guckert (1970) and Valentine and Stansbery (1971) summarize the various systems, and justification of the classification used here is found in the latter paper. The species treated in the following accounts are arranged alphabetically under each subfamily. To facilitate an understanding of the relationships between the various higher taxa, a brief outline is presented in Table 3.

PLATES: All shells illustrated in the photographs were collected in the Lake M-P-B drainage system unless stated otherwise in the REMARKS section. In those species where pronounced sexual dimorphism
TABLE 3. Outline of the higher taxa of freshwater pelecypods.

Class Pelecypoda

Order Eulamellibranchia: gill filaments folded and united by tissue junctions; hinge with teeth of different shapes and sizes or teeth absent; 2 adductor muscles of equal size.

Superfamily Sphaeriacea:

Family Corbiculidae: asiatic clam; 1 (?) species in the United States.

Family Sphaeriidae: finger nail and pill clams; represented in North America by 35 species in 3 genera.

Superfamily Mutelacea: 2 families of freshwater mussels in Africa and South America, none in North America.

Superfamily Unionacea: principally a North American group, but some genera are cosmopolitan; a glochidium larval stage.

Family Hyriidae: South America and Australasia, none in North America.

Family Margaritiferidae: 2 North American genera, neither of which occurs in the Lake M-P-B drainage system.

Family Unionidae:

Subfamily Unioninae: absent from North and South America.

Subfamily Ambleminae: 18 genera in the United States, 8 of which occur in the Lake M-P-B drainage system.

Subfamily Anodontinae: 8 genera in the United States, 4 of which occur in the Lake M-P-B drainage system.

Subfamily Lampsilinae: 18 genera in the United States, 10 of which occur in the Lake M-P-B drainage system.
is exhibited (Subfamily Ambleminae-\textit{Tritogonia verrucosa} and Subfamily Lampsilinae-most species), both the male and the female are illustrated.

SYNONYMY: The synonymy is limited to the original description, the first usage of the current name combination, and a standard treatise in which a more complete synonymy is given.

DISTRIBUTION. The approximate distribution of the species in North America, as recorded in the literature, is given. Distribution maps illustrate the presently known range of the species within the study area. The black dots (•) represent localities from which living or "freshly dead" specimens were collected and the open circles (o) represent museum and/or literature records.

DESCRIPTION. Shell descriptions are based upon the descriptions of Simpson (1914) and Baker (1928). No attempt has been made to redescribe completely the shells, but because a photograph alone is not sufficient, additional diagnostic characters and local variations are included to facilitate identification. The basic shell morphology is illustrated in Figures 1, 2, and 3 and the terminology is defined in the GLOSSARY.

HABITAT. The habitat in the Lake M-P-B drainage system in which each species was collected is described. While some of the species are characteristically associated with particular habitats (bayou, headwaters), many unionids exhibit a wide range of tolerance to many factors, including bottom type, current, and depth. Specific habitat preferences are noted, when observed in nature.
FIGURE 1. Shell morphology of the freshwater mussel *Quadrula quadrula*: A, exterior view of the right valve; B, interior view of the left valve.
FIGURE 2. Shell shapes; A, rhomboidal; B, triangular; C, quadrate; D, elliptical; E, F, oval; G, round. (Redrawn from Burch (1975)).
FIGURE 3. Beak sculpture and shell morphology. A, single-looped beak sculpture; B, double-looped beak sculpture; C, female *Ligumia subrostrata* with rostrate shell. (A and B redrawn from Burch (1975)).
REMARKS. Finally, remarks are made concerning the following topics:

(1) Taxonomic and nomenclatural problems—Few species complexes in the literature have been re-evaluated. Thus for some naiades, several nominal species may be listed because in some monographs the name used for the species was the nominal form that had its type locality within the region covered by the study. The neutral term "form" (Mayr, 1969:47) is used to refer to these incompletely analyzed species complexes if it has not been determined whether they represent species, subspecies, or ecophenotypes.

(2) Similar species—When one species superficially resembles another, distinguishing features are noted.

(3) General comments—This consists of additional remarks on biology, distribution, and Ohio State University Museum of Zoology (OSUM) catalogue numbers for specimens from this region that have been processed into that collection.
Accounts of Species

Family Unionidae

Subfamily Ambleminae

Amblema plicata (Say). Three-ridge, Blue-point

Plate 1, Map 2

Unio plicata Say, 1817, Nicholson's Encyc., 2, pl. 3, fig. 1.
Quadrula plicata (Say), Simpson, 1914, Descr. cat. Naiades, p. 814.

GENERAL DISTRIBUTION. Entire Mississippi River drainage from western New York west to Minnesota, eastern Kansas and Texas; Gulf drainages from Texas to the Yellow River of Florida; St. Lawrence drainage; Red River of the North; Saskatchewan River; Lake Winnipeg (Burch, 1975).

DESCRIPTION. Shell subrhomboid, solid; beaks low; posterior truncate; surface with several plications or folds, usually parallel to posterior ridge, which may extend onto posterior slope but are absent from anterior 1/3 of shell; periostracum dark brown or black.

Two pseudocardinals in left valve, three in right; two laterals in left valve, one in the right, which may be doubled; wide interdentum; beak cavities deep, compressed; nacre white with purple tint posteriorly; large individuals may reach 150 mm (6 inches).

HABITAT. Although Ortmann (1919) stated that this species is not found in mud, in the Lake M-P-B drainage system A. plicata is
found in both mud bottom, pondlike areas and in sand-gravel in moderate currents. Throughout its entire range, it has not been encountered in streams or rivers less than 30 feet wide.

REMARKS. The name *Crenodonta* Schluter, 1838, of Clench and Turner (1956), Clarke and Berg (1959), and Murray and Leonard (1962), is the same as the more familiar *Amblema* Raf., 1820, as used here. A vast number of species names have been applied to populations of *Amblema plicata*, including *costata*, *peruviana* and *perplicata*. Valentine and Stansbery (1971) believe all populations in the Mississippi River system to be variants of *plicata*, a highly plastic species, with the development of sculpture and shell proportions correlated with stream size as noted by Ortmann (1920). The form present in this portion of the gulf drainage system is *perplicata* Conrad, 1841 (see Simpson, 1914:817, for a more specific description, distribution and synonymy for this form).

*Amblema plicata* can only be confused with one other species, *Megalonalas gigantea*. The latter differs in having distinct zig-zag sculpturing on the beaks and the adult is larger and more elongate.
PLATE 1. *Amblema plicata*
MAP 2. Amblema plicata
**Elliptio beadleiana** (Lea)

**Plate 2, Map 3**


*Fusconaia beadleiana* (Lea), Haas, 1969, Das Tierreich, 88:316.

**GENERAL DISTRIBUTION.** Mississippi to eastern Texas (Simpson, 1914).

**DESCRIPTION.** Shell subrhomboid to subtriangular, subsolid; beaks only slightly elevated; posterior ridge evident, subangular; anterior end rounded, posterior slightly rounded; periostracum reddish-brown.

Two pseudocardinals in left valve; lateral double; right valve with one large, triangular pseudocardinal and with a smaller denticle above; lateral curved, partially doubled in right valve; interdentum moderately wide; white to pink nacre; length to about 55 mm (2-1/4 inches).

**HABITAT.** *Elliptio beadleiana* is found throughout the study area, although not abundantly, in a mud or sand-gravel bottom. It is most common near the headwaters, but it does occur for some distance downstream.

**REMARKS.** Frierson (1902, 1911) believed *beadleiana*, *Unio chickasawhensis* Lea, 1861 and *Unio* (=*Fusconaia*) *askewi* (Marsh, 1896) to be identical with the variation attributable to differences in habitat. Ortmann (1912, 1914), after determining that all four gills in *askewi* are marsupial while only the outer two are marsupial in
beadleiana, hesitatingly assigned beadleiana to Elliptio. This was based upon similarities in shell morphology between beadleiana and E. crassidens. Preliminary examination of gravid females collected during this study confirms Ortmann's observations and pending further detailed study, his treatment is followed here. Fusconaia chickasawhensis in Grantham (1969) is considered here as a synonym of beadleiana.
Plate 2. Elliptio beadleiana
MAP 3. *Elliptio beadleiana*
Elliptio crassidens (Lamarck). Elephant's ear
Plate 3, Map 4

Elliptio crassidens (Lamarck), Ortmann, 1912, Ann. Carnegie Mus.,
8:266, figs. 10, 10a.

GENERAL DESCRIPTION. Mississippi drainage generally and Amite
River in Louisiana east to St. Marys River system in Florida (Johnson,
1970).

DESCRIPTION. Shell rhomboid; posterior ridge well developed,
angled; anterior end sharply rounded, with dorsal margin and posterior
ridge usually ending in a point; periostracum reddish-brown to black
and marked with prominent growth lines.

Left valve with two triangular pseudocardinals, two short,
straight lateral teeth; right valve with single pseudocardinal and
single lateral; interdentum wide; beak cavities very shallow; nacre
usually salmon to purple; adults may reach 140 mm (5-1/2 inches).

HABITAT. In the Lake M-P-B drainage system, this species is
most frequently found in streams of moderate to swift currents in
a sandy bottom. Elliptio crassidens ranges further upstream in
southern rivers than it does in the Ohio River system (Dr. D. H.
Stansbery, pers. comm.). In the Lake M-P-B drainage system, it is
also more abundant near the headwaters than it is downstream.
PLATE 3. *Elliptio crassidens*
MAP 4. *Elliptio crassidens*
**Fusconaia ebena** (Lea). Ebony shell

Plate 4, Map 5


*Quadrula ebenus* (Lea), Simpson, 1914, Descr. cat. Naiades, p. 897.

GENERAL DISTRIBUTION. Mississippi River drainage and the Pearl, Alabama, and Tombigbee rivers (Baker, 1928).

DESCRIPTION. Shell oval, heavy, inflated; beaks elevated, turned forward; anterior truncate below beak and posterior end broadly rounded; posterior ridge faint; periostracum reddish-brown to black with prominent concentric rest periods.

Left valve with two pseudocardinals which are joined above and appear as one; right valve with one large tooth that appears to stem from a deep depression; laterals double in left valve and partially double in right; interdentum wide; umbonal cavity deep, compressed; nacre white; length to 90 mm (3-1/2 inches).

HABITAT. Throughout its range, *F. ebena* is most frequently found in large rivers with a moderate to swift current in a sand-gravel bottom and under such conditions it can become very abundant. During this study, it was not found outside of the Lake Borgne drainage system.
PLATE 4. Fusconaia ebena
**Fusconaia flava** ecoform *flava* (Rafinesque). Pig-toe

Plates 5 & 6, Map 6, Tables 4 & 5


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**Fusconaia flava** ecoform *undata* (Barnes). Pig-toe

Plates 5 & 6, Map 6, Tables 4 & 5

*Unio undatus* Barnes, 1823, Am. Jour. Sci., 6:121, pl. 4, fig. 4.


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**GENERAL DISTRIBUTION.** Entire Mississippi River drainage; western New York and Pennsylvania to eastern South Dakota, Nebraska and Kansas; south to Texas, east along Gulf to Alabama (Parmalee, 1967); St. Lawrence River system from Wisconsin to New York; Red River of the North and its tributaries (Clarke, 1973).

**DESCRIPTION.** Ecoform *flava*: Shell quadrate to subrhomboid, thin to solid, compressed; beaks slightly elevated; anterior end rounded, posterior end truncate; posterior ridge obvious, roundly angled, some with median sulcus in front; periostracum reddish or brownish.

Two triangular pseudocardinals and two laterals in left valve; one large, triangular, serrated pseudocardinal in right valve, usually
a smaller denticle anteriorly; lateral partly doubled; interdentum
moderately wide; nacre white to pink or purple; adult shells in
excess of 70 mm (2-3/4 inches).

Ecoform undata: Shell triangular, solid, inflated; beaks
high and full; anterior end slightly truncate above, posteriorly
truncate; posterior ridge sharply angled with median depression in
front of ridge; greatest shell height and width just anterior to
sulcus; periostracum yellowish-brown to brown or black in older shells.

Two laterals and two pseudocardinals in left valve; pseudo-
cardinals heavy, rough, often joined anteriorly and appear as one;
a single, massive, serrated pseudocardinal in right valve that emanates
from a pit; lateral partly doubled; interdentum wide; nacre white to
pink; shell length to 70 mm (2-3/4 inches).

HABITAT. Fusconaia flava s.l. is one of the most widely
distributed unionids throughout the Lake M-P-B drainage system. The
headwaters ecoform, flava, is found in a stable sand or sand-gravel
bottom in water from a few inches to several feet deep. The large
river ecoform, undata, occurs in both a sand or sand-gravel bottom in
a current or in the soft mud bottom of a quiet pool.

REMARKS. The genus Fusconaia may reach its greatest development
in streams and rivers along the Gulf coast. The result is extreme
morphological variability, due to differing genotypes and ecophenotypic
expression, and a considerable number of nominal species.

As noted earlier, a correlation exists between shell shape and
environment, and of the unionids considered in this study, members of
the Fusconaia flava complex from the Amite River best illustrate this
phenomenon. Adult shells from 7 headwater and 2 large river localities (Map 6) were measured (using vernier calipers) and width/length and height/length ratios calculated (Table 4). Although the sample size is small for some sites, the trend toward an increase in both shell obesity and shell height is evident moving downstream from the east and west forks into the main channel (Plates 5 & 6).

Conchological variability in this genus has led to a considerable synonymy with several names in use for taxa of various levels in the *flava* complex. Ortmann (1920) considered those forms with a W/L ratio of < .55 to be *Fusconaia flava* s.str. while *F. flava* *trigona* had a W/L ratio of > .55. He reported ratios of > .60 for *Unio undatus*, a possible synonym of *trigona*, although he did not consider it in detail because of lack of material. The *F. flava* complex, as treated in this study, is a synthesis of the views of Ortmann (1919, 1920), Stansbery (1961), and Clarke (1973). It is outlined in Table 5 and includes two ecoforms (= ecophenotypes): *F. flava* ecoform *flava* and *F. flava* ecoform *undata*. 
PLATE 5. *Fusconaia flava* complex.
Upper, *F. flava* ecoform *flava*; middle, intermediate;
lower, *F. flava* ecoform *undata*.
Left, *F. flava* ecoform *flava*; middle, intermediate; right, *F. flava* ecoform *undata*. 
MAP 6. *Fusconaia flava*. Numbered localities identified in Table 4.
TABLE 4. Mean values of shell ratios for individuals of the *Fusconaia flava* complex from the Amite River. Localities (identified in Map 6) are arranged from tributaries toward mouth. L = maximum antero-posterior length of shell; W = maximum width of shell with both valves in place; H = maximum dorso-ventral dimension of shell measured at right angle to length, excluding umbo.

<table>
<thead>
<tr>
<th>Locality</th>
<th>N</th>
<th>W/L</th>
<th>H/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork Amite River, Amite Co., Mississippi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>0.459</td>
<td>0.760</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>0.524</td>
<td>0.770</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>0.493</td>
<td>0.749</td>
</tr>
<tr>
<td>6</td>
<td>14</td>
<td>0.553</td>
<td>0.769</td>
</tr>
<tr>
<td>East Fork Amite River, Amite Co., Mississippi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>7</td>
<td>0.440</td>
<td>0.739</td>
</tr>
<tr>
<td>10</td>
<td>7</td>
<td>0.495</td>
<td>0.747</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>0.570</td>
<td>0.763</td>
</tr>
<tr>
<td>Amite River, East Feliciana-St. Helena Parish Line, Louisiana</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>8</td>
<td>0.686</td>
<td>0.840</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>0.708</td>
<td>0.920</td>
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</table>
TABLE 5. Outline of the *Fusconaia flava* complex.

<table>
<thead>
<tr>
<th>Shell Morphology (after Stansbery, 1961)</th>
<th>Ecoform</th>
<th>Approximate W/L Ratio</th>
<th>Regional Nominal Species in Complex (see Simpson, 1914)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headwaters: flava Rafinesque, 1820</td>
<td></td>
<td>&lt;.55</td>
<td><em>rubiginosa</em> Lea, 1829</td>
</tr>
<tr>
<td>compressed</td>
<td></td>
<td></td>
<td>cerina Conrad, 1838</td>
</tr>
<tr>
<td>elongate</td>
<td></td>
<td></td>
<td>rubida Lea, 1861</td>
</tr>
<tr>
<td>low umbos</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>non-sulcate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>quadrate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large River: undata Barnes, 1823</td>
<td></td>
<td>&gt;.55</td>
<td><em>trigona</em> Lea, 1831</td>
</tr>
<tr>
<td>obese</td>
<td></td>
<td></td>
<td>chunii Lea, 1861</td>
</tr>
<tr>
<td>short</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>high umbos</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sulcate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>triangular</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Megalonalas gigantea** (Barnes). Washboard Plate 7, Map 7


*Quadrula heros* (Say), Simpson, 1914, Descr. cat. Naiades, p. 825.

**GENERAL DISTRIBUTION.** Entire Mississippi River system, Ochlockonee River system of Florida to Nuevo Leon, Mexico (Burch, 1975).

**DESCRIPTION.** Shell rhomboid, heavy; posterior ridge rounded and merged with several oblique, undulating corrugations on posterior half of shell; umbonal region with pustules and irregular "M" or "W" shaped zig-zag undulations, particularly on first few years growth; periostracum brown or black.

Left valve with two heavy pseudocardinals, two long laterals; right valve with single large pseudocardinal, occasionally with smaller teeth on either side, and one lateral; nacre white; anterior muscle scars filled with rough nacreous material; shell length to 200 mm (8 inches) not uncommon.

**HABITAT.** In Louisiana drainages, *M. gigantea* has been collected from both quiet mud bottom bayous and large rivers with a sand-gravel bottom. Murray and Leonard (1962) characterized this species as a typically deep water (6 feet or more) species, but locally it is common in less than 3 feet of water.

**REMARKS.** Although Morrison (1969) recognized *nervosa* Raf., 1820, as an older synonym for *gigantea*, *nervosa* is regarded as a nomen dubium by many authors.
PLATE 7. *Megaloniais gigantea*
MAP 7. Megalonaias gigantea
Plectomerus dombeyanus (Valenciennes). Bank-climber
Plate 8, Map 8


Amblema (Plectomerus) dombeyana (Valenciennes), Frierson, 1927, Check List, p. 62.


GENERAL DISTRIBUTION. Gulf drainage from Alabama River to eastern Texas and north in the Mississippi system to northwest Tennessee (Simpson, 1914).

DESCRIPTION. Shell rhomboid, solid, heavy; beaks low; posterior ridge prominent and high, may be biangulate or end in a point at base of shell; anterior end rounded, posterior truncate, with low post-dorsal wing; shell surface with a few folds in front of posterior ridge, which may curve up posterior slope, and zig-zag pattern on umbonal ridge; periostracum brown or black.

Two large, ragged pseudocardinals in left shell, three in right shell; laterals long, double in left valve and partially double in right; anterior muscle scars filled with roughened nacre; nacre purple; shell length to 150 mm (6 inches).

HABITAT. Little is known about the ecology of this species, a species that is endemic to the Gulf area. In the Lake M-P-B drainage system, P. dombeyanus is typically found in a mud bottom in sluggish water, i.e., a bayou species. Although it is less abundant it is also
a river species where it occurs in a moderate to swift current with a sand-gravel bottom.

REMARKS. *P. dombeyanus* may be distinguished from two other large naiades, *A. plicata* and *M. gigantea*, by its strong posterior ridge and purple nacre.
PLATE 8. *Plectomerus dombeyanus*
MAP 8. *Plectomerus dombeyanus*
Quadrula pustulosa (Lea). Pimple-back

Plate 9, Map 9

Quadrula pustulosa (Lea), Simpson, 1914, Descr. Cat. Naiades, p. 848.

GENERAL DISTRIBUTION. Entire Mississippi River drainage, Michigan and Lake Erie (Simpson, 1914); Gulf drainages from Mississippi to Texas.

DESCRIPTION. Shell quadrate to oval, solid; beaks elevated; posterior 2/3 of shell usually densely covered with pustules and posterior slope with ridges, but smooth and intermediate forms not uncommon; periostracum reddish-brown to black.

Pseudocardinals triangular, two in left valve, three in right; lateral double in left valve and lateral in right valve single or double; nacre white to pink or purple; shell length to about 65 mm (2-1/2 inches).

HABITAT. Quadrula pustulosa is one of the most common and abundant species in the Lake M-P-B drainage system. It occurs in all bottoms from mud to gravel, except shifting sand, in small to large rivers and ponds.

REMARKS. Because of the variation in shell sculpture and color of the nacre, this species is one of the most variable unionids. Consequently, the literature contains numerous species that may represent no more than ecophenotypes. In the Lake M-P-B drainage
system, the nominal species of the *Q. pustulosa* complex includes *Q. refulgens* (Lea, 1868). Comments and a more detailed synonymy and distribution concerning *refulgens* are found in Simpson (1914:855) and Frierson (1927:49).
PLATE 9. *Quadrula pustulosa*
MAP 9. Quadrula pustulosa
**Quadrula quadrula quadrula** (Rafinesque). Maple-leaf

Plates 10 & 39, Map 10


**GENERAL DISTRIBUTION.** Ohio-Mississippi River system, Texas to Alabama to Minnesota and Pennsylvania; St. Lawrence River system and Red River of the North (Clarke, 1973).

**DESCRIPTION.** Shell quadrate, solid; posterior ridge well developed, angled; in front of ridge is well defined median sulcus (Plate 39-D; Fig. 1-A) or depression that runs from near umbo to ventral margin; sinus usually completely smooth and typically bounded in front and behind by a row of knobs; pustules may be lacking from anterior and ventral regions of shell but present on posterior slope where they may become confluent to form ridges; periostracum greenish to brown or black.

Two triangular pseudocardinals in left valve, three in right with middle tooth largest; laterals double in left, partially double in right valve; interdentum wide; length to about 65 mm (2-1/2 inches).

**HABITAT.** This species occurs in a wide variety of habitats from small to large rivers and in a mud to sand or gravel bottom.

**REMARKS.** (See REMARKS under *Q. quadrula apiculata.* ) *Quadrula quadrula* is a highly variable species. Neel (1941), after examining
all known forms, recognized only two subspecies: *Q. quadrula* s. str. with a smooth median sulcus and *Q. quadrula* *apiculata*, which has a completely pustulose median sulcus.

Only one subfossil valve of *Q. q. quadrula* was found during this study. Therefore this subspecies may no longer be present in this gulf drainage system. The specimen illustrated in Plate 10 was collected in the Red-Atchafalaya drainage system.
PLATE 10. *Quadrula quadrula quadrula*
MAP 10. Quadrula quadrula quadrula
**Quadrula quadrula apiculata** (Say)

Plate 11, Map 11

**Unio apiculatus** Say, 1829, New Harm. Diss., 2:309.

**Quadrula quadrula apiculata** (Say), Frierson, 1927, Check List, p. 47.


**GENERAL DISTRIBUTION.** Tributaries of the Alabama River to central Texas (Neel, 1941).

**DESCRIPTION.** Shell quadrate, solid, heavy; posterior ridge prominent, angled, high in some; median sulcus distinct in most, obliterated in some, but always completely pustulate; sculpture on remainder of shell surface variable; may be smooth, partially covered with small pustules or completely covered with pustules arranged in rows to form an inverted "W"; periostracum greenish to brown or black.

Left valve with two triangular pseudocardinals and two long laterals; right valve with three pseudocardinals, the middle tooth larger and radially striate, and one partly doubled, long lateral; interdentum wide; nacre white; average shell length 75 mm (3 inches).

**HABITAT.** The habitat for **apiculata** is similar to that of **quadrula s.str.** In the Lake M-P-B drainage system, and particularly to the west of the Mississippi River in gulf coastal drainages, **apiculata** may be considered a bayou species and may be locally abundant in a sluggish water, mud bottom habitat. It lives at depths of from 1 to 5 feet.
REMARKS. The differences between quadrula s.str. and spiculata are discussed under the former. This subspecies is the predominant form along the gulf coast and it is not uncommon to find it near or adjacent to the coast itself.

Grantham (1969) collected Q. aspera (Lea, 1831) from the Pearl River, a form that Neel (1941) considered to be merely an ecophenotype.
PLATE 11. *Quadrula quadrula apiculata*
Tritogonia verrucosa (Rafinesque). Pistol-grip

Plate 12, Map 12


Tritogonia verrucosa (Rafinesque), Agassiz, 1852, Arch. fur Nat., 1:48.


GENERAL DISTRIBUTION. Mississippi drainage generally and from the Alabama River system west to central Texas (Simpson, 1914).

DESCRIPTION. Rhomboidal shell with curved, elevated posterior ridge that ends well forward on posterior base; posterior slope sculptured with strong ridges, remainder of shell with variably sized pustules; periostracum reddish-brown to black.

Two pseudocardinals in left valve, three in right; two laterals in left, one in right; nacre white, occasionally purple; shell length may exceed 150 mm (6 inches).

Shell of male shorter with obliquely truncate posterior margin; female more compressed and elongate posteriorly.

HABITAT. In the Lake M-P-B drainage system, T. verrucosa is most frequently found in a stable sand or sand-gravel bottom in a current. It was never encountered in a bayou. Because of the elongate shell and their tendency to burrow deeply, they are more difficult to dislodge and easily overlooked.

REMARKS. Tritogonia verrucosa is the only member of the Subfamily Ambleminae with sexually dimorphic shells.
PLATE 12. *Tritogonia verrucosa*
MAP 12. Tritogonia verrucosa
Uniomerus declivis (Say)
Plate 13, Map 13


Elliptio declivis (Say), Frierson, 1927, Check List, p. 34.

**GENERAL DISTRIBUTION.** Lower portion of the Gulf states from Alabama to Texas (Simpson, 1914).

**DESCRIPTION.** Shell subrhomboidal, solid; anterior broadly rounded, dorsal and ventral margins straight to slightly convex; posterior ridge high, becoming acutely rostrate posteriorly in older shells; posterior slope with shallow depression above ridge; beaks situated well anteriorly, sculpture not visible; periostracum brown to black, rough.

Two triangular pseudocardinals in left valve; one in right, with vestigial upper tooth in some; laterals in left valve double, single in right; beak cavity shallow; interdentum absent; nacre white, sometimes with purple tint; shell length to 100 mm (4 inches).

**HABITAT.** In Louisiana gulf coastal drainages, this species occurs in a mud bottom in sluggish water.

**REMARKS.** Uniomerus is a very plastic genus. Johnson (1970) considered it to be monotypic, the single species being *U. tetralasmus*. However, Frierson (1903, 1927), Strecker (1931), and Stansbery (1974, pers. comm.) recognize *declivis* as distinct from *tetralasmus*. The two differ in a number of ways: in *declivis* the beaks are more nearly
terminal, the pseudocardinal teeth of *declivis* are heavier and not compressed and *declivis* is rostrate posteriorly in contrast to *tetralaemus* which is broadly rounded or bluntly pointed.

*Uniomerus declivis* was not found in the Lake M-P-B drainage system during this study. One live individual was collected from the Tangipahoa River in 1964 by Ohio State University personnel (OSUM 13973) and the species is probably now absent from this area. The species does occur to the west of the Mississippi River (Stern, unpub.) where it has only been collected from bayous.

Some male *Ligumia subrostrata* superficially resemble *declivis*, but in *subrostrata* the beaks are not as anteriorly placed, the hinge teeth are compressed and rays are present even on older shells.

The specimen illustrated in Plate 13 was collected in the Bayou Teche drainage system.
PLATE 13. Uniomerus declivis
MAP 13. Uniomerus declivis
Unio tetralasmus (Say). Pond-horn

Plates 14 & 39, Map 14

Unio tetralasmus Say, 1830, Am. Conch., 3, pl. 23.

GENERAL DISTRIBUTION. Mississippi River drainage north to Ohio River; Rio Grande system, Texas east to peninsular Florida; Altamaha River system north to Chowan River system, North Carolina (Johnson, 1972a).

DESCRIPTION. Shell thin, rhomboid, with dorsal and ventral margins nearly straight and parallel; beak sculpture consisting of several prominent ridges rounded up sharply behind (Plate 39-A); usually two furrows on posterior slope; periostracum yellowish-brown, shiny and concentrically banded; lateral surface and posterior slope with green rays in younger shells.

Two compressed pseudocardinals in each valve, upper in right valve smaller; laterals thin, double in left, single in right, long; beak cavity shallow; interdentum absent; nacre white; shell reaching 135 mm (5-1/4 inches) in length.

HABITAT. In the Lake M-P-B drainage system, U. tetralasmus lives in small sandy bottom streams (less than 10 feet wide) and in ponds with a muddy bottom, where it may become locally abundant.

REMARKS. Though Johnson (1970) regards Uniomerus to be a monotypic genus, many authorities recognize additional species (see U. declivis).
As reported by many authors (Simpson, 1892; Frierson, 1903, 1923; Strecker, 1908; and Boss, 1974), this species is very resistant to desiccation and can live up to several months out of water.

*Uniomerus tetralasmus* occurs near the headwaters in several localities in Mississippi, though Grantham (1969) did not report it from the state.
PLATE 14. Uniomerus tetralasmus
Subfamily Anodontinae

Anodonta grandis Say. Floater
Plates 15 & 40, Map 15


GENERAL DISTRIBUTION. Mississippi-Missouri River drainage, St. Lawrence drainage, Canadian Interior Basin from western Ontario to Alberta and in Gulf drainages from Texas to Mississippi (Clarke, 1973).

DESCRIPTION. Shell outline variable from oval to elliptical; thin to moderately solid; beaks well elevated above dorsal margin, sculpture double-looped with nodules (Plate 40-A); periostracum olive-green to brown and black.

Both valves edentulous; hinge line slightly thickened under beak; umbonal cavity shallow; nacre white, may be tinged with cream or pink; adults may reach 190 mm (7-1/2 inches).

HABITAT. This is a species which attains its greatest development and abundance in a mud or stable sand bottom of oxbows, ponds and pondlike extensions of rivers. It is rare in a rocky bottom.

REMARKS. The A. grandis complex consists of a large number of described species and these are discussed extensively by Ortmann (1919), Frierson (1927), and Stansbery (in Starrett, 1971). The complex is represented in this drainage system by the form stewartiana Lea, 1834, a more detailed treatment of which is found in Simpson (1914:429)
Although *Anodonta* is the only unionid genus completely lacking hinge teeth, it may superficially resemble the genus *Strophitus*. Differences are noted under the latter. The differences between *A. grandis* and *A. imbecilis* are discussed under *imbecilis*. 
PLATE 15. *Anodonta grandis*
Anodonta imbecillis Say. Floater
Plate 16, Map 16


GENERAL DISTRIBUTION. Total Mississippi drainage, extreme
northeastern Mexico east to Florida, Georgia north to Maryland
(Johnson, 1970).

DESCRIPTION. Shell thin, fragile; outline elliptical, posterior
end pointed; valves compressed in young shells, often becoming quite
swollen in adults; dorsal margin straight, ventral slightly convex;
beaks low, not elevated above hinge line; periostracum smooth and
shiny, yellow to greenish; grey or brown concentric bands and green
rays in some.

Both valves lacking pseudocardinal and lateral teeth; muscle
scars indistinct; umbonal cavity shallow or absent; nacre bluish—
white, cream toward beak cavities; adult shells usually not over 80
mm (3-1/4 inches) in length.

HABITAT. The habitat for this species is similar to that of
A. grandis and the two occur sympatrically in many localities.

REMARKS. The low umbos of imbecillis will readily distinguish it
from A. grandis.

Although as a group naiades are dioecious, van der Schalie
(1970) reported that imbecillis is one of four unionid species which
are predominantly hermaphroditic. There is no sexual dimorphism.
Howard (1914) and Allen (1924) stated that this species exhibits direct development and can metamorphose into a juvenile mussel while still in the marsupium, thus bypassing the parasitic glochidial stage. However, Heard (1975) examined several dozen gravid individuals and found only glochidia in the marsupial demibranchs.
PLATE 16. *Anodonta imbecilis*
MAP 16. Anodonta imbecilis
Arcidens confagosus (Say). Rock pocketbook

Plate 17, Map 17


Arcidens confagosus (Say), Simpson, 1914, Descri. cat. Naiades, p. 475.

GENERAL DISTRIBUTION. Mississippi River drainage, eastern Texas into Louisiana, north to eastern Kansas, southern Ohio and southern Wisconsin (Burch, 1975).

DESCRIPTION. Shell rhomboid in outline, solid; beaks high, sculptured with double-loops which give way to pustules on the disk of shell; surface with ridges on posterior 1/3 of shell; periostracum brown to black.

Left valve with two elongate, compressed pseudocardinals, the posterior tooth interrupts hinge line where it fits into right valve; laterals greatly reduced or absent; right valve with single, compressed pseudocardinal and lateral also reduced and short or absent; nacre bluish-white; specimens range up to 110 mm (4-1/4 inches).

HABITAT. Although the type locality for this species is in New Orleans, Louisiana, only one shell was collected in the Lake M-P-B drainage system. When collected live elsewhere in the state, it is found in shallow (less than 4 feet), sluggish water in a mud bottom—a bayou species.

REMARKS. The specimen illustrated in Plate 17 was collected in the Bayou Teche drainage system.
PLATE 17. *Arcidens confragosus*
MAP 17. Arcidens confragosus
Lasmigona complanata (Barnes). White heel-splitter

Plate 18, Map 18


Lasmigona complanata (Barnes), Ortmann, 1919, Mem. Carnegie Mus., 8:133.

Symphynota complanata (Barnes), Simpson, 1914, Descr. cat. Naiades, p. 490.

GENERAL DISTRIBUTION. Ohio-Mississippi River system from Ohio and Pennsylvania west to Minnesota and Iowa and south to Oklahoma and Louisiana; Alabama River system; upper St. Lawrence River system; Lake Winnipeg-Nelson River system from western Ontario to Alberta (Clarke, 1973).

DESCRIPTION. Shell ovate with distinct posterior wing; beaks low with strong double-looped sculpture evident on some; posterior ridge low, often with distinct plications on posterior slope; periostracum blackish in older shells.

Pseudocardinals large, two in the left valve and one fan-shaped tooth in right valve; lateral teeth in both valves absent or obsolete and represented only by thickening on interdentum; beak cavity compressed and shallow; nacre white; shell length 150 mm (6 inches).

HABITAT. This species was encountered in both a mud and sand bottom. All localities were along the Pearl River in a moderate to rapid current.

REMARKS. Lasmigona complanata can only be confused with Proptera inflata. The latter is distinguishable by its pink to purple nacre and lamellar lateral teeth.
PLATE 18. *Lasigmone complanata*
MAP 18. Lasmigona complanata
Strophitus radiatus (Conrad)

Plate 19, Map 19


Strophitus radiatus (Conrad), Haas, 1969, Das Tierreich, 88:375.

GENERAL DISTRIBUTION. Apalachicola River system of Georgia and Florida to Alabama-Coosa River system of Alabama (Johnson, 1967) and west to Amite River, Louisiana.

DESCRIPTION. Shell subrhomboid to elliptical, valves thin; posterior ridge rounded, posterior slope smooth; umbos raised above dorsal margin and located near anterior 1/3 of shell; periostracum greenish-yellow to brown with green rays of various widths over most of the shell surface.

Pseudocardinal tooth in left valve rudimentary, somewhat bifurcate, the highest portion often posterior to umbo; pseudocardinal tooth in right valve long, narrow and parallel to anterior-dorsal margin; laterals absent; nacre bluish-white, frequently with yellow spots near beak cavities; shells reach 70 mm (2-3/4 inches) in length.

HABITAT. In the Lake M-P-B drainage system, S. radiatus was always encountered in small rivers and creeks in shallow water. It occurs in both a mud and sand-gravel bottom.

REMARKS. There has been some disagreement concerning the genus to which this species belongs. Johnson (1967) places it in the genus
Anodontoides while both Frierson (1927) and Haas (1969) placed it in the genus *Strophitus*. Until the nature of the marsupial demibranchs can be determined, and because *radiatus* conchologically agrees with the generic description of *Strophitus* by Simpson (1900), the latter approach is utilized here.

*Strophitus* may be distinguished from the genus *Anodonta* by its thicker hinge line and the indications of pseudocardinal teeth, which are totally lacking in *Anodonta*. 
PLATE 19. *Strophitus radiatus*
Subfamily Lampsilinae

Carunculina parva (Barnes). Lilliput mussel

Plate 20, Map 20


**GENERAL DISTRIBUTION.** Mississippi River drainage from western New York to Minnesota, south to central Texas, east to Florida (Baker, 1928; Burch, 1975).

**DESCRIPTION.** Shell very small, oval to elliptical, solid; posterior ridge indistinct; both anterior and posterior margins rounded; dorsal and ventral margins nearly straight, parallel; beaks only slightly elevated, sculptured with strong ridges which are open anteriorly and are curved up sharply behind; periostracum brown to black, satin-like finish in some.

Left valve with two compressed, triangular pseudocardinals and two laterals, the lower blade on lateral much higher; two pseudocardinals in right valve, the upper tooth smaller, thin; one partially doubled lateral; umbonal cavity shallow; interdentum absent; nacre slivery-white; adult shell length to 30 mm (1-1/4 inches).

**HABITAT.** In the Lake M-P-B drainage system, the lilliput occurs in small to large streams and rivers, although it is most typically found in mud bottom, sluggish water lakes, ponds, and bayous.
REMARKS. This species may be locally hermaphroditic (Tepe, 1943; van der Schalie, 1970) and thus may lack pronounced sexual dimorphism. Females tend to be more cylindrical and more swollen posteriorly than males.

Although Morrison (1969) has reintroduced the use of the name *Toxolaema* Raf., 1831, Ortmann and Walker (1922) and Johnson (1970) regard the type species as a nomen dubium and continue to use the more familiar *Carunculina* Baker, 1898.

The distinct beak sculpture and their small size will distinguish members of the genus *Carunculina* from the other unionids in the Lake M-P-B drainage system. *Uniomerus* exhibits a similar beak sculpture, but is much larger. *Carunculina parva* can only be confused with *C. texasensis* and the differences are considered under the latter.
PLATE 20. *Carunculina parva*
MAP 20. Carunculina parva
Carunculina texasensis (Lea)
Plates 21 & 39, Map 21

Carunculina texasensis (Lea), Ortmann, 1914, Nautilus, 28:68.

GENERAL DISTRIBUTION. Southern Mississippi River drainage from Texas east to Mississippi, north to Tennessee, Missouri and southern Illinois (Simpson, 1914).

DESCRIPTION. Shell oval to elliptical, small, solid; posterior ridge broadly rounded; dorsal and ventral margins nearly straight, parallel; beaks slightly elevated, sculptured with strong ridges which are rounded posteriorly and open anteriorly (Plate 39-B); periostracum brown or black.

Two pseudocardinals in left valve which are triangular, compressed; two laterals; one large, one small, thin pseudocardinal in right valve; lateral single; no interdentum; nacre silvery or bluish-white, umbonal cavity tinged with salmon; adult shell length averages 45 mm (1-3/4 inches).

Pronounced sexual dimorphism; male bluntly pointed or biangulate behind; female truncate and with pronounced marsupial swelling.

HABITAT. In addition to being one of the smallest unionids in the Lake M-P-B drainage system, it is also one of the most widely distributed. It occurs from the headwaters of small streams to large rivers in a sand or sand-gravel bottom. It is most often found in
sluggish current, mud bottom habitats of lakes, ponds, and bayous, where it can become very abundant. Wherever this species occurs, it is typically near the banks in water as shallow as 2 to 3 inches.

REMARKS. Carunculina texensis can be confused with C. parva. Where parva is equally rounded anteriorly and posteriorly, in texensis there is pronounced sexual dimorphism.

The validity of most of the nominal species in this genus has been discussed, most notably by Call (1896), and texensis has been treated as both a subspecies of parva and as a separate species.

In the southern Mississippi River drainage, texensis seems to replace parva though the two species occur sympatrically at several localities.
PLATE 21. *Carunculina texasensis*
MAP 21. Carunculina texasensis
**Glebula rotundata** (Lamarck)

*Plate 22, Map 22*


**GENERAL DISTRIBUTION.** Apalachicola River, Florida to eastern Texas (Clench and Turner, 1956).

**DESCRIPTION.** Shell oval to subelliptical, solid; beaks only slightly elevated; posterior ridge moderately angular, often sulcus anterior to ridge in older specimens; shell rounded anteriorly, bluntly pointed or biangulate behind; periostracum brown to black.

Two pseudocardinals in left valve, which are split into series of radiating lamellae, and two remote laterals; two pseudocardinals in right valve, the upper small and compressed and the lower also split into series of radiating lamellae; single lateral, sometimes partly double; interdentum narrow and rounded; nacre white, often purplish in younger shells; average shell length 75 mm (3 inches), but very old individuals may reach 110 mm (4-3/8 inches) in length.

**HABITAT.** *Glebula rotundata*, like *Plectomerus dombeyanus*, is a bayou species in Louisiana drainages and it may become locally abundant. It is most often found in a mud bottom in sluggish water. It is endemic to the Gulf coast and, although it occurs in northern Louisiana (over 200 miles inland), it reaches its greatest development in southern Louisiana (Clench and Turner, 1956).
PLATE 22. Glebula rotundata
Lampsilis anodontoides (Lea). Yellow sand shell

Plate 23, Map 23

Unio anodontoides Lea, 1831, Trans. Am. Phil. Soc., 4:81, pl. 8, fig. 11.


GENERAL DISTRIBUTION. Entire Mississippi River drainage; Gulf drainage from peninsular Florida to Rio Grande (Simpson, 1914).

DESCRIPTION. Shell elliptical, solid, elongate; dorsal and ventral margins straight, parallel; posterior ridge close to dorsal margin, rounded to angled; beaks slightly elevated above hinge line; periostracum yellow, shiny, lacks rays; umbonal region frequently reddish or brownish as is posterior slope.

Two compressed, serrated pseudocardinal teeth in left valve; lateral double, long; two pseudocardinal teeth in right valve; anterior tooth low, elongate, posterior tooth triangular, erect, serrated; lateral tooth single, elevated and truncate posteriorly; no interdentum; nacre slivery-white; umbonal cavity in some pink or cream; large individuals may reach 125 mm (5 inches).

Posterior end of male ends in blunt point midway between dorsal and ventral margin; female with obvious marsupial swelling and diagonally truncate behind.

HABITAT. Lampsilis anodontoides occurs in small to large rivers in a mud to sand-gravel bottom in the Lake M-P-B drainage system.
It may become locally abundant and is found at depths varying from a few inches to several feet. Like most members of the genus *Lampsilis*, it is an active crawler.

**REMARKS.** The name *teres* Raf., 1820, of some authors, is a synonym of *anodontoides*. Johnson (1972a) lists the references concerning the argument over the recognition of *teres* because of priority versus its rejection as a nomen oblitum.

*Lampsilis anodontoides* can only be confused with *Ligumia recta* and the differences are discussed under the latter.
PLATE 23. *Lampsilis anodontoides*
MAP 23. Lampsilis anodontoides
**Lampsilis excavata** (Lea)

*Palte 24, Map 24*


**Lampsilis excavatus** (Lea), Simpson, 1900, *Synopsis*, p. 528.


**GENERAL DISTRIBUTION.** Escambia River system of Florida and Alabama west to Pearl (Clench and Turner, 1956) and Amite rivers of Mississippi and Louisiana.

**DESCRIPTION.** Shell inflated, solid, ovate in outline; posterior ridge prominent, angled; beaks full and well elevated above hinge line; periostracum yellow in younger shells, turning brownish in older individuals; narrow green rays over entire surface present on most.

Pseudocardinals located anterior to beaks; two in left valve; anterior tooth erect, triangular, serrate, compressed; posterior tooth much smaller; two small, remote laterals; two compressed pseudocardinals in right valve, the upper tooth much smaller; lateral single, high, truncate behind; umbonal cavity deep, wide; interdentum narrow, rounded; nacre bluish-white or salmon; adult shell length to 125 mm (5 inches).

Male shell bluntly pointed posteriorly; shell of female truncate behind with marsupial swelling.

**HABITAT.** This mussel inhabits many of the small and medium size rivers in the Lake M-P-B drainage system. It occurs in the mud bottom of sluggish pools as well as the sand-gravel bottom of the main channel.
REMARKS. Cvancara (1963) analyzed the latitudinal variation, for several shell ratios, among three closely related species—
*Lampsilis ventricosa* (Barnes, 1823), *L. ovata* (Say, 1817) and *L. excavata*. He concluded that a north-south cline existed and suggested that the three could be treated as separate subspecies of a single species complex.

Additional nominal species in this region include *L. satura* (Lea, 1852) in Grantham (1969) and *L. ornata* (Conrad, 1835) of Frierson (1927) and Stansbery (1975, pers. comm.). The true relationships and status of these species may never be determined, but as in *Lampsilis radiata*, they may all represent only gulf coast forms of the *L. ovata* complex to the north. In lieu of further examination of material collected to the west, the more familiar *excavata* is used.
PLATE 24. Lampsilis excavata
Lampsilis radiata hydiana (Lea)

Plate 25, Map 25

Lampsilis fasciata hydiana (Lea), Frierson, 1927, Checklist, p. 72.

GENERAL DISTRIBUTION. East Texas, Louisiana, Arkansas and Oklahoma (?) (Valentine and Stansbery, 1971).

DESCRIPTION. Shell subelliptical, heavy, solid, moderately to greatly inflated; beaks full, elevated above hinge line; posterior ridge broadly rounded, indistinct; periostracum yellow, darker on umbo and posterior slope; dark green rays of varying widths cover entire surface.

Left valve with two triangular, serrate, compressed pseudo-cardinals and two curved laterals; right valve with one erect, triangular, somewhat compressed pseudocardinal and one low, lamellar tooth in front; lateral single, curved; interdentum narrow to absent; nacre white; shell length to 90 mm (3-1/2 inches).

Shell of male broadly rounded anteriorly and posteriorly; dorsal and ventral margins straight and parallel or slightly convex; female with marsupial swelling and round to truncate posteriorly.

HABITAT. Lampsilis radiata hydiana lives in sluggish or quiet water in a mud or stable sand bottom. It is a bayou species in most of its range and is typically found at depths of from 1 to 3 feet.

REMARKS. The Amite River may represent the eastern limit of this subspecies. It was not collected in Mississippi by Grantham (1969). It is commonly encountered west of the Mississippi River (Stern, unpub.) and is replaced by Lampsilis straminea in the Lake.
M-P-B drainage system and to the east (see REMARKS section under L. straminea).

The much heavier shell of *hydiana* will distinguish it from *Villosa vibex*, a similarly rayed species.
PLATE 25. *Lampsilis radiata hydiana*
MAP 25. *Lampsilis radiata hydiana*
Lampsilis straminea (Conrad)

Plate 26, Map 26

Lampsilis stramineus (Conrad), Simpson, 1900, Synopsis, p. 538.
Lampsilis straminea (Conrad), Simpson, 1914, Descri. cat. Naiades, p. 72.

GENERAL DISTRIBUTION. Southeastern Louisiana to southern Mississippi and Alabama (Simpson, 1914).

DESCRIPTION. Shell subelliptical in outline, solid, moderately to greatly inflated; beaks slightly elevated above dorsal margin; posterior ridge rounded, not evident; periostracum yellow; becoming brownish in older shells; occasional individuals with faint rays on posterior slope and body of shell.

Two triangular, serrate pseudocardinals and two curved laterals in left valve; two pseudocardinals in right valve, the upper tooth compressed and small; single, curved lateral; interdentum narrow; nacre white, sometimes pink or salmon; shell length 75 mm (3 inches).

Shell of male evenly rounded in front and behind; dorsal and ventral margins straight and parallel to slightly convex; marsupial swelling in female evident in some; rounded to truncate posteriorly.

HABITAT. Lampsilis straminea is one of the most widespread and abundant species of unionids in the Lake M-P-B drainage system. It is found in small streams and rivers in a mud or sand-gravel bottom in shallow water near the banks.

REMARKS. The species Lampsilis claibornensis (Lea, 1838) of Clench and Turner (1956) and Grantham (1969) occurs from west Florida
to at least the Pearl River. Both Burch (1975) and Stansbery (1975, pers. comm.) have suggested that *claibornensis* is probably the same thing as *straminea*. When comparing the description of both, the only difference is that *claibornensis* is concentrically sculptured but smooth, while *straminea* is sculptured with strong, prominent ridges. This character is probably ecologically produced and occurs among many unionids. The two are treated here as synonyms.

Several lots containing what may be intergrades between *hydiana* and *straminea* were collected from the Comite and Amite rivers. Although a re-evaluation of these taxa is not within the scope of this work, present observations concerning conchological characters and ecological niche suggest that *hydiana*, *straminea*, and *claibornensis* may all be forms of the widespread and geographically variable species *Lampsilis radiata* (Gmelin, 1792). Lea (1838), Call (1895), Frierson (1911, 1927), Simpson (1914), and Haas (1969) all discuss individuals that they felt were intermediates between the three species.

This species can also be confused with *Villosa vibex* and *V. liensosa* and the differences are discussed under those species.
PLATE 26. *Lampsilis straminea*
MAP 26. Lampsilis straminea
Leptodea fragillis (Rafinesque). Fragile paper shell

Plate 27, Map 27


GENERAL DISTRIBUTION. Entire Mississippi River drainage; Texas east along Gulf coast to Alabama; St. Lawrence River drainage from Quebec City to Lake St. Clair (Clarke and Berg, 1959).

DESCRIPTION. Shell large, thin, compressed; oval to subelliptical; round anteriorly, obliquely truncate posteriorly; dorsal margin alate posteriorly (obliterated in older shells); umbo only slightly elevated; posterior ridge indistinct; periostracum yellow to pale brown, with green rays on some juveniles; posterior slope darker.

Pseudocardinal teeth low, small, lamellar, parallel with hinge line; two in left and one in right valve, although frequently absent; two thin, remote laterals in left valve, the lower one weakly expressed, and one lateral in right valve; beak cavities shallow; no interdentum; nacre usually pink; average shell length 115 mm (4-1/2 inches).

HABITAT. Leptodea fragillis is common throughout the Lake M-P-B drainage system in both small streams and medium sized rivers. It is found in a variety of bottoms ranging from mud to a sand-gravel mixture, but not in a rocky bottom. It is common in shallow water and because it is an active crawler, it is easily located by its tracks.
REMARKS. This species can only be confused with *Proptera inflata*. The latter differs in several ways: older individuals are strongly alate with a brown to black periostracum, the hinge teeth are more prominent and the nacre is purple.
PLATE 27. *Leptodea fragilis*
MAP 27. *Leptodea fragilis*
Ligumia recta (Lamarck). Black sand mussel

Plate 28, Map 28


Lampsilis recta (Lamarck), Simpson, 1914, Descr. cat. Naiades, p. 95.

GENERAL DISTRIBUTION. Mississippi River drainage from Pennsylvania to Minnesota, south to Oklahoma and Louisiana; east to Alabama and Georgia; St. Lawrence system; Canadian Interior Basin in Winnipeg and Red River systems (Clarke, 1973).

DESCRIPTION. Shell heavy, elliptical, extremely elongate (height/length ratio .50 or less); posterior ridge rounded, indistinct; dorsal and ventral margins nearly straight, parallel; beaks low; periostracum brown to black.

Pseudocardinals triangular, two in left and one in right valve; laterals long, straight, two in left and one in right valve; interdentum absent; umbonal cavity shallow; nacre white, sometimes purple; adult shell length 140 mm (5-1/2 inches).

The male pointed posteriorly; shell of female with marsupial swelling and more bluntly pointed behind.

HABITAT. Throughout its entire range, L. recta is almost exclusively confined to large rivers with a moderate current and a mud or sand-gravel bottom.

REMARKS. Several recent studies (Murray and Leonard, 1962; Starrett, 1971; and Yokley, 1972) indicate that this species is becoming
increasingly rare, in areas where it was once common, because of increased turbidity and siltation. Only one pair of subfossil valves was collected in the Lake M-P-B drainage system during this study and *L. recta* may no longer be present in this gulf drainage.

*Ligumia recta* might be confused with *Lampsilis anodontoides*. In the latter, the periostracum is yellow and the pseudocardinals are much more compressed and are doubled in each valve.
PLATE 28. Ligumia recta
MAP 28. Ligumia recta
Ligumia subrostrata (Say). Common pond mussel

Plates 29 & 40, Map 29

Ligumia subrostrata (Say), Grier and Mueller, 1922, Nautilus, 35:100.

GENERAL DISTRIBUTION. Entire Mississippi River drainage; north as far as Wisconsin and south Dakota; Texas east to Alabama (Murray and Leonard, 1962).

DESCRIPTION. Shell elongate, irregularly elliptical; beaks elevated above hinge line; beak sculpture double-looped (Plate 40-B); dorsal and ventral margins straight, parallel; posterior ridge rounded to angled; periostracum greenish-yellow, changing to black in older individuals; green rays of varying widths on most of shell.

Two compressed, elevated, serrate pseudocardinal teeth in each valve; two straight, thin laterals in left valve, one in right; interdentum narrow to absent; nacre white; adult shell length 90 mm (3-1/2 inches).

Shell of male characteristically rostrate posteriorly; female diagonally truncate posteriorly, rostrate (Fig. 3-C), and with distinct marsupial swelling.

HABITAT. In contrast to Ligumia recta, throughout most of its range this species occurs most frequently in the mud or stable sand bottom of ponds, lakes, and bayous. It typically lives in shallow water along the banks to a depth of 2 feet.
REMARKS. Although the two species are allopatric, Johnson (1970) does not recognize *L. subrostrata* as distinct from *Ligumia nasuta* (Say, 1817), a species found from Lake Erie east into Atlantic slope streams. However, nearly all authors from Call (1895) to Fuller (1974) regard *subrostrata* as a distinct species.

Under appropriate conditions, this species may become extremely abundant. At one site, a small pond, an average density of 200 individuals/meter$^2$ was observed (Dr. T. Dietz, pers. comm.).

The differences between some male shells of *subrostrata* and *Uniomerus declivis*, with which they may be confused, are discussed under *declivis*. 
PLATE 29. Ligumia subrostrata
MAP 29. *Ligumia subrostrata*
**Obliquaria reflexa** Rafinesque. Three-horned warty-back

Plates 30 & 39, Map 30


**GENERAL DISTRIBUTION.** Mississippi River drainage from western Pennsylvania north into southern tip of Ontario (Clarke, 1973); Michigan and Minnesota; southwest to eastern Kansas, Oklahoma and Texas and east to Georgia (Burch, 1975).

**DESCRIPTION.** Shell triangular to oval; anterior end rounded, posterior bluntly pointed, truncate; posterior ridge well developed and posterior slope often plicate; a row of prominent knobs extends from beak to center of ventral margin with knobs of one valve alternating in position with those of other valve (Plate 39-C); often a shallow sulcus between row of knobs and posterior ridge; periostracum typically yellowish-brown but ranging to black in old shells.

Left valve with two ragged pseudocardinals and two laterals; right valve with one large, deeply serrated pseudocardinal, vestigial tooth above and one partially doubled lateral tooth; nacre white, occasionally pink, much thicker anteriorly; large specimens may reach 65 mm (2-1/2 inches) in length.

**HABITAT.** In the Lake M-P-B drainage system, *O. reflexa* occurs in medium size rivers and streams with a moderate current. It prefers a stable sand or sand-gravel bottom.
PLATE 30. *Obliquaria reflexa*
MAP 30. Obliquaria reflexa
Obovarla jacksoniana Frierson

Plate 31, Map 31

Obovarla jacksoniana Frierson, 1912, Nautilus, 26:23, pl. 3, figs. 1-3.

GENERAL DISTRIBUTION. Yalabusha and Pearl rivers, Mississippi (Simpson, 1914) to Amite River, Louisiana.

DESCRIPTION. Shell oval to elliptical, clearly longer than high; rounded anteriorly; ventral margin decidedly convex, curved upward posteriorly to meet dorsal margin about half way up height of shell in blunt point; posterior ridge low and rounded; beaks low, located on anterior 1/2 to 1/3 of shell; periostracum greenish-brown to black, lighter posteriorly; faint green rays posteriorly on younger shells.

Two triangular, erect pseudocardinals and two laterals in left valve; one massive, triangular pseudocardinal in right valve, smaller tooth above; partially doubled lateral; umbonal cavity shallow; interdentum moderately wide; adult shell length to about 50 mm (2 inches).

HABITAT. Obovarla jacksoniana inhabits only small to medium size streams and rivers in a mud to sand-gravel bottom in the Lake M-P-B drainage system.

REMARKS. If O. castanea (Lea, 1831) is a synonym, as Stansbery (1974, pers. comm.) suspects, then its range extends from the Neches River, Texas east to the Alabama River (Simpson, 1914).

Its range completely overlaps that of O. unicolor, a highly variable species, and the two can be confused. Obovarla jacksoniana is more elongate and has anteriorly located beaks.
PLATE 31. *Obovaria jacksoniana*
Obovaria unicolor (Lea)

Plate 32, Map 32


Obovaria unicolor (Lea), Simpson, 1900, Synopsis, p. 601.


GENERAL DISTRIBUTION. Streams flowing into the Gulf from the Amite River, Louisiana to Alabama (Simpson, 1914).

DESCRIPTION. Shell round to oval, solid, heavy in old individuals; beaks centrally placed, or nearly so, and elevated; posterior ridge rounded, barely discernable; posterior end blunt in some females; periostracum yellowish-brown to black.

Left valve with two triangular pseudocardinals and two slightly curved laterals; right valve with two, occasionally three pseudocardinal teeth, the central one much larger; lateral tooth partly doubled; beak cavity deep, compressed; interdentum moderately wide; nacre white, sometimes pink; length to 55 mm (2-1/4 inches).

HABITAT. The habitat for unicolor, in the Lake M-P-B drainage system, is similar to that of jacksoniana. Of the two species, unicolor is much more abundant.

REMARKS. Simpson (1914), La Rocque (1967), and Parmalee (1967) include southeastern Louisiana in the distribution of Obovaria subrotunda (Raf., 1820). Grantham (1969), Stansbery (1974, pers. comm.), and Burch (1975) recognize unicolor as a species distinct from subrotunda. Obovaria unicolor, however, may be no more than the Gulf coast form of the more widespread subrotunda to the north and east.
PLATE 32. *Obovaria unicolor*
MAP 32. *Obovaria unicola*
Proptera inflata (Lea)
Plate 33, Map 33


Proptera inflata (Lea), Frierson, 1927, Check List, p. 87.

GENERAL DISTRIBUTION. Along Gulf from Alabama and Tombigbee River areas (Simpson, 1914) west to Amite River, Louisiana.

DESCRIPTION. Shell oval, compressed to moderately inflated, thin; valves may gape anteriorly 5 to 10 mm; umbos low; prominent wing posteriorly; some young shells also alate anterior to beaks; posterior ridge high, rounded; periostracum brown to black, with green rays in young specimens.

One elongate, lamellar pseudocardinal and two short, remote laterals in left valve; right valve with one raised lamellar, elongate pseudocardinal and one high, short, truncated lateral; umbonal cavity very shallow; no interdentum; nacre pink to purple; shell length to 140 mm (5-1/2 inches).

HABITAT. Proptera inflata is confined to medium size rivers where it occurs in either a mud or sand-gravel bottom in a slow to moderate current. It was collected only from the Amite River and these sites may represent the last living populations in the Lake M-P-B drainage system.

REMARKS. Proptera inflata may superficially resemble Leptodea fragilis and the differences are discussed under the latter species. Potamilus Raf., 1818, of some authors, is a nomen oblitum.
PLATE 33. *Proptera inflata*
MAP 33. Proptera inflata
**Proptera purpurata** (Lamarck). Purple shell mussel

Plate 34, Map 34

**Unio purpurata** Lamarck, 1819, An. sans Vert., 6:71.


**Lampsils purpurata** (Lamarck), Simpson, 1914, Descr. cat. Naiades, p. 166.

**GENERAL DISTRIBUTION.** East Texas north to Kansas, southern Missouri and western Tennessee; along Gulf coast to Alabama River drainage (Simpson, 1914).

**DESCRIPTION.** Shell very large, solid, heavy; valves oval, inflated; beaks high and full, evidence of small wing posteriorly; posterior ridge slightly angled with 1 or 2 radiating ridges on posterior slope; periostracum black.

Two thick, heavy, ragged pseudocardinals in each valve, lower tooth in right valve larger; two strong laterals in left valve, one in right; anterior muscle scars deeply impressed; interdentum absent; nacre rich, dark purple; extremely large adults may reach 190 mm (7-1/2 inches).

Shell of male pointed to biangulate behind; the female shell with marsupial swelling posteriorly and more truncate than male.

**HABITAT.** In the Lake M-P-B drainage system, the purple shell mussel is found in medium to large rivers in a moderate current or in quiet pools. Bottom preference varies from mud to a sand-gravel combination. It is rarely found near the headwaters.
PLATE 34. Proptera purpurata
**Truncilla donaciformis** (Lea). Fawn's foot

Plate 35, Map 35

**Unio donaciformis** Lea, 1828, Trans. Am. Phil. Soc., 3:267, pl. 4, fig. 3.


**Plagiola donaciformis** (Lea), Simpson, 1914, Descr. cat. Naiades, p. 308.

**GENERAL DISTRIBUTION.** Mississippi River drainage from western Pennsylvania west to Kansas; south to Texas, Louisiana and Alabama; north to Minnesota (Baker, 1928); St. Lawrence system (Burch, 1975).

**DESCRIPTION.** Shell oval to elliptical, not heavy; anterior end rounded, posterior end bluntly pointed; posterior ridge sharply angled; beaks slightly elevated above hinge line; periostracum dull yellow or greenish, marked with many green rays of varying widths; rays not solid, but broken into zig-zag or arrowhead-shaped lines.

Two compressed, elevated pseudocardinal teeth in left valve; posterior tooth located directly below beak, flared upward; two straight lateral teeth; one triangular pseudocardinal in right valve, one lateral; umbonal cavity shallow; interdentum absent; nacre white; shell small, does not exceed 50 mm (2 inches).

**HABITAT.** This species was collected only from the Amite River. At all three sites, the river is of medium size with a moderate current and a sand-gravel bottom.

**REMARKS.** Its small size and distinctive periostracum makes **T. donaciformis** easily recognizable.
MAP 35. Truncilla donaciformis
**Villosa lienosa** (Conrad)

Plate 36, Map 36

*Unio lienosus* Conrad, 1834, Am. Jour. Sci., 25:339, pl. 1, fig. 4


**GENERAL DISTRIBUTION.** Texas east to southwest Georgia and peninsular Florida; north to lower Ohio and Wabash rivers (Burch, 1975).

**DESCRIPTION.** Shell somewhat elliptical in outline, solid; beaks moderately elevated above hinge line; posterior ridge broadly rounded; periostracum dark brown to black, rayless.

Left valve with two roughened, triangular pseudocardinals, two laterals; one triangular pseudocardinal in right valve, usually with a smaller compressed tooth in front; one curved lateral; interdentum absent; nacre white, although more typically salmon or purple; shell length 75 mm (3 inches).

Male shell rounded anteriorly and posteriorly; dorsal and ventral margins evenly convex; shell of female round anteriorly, decidedly truncate posteriorly; pronounced marsupial swelling.

**HABITAT.** *Villosa lienosa* inhabits small to medium size streams and rivers in the Lake M-P-B drainage system. It prefers a mud or stable sand bottom and is widely distributed in this drainage system.

**REMARKS.** Up until recently (Goodrich and van der Schalie, 1944; La Rocque, 1953) the genus *Micromya* Agassiz, 1852, was used in place of *Villosa* Frierson, 1927. As noted by Valentine and Stansbery (1971),
*Micropyla* is not available for use in the Mollusca, having been proposed 12 years earlier for a genus of flies.

The shell of *V. lienosa* has few distinguishing features and in some populations sexual dimorphism is lacking. It can be confused with some specimens of *Lampsilis straminea*. The yellow periostracum of *straminea*, evident after scrubbing the valves, will separate the two.
PLATE 36. Villosa lienosa
Villosa vibex (Conrad)
Plate 37, Map 37

Unio vibex Conrad, 1834, New F. W. Shells, p. 31, pl. 4, fig. 3.


GENERAL DISTRIBUTION. Amite River system, Louisiana east to peninsular Florida and north to Cape Fear River system, North Carolina (Johnson, 1972a).

DESCRIPTION. Shell subelliptical to oval, thin; beaks only slightly elevated; posterior ridge broadly rounded; periostracum greenish-yellow to black; on most individuals entire surface covered with numerous green rays of varying widths.

Pseudocardinals very compressed; two in left valve, anterior tooth triangular, posterior tooth vestigial to absent; one high, triangular pseudocardinal tooth in right valve, vestigial tooth above; two laterals in left valve and one in right; umbonal cavities shallow; interdentum very narrow; nacre bluish-white, sometimes pink; adult shell length 65 mm (2-1/2 inches).

Anterior end rounded in both male and female; posterior end of female broadly rounded; males somewhat pointed so as to be subrhomboid.

HABITAT. In the Lake M-P-B drainage system, this species lives in small creeks and rivers in a mud or stable sand bottom. It is more typically a headwaters species.
REMARKS. *Villosa vibex* can be confused with *V. lienosa*, *Lampsilis radiata hydiana* and *L. straminea*. It can be distinguished from both *lienosa* and *straminea* by its far more prominent rays and from all three species by its much thinner shell. Also sexual dimorphism is not as strongly developed in *vibex* as it is in *lienosa*, *hydiana* and *straminea*. 
PLATE 37. *Villosa vibex*
MAP 37. Villosa vibex
**Additional Louisiana Unionacea**

Most of the freshwater mussel surveys undertaken in Louisiana date back to the turn of the century (Vaughan, 1892; Frierson, 1897, 1902; Shira, 1913; Coker, 1915). Because these studies were of such limited nature, it is difficult to assess what changes have taken place in the faunal composition. The following tables are intended as a supplement to the species treated in this survey in the event that any of these species turns up with future collecting. This also serves as an introduction to a larger study, now in progress, on the unionid fauna of Louisiana. Table 6 includes those species which have been collected live during the last 10 years and are believed to still occur in Louisiana. The most recent literature record or collection (unpublished data from my collection) and a citation of a standard treatise, where the species is discussed, are included. Table 7 lists those species for which there are literature records but which may now be extirpated. Because descriptions and illustrations were lacking for most of these species, it is not possible to determine the validity of all of their records.

**Additional Freshwater Pelecypods**

The Lake M-P-B drainage system supports a rich pelecypod fauna in addition to the group treated here. Although some of the groups in the following annotated list are predominately brackish water, they can be encountered in freshwater and are dealt with only for comparative purposes. For a more detailed account, a literature citation is also included.
TABLE 6. Unionid species still believed to occur in additional Louisiana drainages.

<table>
<thead>
<tr>
<th>Species</th>
<th>Literature Record or Collection Data</th>
<th>Standard Treatise†</th>
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<tr>
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<td>Family Margaritiferidae</td>
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<td><em>Margaritifera hembelli</em> (Conrad, 1838)</td>
<td>Stern (unpub.)</td>
<td>Clench and Turner (1956)</td>
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<tr>
<td>Subfamily Amblemminae</td>
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<td>Stern (unpub.)</td>
<td>Murray and Leonard (1962)</td>
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<td>Stern (unpub.)</td>
<td>Simpson (1914)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><em>Lampsilis anodontoides fallaciosa</em> (Smith, 1899)</td>
<td>Stern (unpub.)</td>
<td>Murray and Leonard (1962)</td>
</tr>
<tr>
<td><em>Lampsilis satura</em> (=ovata?) (Lea, 1852)</td>
<td>Stern (unpub.)</td>
<td>Simpson (1914)</td>
</tr>
<tr>
<td><em>Proptera capax</em> (Green, 1832)</td>
<td>Branson (1966)</td>
<td>Parmalee (1967)</td>
</tr>
<tr>
<td><em>Proptera laevissima</em> (Lea, 1829)</td>
<td>Stern (unpub.)</td>
<td>Murray and Leonard (1962)</td>
</tr>
<tr>
<td><em>Truncilla truncata</em> Raf., 1820</td>
<td>Stern (unpub.)</td>
<td>Murray and Leonard (1962)</td>
</tr>
</tbody>
</table>

*Frierson (1911) reported these species from the Pearl River at Jackson, Mississippi, but they were not found during this study in the Lake Maurepas-Pontchartrain-Borgne drainage system.

†Standard treatise in which a description, distribution, and synonymy of the species can be found.
<table>
<thead>
<tr>
<th>Species</th>
<th>Literature Records</th>
<th>Standard Treatise†</th>
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<tbody>
<tr>
<td>Family Unionidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subfamily Amblemae</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Elliptio complanatus</em> (Lightfoot, 1786)</td>
<td>Miller (1936)</td>
<td>Matteson (1948a, 1948b)</td>
</tr>
<tr>
<td><em>Fusconaia friersoni</em> (B.H. Wright, 1896)</td>
<td>Frierson (1899a)</td>
<td>B.H. Wright (1896)</td>
</tr>
<tr>
<td><em>Quadrula cylindrica</em> (Say, 1817)</td>
<td>Vanatta (1910)</td>
<td>Murray and Leonard (1962)</td>
</tr>
<tr>
<td><strong>Quadrula houstonensis</strong> (Lea, 1859)</td>
<td>Vaughan (1892, 1893)</td>
<td>Simpson (1914)</td>
</tr>
<tr>
<td><em>Quadrula metanerva</em> (Raf., 1820)</td>
<td>Vanatta (1910)</td>
<td>Murray and Leonard (1962)</td>
</tr>
<tr>
<td>Subfamily Anodontinae</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Strophitus subvexus</em> (Conrad, 1834)</td>
<td>Frierson (1899a)</td>
<td>Johnson (1967)</td>
</tr>
<tr>
<td><em>Strophitus undulatus</em> (Say, 1817)</td>
<td>Vaughan (1892, 1893)</td>
<td>Clarke and Berg (1959)</td>
</tr>
<tr>
<td>Subfamily Lampsilinae</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Actinonaias carinata gibba</em> (Simpson, 1900)</td>
<td>Vanatta (1910)</td>
<td>Simpson (1914)</td>
</tr>
<tr>
<td><em>Proptera amphichaenus</em> (Frierson, 1898)</td>
<td>Frierson (1899a, 1899b)</td>
<td>Frierson (1898)</td>
</tr>
</tbody>
</table>

*Not considered to be a valid record because of the distribution of this species.*

**Frierson (1899a) did not consider this to be a valid record.**

†Standard treatise in which a description, distribution, and synonymy of the species can be found.
Family Corbiculidae

*Corbicula* cf. *manilensis* (Philippi, 1841). Asiatic clam
Plate 38-A, Map 38

Since its introduction into this hemisphere in 1938 (Gregg, 1947), *Corbicula* has spread from the Columbia River in the State of Washington to the Atlantic drainages (Sickel, 1973; Fuller and Powell, 1973). It was first reported from Louisiana in 1963 (Dundee and Harman, 1963) and has since been encountered throughout the state (Stern, unpub.). The asiatic clam poses a threat to the native bivalve fauna because of its free swimming larva and its ability to exploit virtually any bottom from concrete to shifting sand. An excellent annotated bibliography on this exotic bivalve in North America, from 1900 to 1971, has been compiled by Sinclair (1971).

*Polymesoda caroliniana* (Bosc, 1802). Carolina marsh clam
Plate 38-C

This species is predominately found in tidal marshes. It does occur inland and at mouths of rivers where it is exposed to freshwater for varying period of time. Its distribution, ecology and anatomy are covered by van der Schalie (1933).
PLATE 38. Additional Louisiana pelecypods.
A, Corbicula manilensis; B, Rangia cuneata; C, Polymesoda caroliniana; D, Sphaerium transversum.
MAP 38. Corbicula manilensis
Family Sphaeriidae

Fingernail and pill clams

Plate 38-D

This freshwater family is represented in this area by several genera, including *Sphaerium* Scopoli, 1777, and *Pisidium* Pfeiffer, 1821. In contrast to the Unionidae, all are hermaphroditic and very small (25 mm or less in length). In this region, they are common inhabitants of bayous and it is not unusual to find them by the tens of thousands. The papers by Herrington (1962), who revised the family, and Burch (1972) contain keys for the identification of all the species and references to other relevant studies.

Family Mactridae

*Rangia cuneata* (Gray, 1831)

Plate 38-B

*Rangia cuneata* is a widely distributed and extremely abundant species. Although it reaches its greatest density in the low salinity brackish water zone, it is common in freshwater where its range overlaps that of several unionid species. *Rangia cuneata* has been collected live in association with *Quadrula quadrula apiculata*, *Anodonta grandis*, *Glebula rotundata*, and *Plectomerus dombeyanus*. The various aspects of the biology of *R. cuneata* are discussed in the publication by Hopkins et al. (1973).
A, *Uniomerus tetralasmus*

B, *Carunculina texansensis*

C, *Obliquaria reflexa*

D, *Quadrula q. quadrula*

PLATE 39. Beak and shell sculpture of selected unionids.
A, *Anodonta grandis*  
B, *Ligumia subrostrata*

PLATE 40. Beak sculpture of selected unionids.
ORIGIN AND AFFINITIES

The course of evolution of the Unionidae in North America is outlined by Walker (1900, 1917). The group is believed to date back to the Triassic period of Texas and the present fauna and its distribution is the result of a continuous series of events, including migration, isolation, and subsequent speciation. Following an extensive period of adaptive radiation that produced the vast Interior Basin fauna, gulf coastal streams from eastern Texas to central Alabama were inundated by the formation of the Mississippi Embayment (Map 39) during the Cretaceous. Marine conditions prevailed as far north as Memphis, but by the Pliocene, superseded by delta growth, the shoreline retreated gulfward (Fisk, 1944).

At the beginning of the Pleistocene, those streams flowing northward were ponded by the advancing ice sheets and diverted southward into the Mississippi Embayment. Throughout the Pleistocene and Recent epochs, the alluvial valley of the Mississippi River continued its gulfward growth accompanied by many shifts in both the course and location of the active delta. Although the Central Gulf Coastal Plain was not covered by ice during the glacial stages, the results of sea level oscillations with the advance and retreat of the ice sheets are evident in the formation of several terraces. Fisk (1939) designated the Pleistocene terraces, from the oldest to the youngest, as Williana, Bentley, Montgomery and Prairie. Doering (1956, 1958)
MAP 39. Central Gulf Coastal Plain

[Modified from Fisk (1944) and Brown (1967)]

A. Area of possible stream confluence between the Noxubee River of the Alabama-Coosa River system and the headwaters of the Pearl River system.

B. Area of possible stream confluence between the headwaters of the Pearl River system, Sucarnooche Creek of the Alabama-Coosa River system and Okatibbee Creek of the Pascagoula River system.

C. Gulf Coastal Plain.

M. Mississippi River Alluvial Valley.

APPALACH. MTS. = Southern Appalachian Mountains.

---► Proposed course of the Pliocene Tennessee River.

<<<<< Gravel ridges.

Principal drainage systems*

<table>
<thead>
<tr>
<th>Mississippi River System:</th>
<th>Lake Maurepas-Pontchartrain-Borgne Drainage System:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ohio River</td>
<td>16. Bayou Manchac</td>
</tr>
<tr>
<td>2. Tennessee River</td>
<td>17. New River</td>
</tr>
<tr>
<td>3. Mississippi River</td>
<td></td>
</tr>
<tr>
<td>4. Yazoo River</td>
<td></td>
</tr>
<tr>
<td>5. Big Black River</td>
<td></td>
</tr>
<tr>
<td>6. Homochitto River</td>
<td>18. Pascagoula River</td>
</tr>
<tr>
<td>7. Bayou Sara</td>
<td>19. Leaf River</td>
</tr>
<tr>
<td>8. Thompson Creek</td>
<td>20. Chickasawhay River</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Red-Atchafalaya River System:</td>
<td></td>
</tr>
<tr>
<td>10. Red River</td>
<td>22. Alabama River</td>
</tr>
<tr>
<td>11. Atchafalaya River</td>
<td>23. Tombigbee River</td>
</tr>
<tr>
<td></td>
<td>24. Black Warrior River</td>
</tr>
<tr>
<td></td>
<td>25. Sucarnoochee Creek</td>
</tr>
<tr>
<td></td>
<td>26. Noxubee River</td>
</tr>
</tbody>
</table>

*Principal rivers of the Lake Maurepas-Pontchartrain-Borgne drainage system are identified in Map 1.
proposed a new terrace stratigraphy in which he recognized three
Pleistocene terraces, the Lissie, Oberlin and Eunice, and an older
preglacial (Pliocene?) terrace, the Citronelle, which was equivalent
to the Williana of Fisk (1939). The Citronelle Formation is not
localized in entrenched valleys, but formed as a blanket fluviatile
deposit (Durham, et al., 1967). It is found from Texas through south­
western Mississippi to the Florida panhandle, generally near the
seaward margin of the Gulf Coastal Plain. Of particular significance
is the fact that an analysis of the heavy minerals of the Citronelle
Formation suggest an Appalachian source (Durham, et al., 1967).
The relationship of these deposits in southeastern Louisiana, as out­
lined by Doering (1958), is shown in Map 40. The Pleistocene terraces
formed the northern limit of the Pontchartrain Basin and those streams
draining these terraces emptied into this basin (Map 40). The evolu­
tion of the present Lake M-P-B drainage system was completed with the
introduction of Mississippi River sediments into the Pontchartrain
Basin 4,500 years ago, during the formation of the Cocodrie Delta
(Saucier, 1963) (Map 40).

Simpson (1896) divided the North American naiades into three
major faunal units and this scheme was elaborated upon by H. and A.
van der Schalie (1950). The mussels of the vast Mississippi River
system represent a rather uniform assemblage referred to as the
Interior Basin fauna. Both Simpson (1892) and H. and A. van der Schalie
(1950), because of the number of endemic genera present, recognized a
subregion of the Interior Basin that consisted of those streams flowing
directly into the Gulf of Mexico from Alabama to Mexico. Johnson
MAP 40. Physiography of the Lake Maurepas-Pontchartrain-Borgne drainage system showing selected terraces and deltas.*

[Modified from Doering (1956) and Saucier (1963)]

Geologic Formations:

Tertiary Deposits

Citronelle Formation

Pleistocene Deposits

Deltas of the Mississippi River:

1. Cocodrie Delta - 4600 to 3600 BP
2. St. Bernard Delta - 2600 to 2000 BP
3. Balize Delta - 600 to present

... - Ancestral, abandoned Amite-Tickfaw-Tangipahoa River channel.

Inset - Shaded region indicates the extent of the Pontchartrain Basin.

*Major rivers are identified in Map 1.
(1970) included those streams from Mexico up to, but not including, the Alabama-Coosa River system, in his West Gulf Coastal region. The Alabama-Coosa River system constitutes what will be referred to in my study as the East Gulf Coastal region.

The reintroduction of an Interior Basin unionid fauna into the Red-Atchafalaya, Lafourche and Teche drainage systems (Map 39), following the retreat of the Mississippi Embayment, is clearly directly attributable to the activities of the Mississippi River and its western tributaries during the Quaternary period. The Teche and Lafourche systems represent older Mississippi River delta complexes while the Atchafalaya River system is currently forming the next major delta. The unionid fauna in the Lake M-P-B drainage system is also essentially an Interior Basin fauna and therefore it has many affinities to the west of the Mississippi River. However, closer examination of the fauna of the Lake M-P-B drainage system suggests (1) greater affinities with the East rather than the West Gulf Coastal region and (2) that the route of immigration was not via the Mississippi River system. The bases for these assumptions follow.

Of the 36 species and subspecies of unionid mussels occurring in the Lake M-P-B drainage system, 28 are represented in the East Gulf Coastal region (Table 8). Further to the east the Apalachicola region contains a distinct assemblage characterized by many endemic genera and species and with few affinities (only 15) in the Lake M-P-B drainage system. Likewise the number of species represented in gulf drainages to the west of the Lake M-P-B drainage system decreases decidedly in the river systems of Texas (Table 8).
TABLE 8. Distribution of the Unionidae of the Lake M-P-B drainage system in other selected gulf coastal drainages.

<table>
<thead>
<tr>
<th>Species</th>
<th>Colorado River system</th>
<th>Trinity River system</th>
<th>Sabine River system</th>
<th>Lake M-P-B drainage system</th>
<th>Pascagoula River system</th>
<th>Alabama-Coosa River system</th>
<th>Apalachicola region</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>Amblema plicata</em>²</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2. <em>Elliptio beadleiana</em>³</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. <em>Elliptio crassidens</em></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4. <em>Fusconaia ebena</em></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. <em>Fusconaia flava</em>⁴</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>7. <em>Plectomerus dombeyanus</em></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. <em>Quadrula pustulosa</em></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>6/</td>
</tr>
<tr>
<td>9. <em>Quadrula q. quadrula</em></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. <em>Quadrula q. apiculata</em></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>11. <em>Tritogonia verrucosa</em></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>12. <em>Uniomerus declivis</em>⁷</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. <em>Uniomerus tetralasmus</em></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. <em>Anodonta grandis</em></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>15. <em>Anodonta imbecillis</em></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>16. <em>Arcidens confagosus</em></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. <em>Lasmigona complanata</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>18. <em>Strophitus radiatus</em>⁸</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
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</table>
TABLE 8 continued.

<table>
<thead>
<tr>
<th>Species</th>
<th>Colorado River system</th>
<th>Trinity River system</th>
<th>Sabine River system</th>
<th>Lake M-P-B, drainage system</th>
<th>Pascagoula River system</th>
<th>Alabama-Coosa River system</th>
<th>Apalachicola region</th>
</tr>
</thead>
<tbody>
<tr>
<td>19. <em>Carunculina parva</em></td>
<td>X X</td>
<td></td>
<td>X</td>
<td>X X X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. <em>Carunculina texasensis</em></td>
<td>X X</td>
<td>X</td>
<td>X</td>
<td>X X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. <em>Glebula rotundata</em></td>
<td>X X</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. <em>Lampsilis anodontoides</em></td>
<td>X X</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. <em>Lampsilis excavata</em></td>
<td>X</td>
<td></td>
<td></td>
<td>10/ X</td>
<td>10/ X</td>
<td>X X X</td>
<td></td>
</tr>
<tr>
<td>24. <em>Lampsilis radiata hydiana</em></td>
<td>X X</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. <em>Lampsilis straminea</em></td>
<td>X</td>
<td></td>
<td></td>
<td>11/ X</td>
<td>X X X</td>
<td>X X X</td>
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<tr>
<td>26. <em>Leptodea fragilis</em></td>
<td>X X</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. <em>Ligumia recta</em></td>
<td>X</td>
<td></td>
<td></td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. <em>Ligumia subrostrata</em></td>
<td>X ?</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. <em>Obliquaria reflexa</em></td>
<td>X X</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. <em>Obovaria jacksoniana</em></td>
<td>12/ X</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. <em>Obovaria unicolor</em></td>
<td>X X</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. <em>Proptera inflata</em></td>
<td>X</td>
<td></td>
<td></td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33. <em>Proptera purpurata</em></td>
<td>X X</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34. <em>Truncilla donaciformis</em></td>
<td>X X</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35. <em>Villosa lienosa</em></td>
<td>X X</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td>X</td>
<td>X X X</td>
<td></td>
</tr>
<tr>
<td>36. <em>Villosa vibex</em></td>
<td>X X</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>14</strong></td>
<td><strong>21</strong></td>
<td><strong>25</strong></td>
<td><strong>36</strong></td>
<td><strong>21</strong></td>
<td><strong>28</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>
TABLE 8 continued.

1 Distributional records from Strecker (1931)—Colorado, Trinity and Sabine River systems; Grantham (1969)—Pascagoula River system; Johnson (1970) and Burch (1975)—Alabama-Coosa River system; Johnson (1970)—Apalachicola Region; and Stern (unpub.).

2 Amblema perplicata of some.

3 Fusconaia of some.

4 Includes Fusconaia undata.

5 If Megalonaias boykiniana is a synonym.


7 See SYSTEMATICS section.

8 See SYSTEMATICS section.

9 Considered as a subspecies of parva by some.

10 See SYSTEMATICS section.

11 Lampsiis

12 Lampsiis claibornensis of some.

12 See SYSTEMATICS section.
For 7 of the 28 species represented in the East Gulf Coastal region, the western limit of their range in gulf drainages is the Amite River system (Table 9). A similar trend is evident in the gulf drainages to the west of the Mississippi River. Six species found in gulf drainages to the west of the Mississippi River are not encountered in the Lake M-P-B drainage system. Thus based upon the number of similar species and the origin and route of immigration of the Lake M-P-B fauna, as suggested by geological evidence (discussed below), the greatest affinity of this fauna appears to be with that of the East Gulf Coastal region (=Alabama-Coosa River system) rather than the West Gulf Coastal region as outlined by Johnson (1970). It is significant that the western limit of distribution, along the gulf coast, for 7 of these species is the Amite River system. The absence of all 7 species from the western tributaries of the Mississippi River in Louisiana would seem to preclude their introduction into the Lake M-P-B drainage system via this path. (Of these 7 species, Grantham (1969) found only 3 populations of *Lasmigona complanata* and *Obovaria unicolor* in the eastern tributaries of the Mississippi River that drain western Mississippi.)

Marine to brackish water conditions prevailed throughout much of the study area until the Recent epoch, as indicated by the extent of the area covered by the Pleistocene deposits (Map 40). If the introduction of a freshwater bivalve fauna is to have occurred during the Pleistocene, it entered from the north. There is evidence (Saucier, 1963) of stream convergence, during Recent times, between the Amite, Tickfaw and Tangipahoa River systems (Map 40). However,
TABLE 9. Louisiana Unionidae whose Gulf coastal distribution terminates at the Lake M-P-B drainage system.

<table>
<thead>
<tr>
<th>Species</th>
<th>Sabine River system</th>
<th>Bayou Teche system</th>
<th>Red-Atchafalaya River system</th>
<th>Lake M-P-B drainage system</th>
<th>Alabama-Coosa River system</th>
<th>Apalachicola region</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Elliptio crassidens</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>2. Lasmigona complanata</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Strophitus radiatus</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4. Ligumia recta</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Obovaria unicolor</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>6. Proptera inflata</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Villosa vibex</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

1. Pusconala askewi X
2. Pleurobema riddelli X X
3. Quadrula nodulata X X X
4. Lampsilis anodontoides fallaciosa X X
5. Proptera capax 2/ 3/
6. Proptera laevissima X X

1Additional distributional records from Stern (unpub.).
2Locality given in original description.
3See Branson (1966).
this channel, in the position of present Lake Maurepas, continued eastward through brackish marshes and swamps before entering Lake Pontchartrain. The likelihood that any of these streams ever became tributary to the Mississippi River system, in the Pontchartrain Basin, is small (Saucier, 1963). Outside of the basin area, the only identifiable Mississippi River tributaries to enter the Lake M-P-B drainage system were Bayou Manchac and New River (Map 39). The significance of these remnant streams has to do with peculiarities of the streams themselves, rather than their importance as Mississippi River tributaries, and is discussed below. Neither Bayou Manchac nor New River is believed to have contributed to the introduction of the present fauna because of their age. Both are believed to have formed only 2,500 years ago with the onset of the St. Bernard Delta stage (Saucier, 1963), (Map 40).

Two Mississippi River tributaries, Bayou Sara and Thompson Creek, presently drain that portion of southeastern Louisiana just to the west of the Amite River system (Map 39). Both have been tributaries for at least the last 30,000 years, one of the most active periods of meander belt and braided stream topography and alluvial deposition. If the Mississippi River alluvial valley was the route of migration, both streams should contain representatives of the Lake M-P-B fauna. Only two species of unionids have been collected, *Anodonta grandis* and *A. imbecilis*, both from a single site on Thompson Creek (Stern, unpub.).

Available information concerning the geological history of the East Gulf Coastal, Apalachicola and Southern Atlantic Slope regions
enabled Johnson (1970) to explain the origin and distribution of those faunas. Although the Mississippi River Alluvial Valley has been well studied, the geological history of the older Pleistocene and Tertiary surfaces is imperfectly known. The introduction of this fauna is therefore subject to more speculation. Several authors (Ortmann, 1913; van der Schalie, 1939, 1945, 1963) have demonstrated the value of mussel distribution in tracing stream confluence. Thus the analysis of present distributional patterns, faunal affinities and available geological information strongly suggests that the unionid fauna of the Lake M-P-B drainage system was introduced from the east, through former stream confluences, by one of two possible routes.

Brown (1967) proposed a Pliocene Tennessee River that flowed from its headwaters in the Appalachian Mountains southwestward through Mississippi to a point in southeastern Louisiana where it entered the Mississippi Embayment (Map 39). Such a river would explain the presence of coarse gravels under northeast-southwest trending ridges that represent a topographic extension of the Appalachian Mountains (Brown, 1967). This Pliocene Tennessee River is consistent with an earlier Eocene Appalachian River in the same area, as discussed by Grim (1936), and the presence of heavy minerals of Appalachian origin in the Citronelle Formation of southeastern Louisiana. These minerals differ from the glacially derived assemblage contained in the sediments of the modern Mississippi and the post-Citronelle coastwise terraces (Durham, et al., 1967). Changes subsequently shifted the course of this river to its present location. In conjunction with this Pliocene Tennessee River, Matteson (1948a) and others have shown that there was
stream confluence between the upper Tennessee River and the Alabama-Coosa River system in the late Tertiary period.

The proposed course of the Pliocene Tennessee River would permit confluence with the streams of the Lake M-P-B drainage system and access to this area by both an Interior Basin and East Gulf Coastal fauna (Map 39). Matteson (1948a) suggested that the origin of the genus *Elliptio* was somewhere in Georgia or eastern Alabama and that *E. crassidens* reached the Interior Basin from the Alabama-Coosa River system. *Elliptio crassidens* is widely distributed in the Lake M-P-B drainage system, but in the Mississippi River system it is not found south of the Tennessee River.

The actual existence of a Pliocene Tennessee River is still subject to some debate. The central Gulf Coastal Plain has been active geologically with coastal subsidence and the uplift and tilting of inland surfaces occurring simultaneously. In many places, the courses of the streams within the coastal plain are parallel to the principal fault and fracture zones, and the northeast-southwest set of faults has controlled the direction of flow in much of this region (Fisk, 1944). Bayou Manchac and New River, two former Mississippi River tributaries, illustrate the active processes in this area. Both encountered and managed to cut directly across an area of an appreciably higher terrace before reentering a lower floodplain level (Saucier, 1963). As noted by Johnson (1970), while major stream confluences can often be demonstrated, minor ones can only be inferred. Therefore, the proximity of the tributaries of the Pearl and Tombigbee rivers suggests the possibility of their former confluence (Map 39).
Pascagoula River system drains that area of the Gulf Coastal Plain between the Lake M-P-B drainage system and the Alabama-Coosa River system. The presence of a similar unionid fauna (Table 8) in this system lends further support to former stream confluence(s) in this area (Map 39). Because the Gulf Coastal Plain was inundated several times during the Pleistocene, only those rivers whose headwaters were above the level of maximum flooding were able to sustain a fauna. The Tchefuncte River was probably repeatedly inundated until after the formation of the youngest terraces, judging by its small unionid fauna in comparison to those of the other river systems in the Lake M-P-B drainage system (Table 10), or it has only recently begun its entrenchment northward.

The integrity of the faunal assemblages to the east and west of the Mississippi River have remained relatively intact, once they became established, for several reasons. It is partially due to the contrasting ecological environments to either side of the river. Douglas (1974) believes that the ecological contrast and the virtual absence of tributary waters restricts the westward advance of 25 species of freshwater fishes from southeastern Louisiana. Bartsch (1916) and Goodrich (1921), working with freshwater mollusks, also recognized that the river itself may act as a faunal barrier. And finally, major alterations by man during historic times (artificial levees, stream channelization) have prevented further immigration.
TABLE 10. Total number of unionid species in each river system of the Lake M-P-B drainage system. (See Maps in SYSTEMATICS section for distribution of each species).

<table>
<thead>
<tr>
<th>River System</th>
<th>Total Number of Unionid Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amite River system</td>
<td>31</td>
</tr>
<tr>
<td>Tickfaw River system</td>
<td>19</td>
</tr>
<tr>
<td>Tangipahoa River system</td>
<td>20</td>
</tr>
<tr>
<td>Tchefuncte River system</td>
<td>7</td>
</tr>
<tr>
<td>Pearl River system</td>
<td>28</td>
</tr>
</tbody>
</table>
KEY TO THE UNIONACEA OF LOUISIANA*

There are a number of publications that, because they are comprehensive in scope, can be of aid in making identifications and are worth mentioning. A key to all of the families of freshwater pelecypods in Louisiana is found in Pennak (1953). Valentine and Stansbery (1971) provide an excellent key to the genera of Unionacea in the United States, based on soft anatomy, while a key to the species of Unionacea in North America has been prepared by Burch (1973, 1975).

The following key includes all of the species and subspecies of unionid mussels occurring in Louisiana (see Tables 6 and 8). Omitted are those species for which there are no literature records or collections within the last 15 years and that are presumed to have been extirpated (Table 7). The key is artificial and based on shell characters only. It is most advantageous to use fresh material and even then it may be necessary to scrub the periostracum to reveal its color and expose the rays, if any. Because of the variability of some species, the key should be used in conjunction with the species descriptions and accompanying plates. Pertinent morphological features of the shell are illustrated in Figures 1, 2, and 3 and terminology is defined in the GLOSSARY.

*This represents a preliminary draft only.
1  Shell surface with pustules, knobs, or undulations.... 2
Shell surface smooth, without pustules or
undulations, only growth lines.......................13

2 (1) Shell surface with undulations only, lacking pustules
and knobs........................................... 3
Shell surface with or without undulations, having
pustules, knobs or irregular W-shaped sculpture..... 5

3 (2) Shell alate, compressed laterally
..................................................Lasmigona complanata (p. 85)
Shell not alate, not highly compressed laterally..... 4

4 (3) Undulations weak, only on posterior slope, never
on lateral surface (known only from 2 or 3
localities in the Bayou Teche system)
....................................................Margaritifera hembeli
Undulations strong, on most of shell except anterior
1/3 of shell....................................Amblema plicata (p. 22)

5 (2) Lateral teeth reduced, represented by thickening
on hinge line...................Arcidens confragosus (p. 82)
Lateral teeth distinct, well developed............. 6

6 (5) Shell quadrate, length and height nearly equal;
posterior margin perpendicular to dorsal and
ventral margins.....................................7
Shell rhomboidal, length clearly greater than height;
posterior margin not perpendicular to dorsal and
ventral margins.....................................11
7 (6) From 2 to 6 knobs extending over lateral portion of shell and/or on posterior ridge; pustules usually absent. ........................... 8
Knobs may be present; pustules always present, a few to many. ........................... 9

8 (7) Knobs on left valve opposite those on right valve

.................................Quadrula nodulata
Knobs on left valve not opposite (i.e. alternating with) those on right valve..Obliquaria reflexa (p. 131)

9 (7) Median sulcus absent; posterior ridge rounded;
periostracum reddish-brown to black

.................................Quadrula pustulosa (p. 51)
Median sulcus present (may be reduced); posterior ridge angled; periostracum greenish to black. ....... 10

10 (9) Median sulcus completely pustulate; pustules on remainder of shell uniform in size

.................................Quadrula quadrula apiculata (p. 59)
Median sulcus smooth or with few pustules near ventral margin; additional pustules non-uniform in size. ....... Quadrula q. quadrula (p. 55)

11 (6) Posterior ridge rounded, indistinct; undulations on all but anterior 1/2 of shell

.................................Megalonaias gigantea (p. 44)
Posterior ridge angled, distinct; lateral surface lacks undulations but may have pustules. ............ 12
12 (11) Umbonal cavity shallow; nacre typically purple to bronze. ................. *Plectomerus dombeyanu*s (p. 47)
Umbonal cavity deep; nacre white

................................. *Tritogonia verrucosa* (p. 63)

13 (1) Hinge with pseudocardinal and/or lateral teeth
absent or poorly developed................................. 14
Hinge with well developed pseudocardinal and lateral teeth................................. 18

14 (13) Pseudocardinal teeth present and either well
developed, or only represented by small tubercle;
lateral teeth absent................................. 15
Pseudocardinal and lateral teeth absent......................... 16

15 (14) Pseudocardinal teeth well developed; shell alate
posteriorly; rayless..... *Lasmigona complanata* (p. 85)
Pseudocardinal teeth represented by small
thickenings on hinge line; not alate; green rays on
most of shell................. *Strophitus radiatus* (p. 88)

16 (14) Shell nearly round in outline; compressed laterally

................................. *Anodonta suborbiculata*
Shell oval to elliptical; moderately to greatly
inflated................................. 17

17 (16) Beaks not elevated above hinge line

................................. *Anodonta imbibilis* (p. 78)
Beaks elevated above hinge line *Anodonta grandis* (p. 74)
18 (13) Interdentum narrow, rounded and offering no
    articulating surface to opposing valve, or absent
    entirely........................................19
Interdentum moderately to very wide, flat, short
    or long in length and offering obvious
    articulating surface to opposing valve..............39
19 (18) Shell alate, compressed, usually thin...............20
Shell not alate, moderately to greatly inflated,
    usually solid........................................22
20 (19) Wing extending well above umbos Proptera inflata (p.140)
Wing forming more or less straight line with umbos....21
21 (20) Periostracum yellow or greenish yellow; nacre white
    or pink..............................Leptodea fragilis (p.119)
Periostracum olive green to brown or black; nacre
    purple....................................Proptera laevissima
22 (19) Adults with brown to black periostracum; rays, if
    present, indistinct..................................23
Adults with periostracum yellow to yellowish-green,
    yellowish-brown; rays, if present, distinct........29
23 (22) Adult shell length not over 55 mm; beak sculpture
    consisting of distinct posteriorly rounded ridges
    which are open anteriorly..........................24
Adult shell length greater than 55 mm; beak
    sculpture not visible..............................25
24 (23) Shell evenly rounded anteriorly and posteriorly;
    length to 30 mm; periostracum silky in appearance
    ...........................................Carunculina parva (p. 92)

Shell rounded anteriorly, pointed or truncate
    posteriorly; length to 55 mm; periostracum dull,
    not shiny..................Carunculina texasensis (p. 96)

25 (23) Shell elongate, length/height ratio 2.0 or
    greater...............................Ligumia recta (p.123)
Shell shorter, length/height ratio less than 2.0......26

26 (25) Pseudocardinal teeth divided into series of parallel,
    vertical, serrate lamellae...Gebula rotundata (p.100)
Pseudocardinal teeth may be rough, but are not
    divided into lamellae...............................27

27 (26) Shell large (100 mm or more); nacre deep purple;
    pseudocardinal teeth thick, strong
    ...........................................Proptera purpurata (p.143)
Shell smaller (less than 100 mm); nacre white, if
    salmon or purple, pseudocardinal teeth
    compressed, triangular.............................28

28 (27) Umbonal cavity very shallow; shell rostrate
    posteriorly.........................Unigerus declivis (p. 66)
Umbonal cavity moderately deep; shell broadly rounded
    or diagonally truncate behind..Villosa lienosa (p.149)

29 (22) Shell elongate, length/height ratio 2.0 or greater....30
Shell shorter, length/height ratio less than 2.0......32
Periostracum lacking green rays

.........................Lampsilis a. anodontoides (p.103)

Periostracum with green rays

..........................31

Shell decidedly rostrate posteriorly; dark green rays of varying widths cover nearly entire shell

..........................Ligumia subrostrata (p.127)

Shell pointed or obliquely truncate posteriorly; light green rays cover posterior 1/2 of shell

..........................Lampsilis anodontoides fallaciosa

Posterior ridge angled

..........................33

Posterior ridge rounded

..........................36

Shell greatly inflated, large (100 mm or more in length); umbonal cavity deep

..........................34

Shell moderately inflated to compressed, shorter (less than 75 mm in length); umbonal cavity shallow.

..........................35

Fragile, thin shell; periostracum rayless; hinge line a gentle S-curve

.........................Proptera capax

Solid, moderately thick shell; periostracum with thin green rays; hinge line more abruptly curved

..........................Lampsilis excavata (p.107)

Posterior ridge moderately angled; green rays broad, not continuous, but broken into W-shaped lines

..........................Truncilla donaciformis (p.146)

Posterior ridge sharply angled; green rays thin, continuous

..........................Truncilla truncata
36 (32) Periostracum with distinct green rays over entire surface.................................37
Periostracum without rays, or if present only a few on posterior slope..........................38
37 (36) Shell heavy, solid; beaks full, elevated well above hinge line; umbonal cavity deep; nacre white

....................Lampsilis radiata hydiana (p.111)
Shell fragile, light; beaks low, only slightly elevated; umbonal cavity shallow; nacre bluish-white or pink..................Villosa vibex (p.153)
38 (36) Umbonal cavity deep; periostracum rough, color more or less uniform; anterior muscle scars well excavated....................Lampsilis straminea (p.115)
Umbonal cavity shallow; periostracum smooth, may be concentrically banded; anterior muscle scars only slightly impressed..Uniomerus tetralasuma (p. 70)
39 (18) Nacre white to deep salmon or purple; umbonal cavity shallow to absent.....................40
Nacre usually white, occasionally pink or purple;

umbonal cavity deep..............................42
40 (39) Nacre white; shell oval.....Obovaria jacksoniana (p.134)
Nacre deep salmon or purple, rarely white; shell rhomboidal........................................41
41 (40) Shell rhomboid, elongate (length/height ratio 2.0 or more); periostracum dark green to black; nacre purple.  \textit{Elliptio dilatatus}

Shell subrhomboid, shorter (length/height ratio less than 2.0); periostracum reddish-brown to black; nacre salmon.  \textit{Elliptio crassidens} (p. 30)

42 (39) Shell triangular to oval; umbos located well anteriorly.  \textit{Fusconaia flava ecoform undata} (p. 36)

Shell rhomboid, round or quadrate; umbos more centrally located.  \textit{Fusconaia ebena} (p. 33)

43 (42) Posterior ridge angled; median depression anterior to ridge.  \textit{Fusconaia flava ecoform undata} (p. 36)

Posterior ridge rounded; lateral surface of shell lacking depression.  \textit{Pleurobema pyramidatum}

44 (43) Shell oval; anterior margin rounded; umbonal cavity very deep.  \textit{Fusconaia ebena} (p. 33)

Shell oblique (slanting); anterior margin straight; umbonal cavity moderately deep.  \textit{Pleurobema pyramidatum}

45 (42) Shell round; beaks centrally located  \textit{Obovaria unicolor} (p. 137)

Shell quadrate; beaks more anteriorly located.  \textit{Obovaria unicolor} (p. 137)

46 (45) Shell compressed, subsolid; beaks only slightly elevated.  \textit{Obovaria unicolor} (p. 137)

Shell inflated, solid; beaks high and full.  \textit{Obovaria unicolor} (p. 137)
47 (46) Posterior end decidedly truncate; lateral tooth of right valve straight

.................Fusconaia flava ecoform flava (p. 36)

Posterior end somewhat rounded; lateral tooth of right valve curved........Elliptio beadleiana (p. 26)

48 (46) Shell short, subquadrate; nacre white

........................................Pleurobema riddelli s.l.

Shell subrhomboid; nacre white to pink

........................................Fusconaia askewi s.l.
GLOSSARY

AD DUCTOR MUSCLE SC AR.—Largest of the nacreous impressions on interior of shell, forming the attachment of the muscles that close the valves (Fig. 1-B).

AL ATE.—Having a wing or winglike projection of the two valves that extends dorsally above the hinge line; usually found as an extension of the posterior slope, but can occur anteriorly.

ANGULAR.—Having an angle, in contrast to being rounded.

BEAK.—That raised portion along the dorsal margin of each valve; also called the umbo; may be elevated (raised) or depressed (not extending above the hinge line) (Fig. 1).

BEAK CAVITY.—That cavity formed from the dorsal extension of the beak; may be deep or may be only represented by a shallow depression (Fig. 1-B).

BIANGULATE.—Having two angles or corners.

CARDINAL TEETH.—Elevations on the hinge plate of one valve that interlock with corresponding elevations/depressions on the opposing valve; typically with lateral teeth both anteriorly and posteriorly; not found in unionids, which have pseudocardinal teeth; cardinal teeth illustrated for Corbicula and Rangia (see Plate 38).

CONCENTRIC.—Having the same center and expanding outward, as in the growth lines of a mussel shell.

COMPRESSED.—Flattened laterally, as opposed to inflated or obese.

DENTATE.—Having hinge teeth present.
DOUBLE-LOPED.—In the form of two adjacent semicircles, end to end, with the openings oriented in the same direction (Fig. 3-B; Plate 40-B).

EDENTULOUS.—Lacking both lateral and pseudocardinal teeth on the hinge line.

ELLiptical.—In the form of an ellipse, as in the outline of some unionids (Fig. 2-D).

ELongate.—Decidedly longer than high; lengthened.

EPIDERMIS.—The proteinaceous outer layer of the shell (*periostracum).

HINGE LIGAMENT.—The elongate, elastic structure that unites the two shells above the hinge line (Fig. 1).

HINGE LINE.—The dorsal portion of the shell bearing the lateral and pseudocardinal teeth.

INFLATED.—Swollen; expanded; obese; can refer to the condition of the beaks or to the shell width.

INTERDENTUM.—That surface on the hinge plate between the lateral and pseudocardinal teeth (Fig. 1-B).

KNOB.—A surface protuberance which is large in size and few in number, in contrast to a pustule (Fig. 1-A).

LAMELLA.—A thin blade, as in the shape of most lateral teeth and some pseudocardinal teeth.

LATERAL TEETH.—The elongate lamellae on the posterior half of the hinge plate (Fig. 1-B).

MARSUPIAL SWELLING.—The enlarged or inflated ventroposterior portion of the shell of the female unionid; formed during shell growth by the deposition of new shell material around the swollen gravid gills.
MEDIAN SULCUS.—A dorsoventral running depression of the shell from the 
region of the beaks toward or to the ventral margin (Fig. 1-A; 
Plate 39-D).

NACRE.—The inner layer of a unionid shell composed of calcium carbonate.

NAIAD.—The common name used for freshwater mussels of the Family 
Unionidae.

OBESE.—Swollen; inflated.

OBLIQUE.—Slanting, as in the posterior margin of some unionid shells.

OVAL.—Oblong, with one end narrower than the other, as in the outline 
of some unionids (Fig. 2-E, F).

PERIOSTRACUM.—The thin outer, non-living proteinaceous layer covering 
the unionid shell.

PLICATIONS.—More or less parallel ridges or waves on the shell of a 
unionid; undulations; folds.

POSTERIOR RIDGE.—A ridge on the shell of many unionids that extends 
from the umbo posteroventrally toward or to the shell margin 
(Fig. 1-A).

POSTERIOR SLOPE.—That area of a mussel shell between the posterior 
ridge and the dorsoposterior margin (Fig. 1-A).

PSEUDOCARDINAL TEETH.—The lamellae or teeth on the anterior half of 
the hinge plate; usually triangular and compact, although not 
always so (Fig. 1-B).

PUSTULE.—Small, usually numerous prominences on the surface of a 
unionid shell (Fig. 1-A).

QUADRATE.—Square or approximately so, as in the outline of some 
unionids (Fig. 2-C).
RAY.—A linear mark typical on the periostracum of some unionids; may be continuous or interrupted.

RHOMBOIDAL.—Having the shape of a rhomboid, as in the outline of some unionid shells (Fig. 2-A).

ROSTRATE.—The narrow, curved posterior portion of some unionid shells that results in an extended, pointed appearance posteriorly (Fig. 3-C).

ROUNDED.—Having a more or less evenly curved contour, as in the outline of some unionids (Fig. 2-G); or in contrast to being angular.

RUDIMENTARY.—Small, imperfectly developed, as in the hinge teeth of some unionids.

SCULPTURE.—The natural markings found on the surface of many freshwater mussels; includes knobs, pustules, undulations.

SEXUALLY DIMORPHIC.—Morphological differences between the males and females of the same species; in unionid mussels this is usually indicated by marsupial swelling found in the female (see MARSUPIAL SWELLING).

SINGLE-LOOPED.—In the form of one loop or semicircle, as in the sculpture of the umbo in some unionids (Fig. 3-A).

SULCUS.—A furrow, channel or depression (Fig. 1-A; Plate 39-D).

TEETH.—The elevations and/or depressions on the hinge line of one valve that interlock with the corresponding structures on the opposing valve; in the Unionacea the anterior articulating surfaces are the pseudocardinal teeth and the posterior ones the lateral teeth (Fig. 1-B).
TRUNCATE.—Having the end cut off more or less squarely, as in the posterior margin of many unionids.

UMBO.—The oldest portion of the bivalve shell and around which the latter shell is laid down in a concentric manner; the raised portion on the dorsal margin of the shell; also called beak (Fig. 1).

UMBONAL CAVITY.—See BEAK CAVITY.

UNDULATION.—A ridge or wave on the shell of some unionids; plications.

UNIONACEA.—The superfamily of bivalve mollusks to which most freshwater mussels belong.

VALVE.—Either the right or left half of a bivalve shell.

WING.—A thin, flat projection extending dorsally from the posterior slope of some freshwater mussels.
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drainage of Alabama, Georgia and Florida (Mollusca:Bivalvia).

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VITA

Edward Marc Stern was born September 19, 1946 in El Paso, Texas. He is a graduate of the University of Texas at El Paso from which he received his B.A. degree in 1969 and his M.S. degree in 1971. He is currently working toward his Ph.D. in the Department of Zoology and Physiology at Louisiana State University in Baton Rouge.
EXAMINATION AND THESIS REPORT

Candidate: Edward Marc Stern

Major Field: Zoology

Title of Thesis: The Freshwater Mussels (Unionidae) of the Lake Maurepas - Pontchartrain - Borgne Drainage System, Louisiana and Mississippi

Approved:

[Signatures]

Major Professor and Chairman
Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:
April 13, 1976